MCA GROUP | FIELD CONTROL REFERENCE

Material Drying Evidence Manual

23 material profiles, psychrometric evidence, and staged controller policy

Prepared 22 July 2026 | MCA-PROV-2026-07-22 | MCA-STAGE-PROV-2026-07-22

IMPORTANT: This is a provisional operational policy and evidence review, not a certified damage schedule, manufacturer instruction, engineering design, or legal opinion.

Contents

The following chapters each contain a dedicated research commentary packet and its references.

Purpose and evidence posture

This manual records the material profiles currently selectable in MCA Drying Monitor and the evidence used to review their operational policy. It has two separate jobs: describe what the software will do, and identify what must still be checked by the technician, manufacturer, project specification, conservator, or restoration specialist.

The app's `pp/h` and `pp/24h` values are percentage-point limits for room-air relative-humidity change. They are not material moisture-content rates, not grain-depression rates, and not proof that a material is dry. The controller uses them as conservative, versioned operational caps while it accumulates fresh sensor history. The conclusion of this review is therefore to retain the values as provisional caps, make the distinction visible in the app and drying log, and avoid inventing a universal material rate that the sources do not publish.

The exact selected subtype, linked comparative readings, condition inspection, equipment state, room-air temperature/RH, dew point, grains per pound, and staged decision are recorded in the job's drying log. A blocked profile remains blocked for unattended automation even if a review-only rate is present.

Review method and limitations

The evidence packet contains prior material research chapters labelled by source family, a source URL reachability audit, three independent Grok audit passes over the policy/code snapshot, and direct verification of primary or official sources where available. The prior Claude/Gemini-labelled chapters are retained as research packets; live Claude calls were not exposed in this session, and the Gemini connector was unavailable because the configured preview model/CLI could not run. No unavailable agent output is represented as a completed live review.

The research chapters are commentary and an audit trail, not a substitute for the cited standards. Several sources are edition- or product-specific. The automated link audit found 119 URLs: 59 returned 200, 36 returned 206, 12 returned 403, 1 returned 202, 4 returned 404, 6 timed out, and 1 returned 400. Reachability does not prove authority or content. The manual records those limitations rather than silently treating a dead or paywalled link as verified.

The app must not use ambient RH alone to approve reinstatement of flooring, confirm a concrete slab, certify fire-rated board, or clear a contaminated, heritage, or high-value item. The operator must use the applicable direct measurement, inspection, product instruction, standard, or specialist plan.

Exact operational register

Policy versions: MCA-PROV-2026-07-22 and MCA-STAGE-PROV-2026-07-22 **Prepared:** 22 July 2026
Status: Provisional operational reference. The controller implementation is deployed, but these limits are not certified damage thresholds and still require job, manufacturer, project, or specialist approval.

Decision statement

The app can select the following plasterboard types separately:

1. Plasterboard - Standard
2. Plasterboard - Moisture Resistant
3. Plasterboard - Fire Rated

The generic Plasterboard profile is retained only to identify an incomplete selection. It blocks unattended automation until a specific subtype is chosen.

No reviewed manufacturer or restoration source publishes universal maximum ambient relative-humidity reduction rates in percentage points per hour or per 24 hours for these materials. The numeric rates below are therefore exact **MCA provisional controller settings**, not proven material damage thresholds. Manufacturer, project, specialist, conservation, contamination, salvage, and substrate requirements override them.

Coverage

This register covers all 23 active material profiles listed by the production app on 22 July 2026: 15 controlled structural profiles and 8 profiles that require specialist control or pack-out. The automated coverage test must fail if an app profile is added or renamed without a matching register entry.

What the rate means

- `pp/h` means percentage points of **room-air relative humidity per hour**.
- `pp/24h` means percentage points of room-air relative humidity over a rolling 24-hour period.
- These values do not measure material moisture loss. A fall from 80% RH to 72% RH is an 8 percentage-point fall, regardless of the starting percentage.
- The controller warns at 75% of the current staged cap, commands equipment OFF at 90%, and does not restart until rate-budget use falls below 60%.
- The hourly allowance is prorated to the available history window. At least five valid environmental readings spanning 30 minutes are required.
- Material progress is determined from linked comparative meter readings on the same scale and method as an unaffected dry-standard reading.

Staged control logic

Stage	Exact rate factor	Entry and exit rule
Assessment	50% of base cap	No linked comparative material reading exists. This stage does not advance from time alone.
Stabilising	50% of base cap	Remains active until there are at least two linked readings at least 6 hours apart, the reading is falling, the latest reading is no more than 24 hours old, and the technician records no distress observed.
Bulk	100% of base cap	All stabilisation gates pass and more than 20% of the original excess reading remains above the entered unaffected dry standard.
Equalising	50% of base cap	More than 0% but no more than 20% of the original excess reading remains.
Ready to verify	50% of base cap	Latest linked reading is at or below the entered unaffected dry standard. This is not automatic completion.
Blocked	0% unattended control	Latest inspection records distress, or the material profile requires pack-out or specialist control.

For mixed rooms, every selected material is evaluated independently. The lowest current hourly cap and the lowest current 24-hour cap govern the room. A material in stabilisation can therefore slow another material that is already in bulk drying. Any blocked selected material blocks unattended automation for the room.

Exact controlled-material settings

Each stage cell shows `hourly cap / 24-hour cap`, followed by the controller's 90% OFF threshold in brackets.

Material selected in app	Temperature and RH control	Assessment / stabilising	Bulk drying	Equalising / verify
Solid Hardwood	27 C max; 35% floor; 40% target; 45% restart	1.0 / 5.0 (OFF 0.9 / 4.5)	2.0 / 10.0 (OFF 1.8 / 9.0)	1.0 / 5.0 (OFF 0.9 / 4.5)
Engineered Timber	30 C max; 35% floor; 40% target; 45% restart	1.0 / 5.0 (OFF 0.9 / 4.5)	2.0 / 10.0 (OFF 1.8 / 9.0)	1.0 / 5.0 (OFF 0.9 / 4.5)
Carpet & Underlay	32 C max; 30% floor; 35% target; 45% restart	2.5 / 10.0 (OFF 2.25 / 9.0)	5.0 / 20.0 (OFF 4.5 / 18.0)	2.5 / 10.0 (OFF 2.25 / 9.0)
Carpet - Synthetic	38 C max; 30% floor; 35% target; 45% restart	4.0 / 15.0 (OFF 3.6 / 13.5)	8.0 / 30.0 (OFF 7.2 / 27.0)	4.0 / 15.0 (OFF 3.6 / 13.5)
Vinyl / LVT	35 C max; 35% floor; 40% target; 48% restart	2.5 / 10.0 (OFF 2.25 / 9.0)	5.0 / 20.0 (OFF 4.5 / 18.0)	2.5 / 10.0 (OFF 2.25 / 9.0)
Concrete Slab	45 C max; 30% floor; 35% target; 45% restart	2.5 / 10.0 (OFF 2.25 / 9.0)	5.0 / 20.0 (OFF 4.5 / 18.0)	2.5 / 10.0 (OFF 2.25 / 9.0)
Concrete - Bare	45 C max; 25% floor; 35% target; 45% restart	4.0 / 15.0 (OFF 3.6 / 13.5)	8.0 / 30.0 (OFF 7.2 / 27.0)	4.0 / 15.0 (OFF 3.6 / 13.5)
Tiles / Grout	40 C max; 30% floor; 35% target; 45% restart	4.0 / 15.0 (OFF 3.6 / 13.5)	8.0 / 30.0 (OFF 7.2 / 27.0)	4.0 / 15.0 (OFF 3.6 / 13.5)
Plasterboard - Standard	38 C max; 25% floor; 28% target; 35% restart	4.0 / 15.0 (OFF 3.6 / 13.5)	8.0 / 30.0 (OFF 7.2 / 27.0)	4.0 / 15.0 (OFF 3.6 / 13.5)
Plasterboard - Moisture Resistant	38 C max; 25% floor; 28% target; 35% restart	5.0 / 17.5 (OFF 4.5 / 15.75)	10.0 / 35.0 (OFF 9.0 / 31.5)	5.0 / 17.5 (OFF 4.5 / 15.75)
Plasterboard - Fire Rated	35 C max; 25% floor; 28% target; 35% restart	3.0 / 12.5 (OFF 2.7 / 11.25)	6.0 / 25.0 (OFF 5.4 / 22.5)	3.0 / 12.5 (OFF 2.7 / 11.25)

Material selected in app	Temperature and RH control	Assessment / stabilising	Bulk drying	Equalising / verify
Timber Frame	32 C max; 30% floor; 35% target; 45% restart	2.5 / 10.0 (OFF 2.25 / 9.0)	5.0 / 20.0 (OFF 4.5 / 18.0)	2.5 / 10.0 (OFF 2.25 / 9.0)
Brick - Modern Fired	40 C max; 35% floor; 40% target; 48% restart	2.5 / 9.0 (OFF 2.25 / 8.1)	5.0 / 18.0 (OFF 4.5 / 16.2)	2.5 / 9.0 (OFF 2.25 / 8.1)
Render - Cement	35 C max; 40% floor; 43% target; 50% restart	2.5 / 9.0 (OFF 2.25 / 8.1)	5.0 / 18.0 (OFF 4.5 / 16.2)	2.5 / 9.0 (OFF 2.25 / 8.1)
Plaster - Decorative	30 C max; 40% floor; 43% target; 50% restart	1.0 / 4.0 (OFF 0.9 / 3.6)	2.0 / 8.0 (OFF 1.8 / 7.2)	1.0 / 4.0 (OFF 0.9 / 3.6)

Profiles that block unattended structural-room control

Material selected in app	App disposition	Numeric review parameter	Required action
Plasterboard	Specialist required	None	Select Standard, Moisture Resistant, or Fire Rated and assess salvageability.
Brick / Masonry	Specialist required	None	Select modern fired brick or obtain a masonry/heritage assessment.
Plaster / Render	Specialist required	None	Identify cement render, decorative plaster, or lime/heritage construction.
Brick - Heritage Soft	Specialist required	1.5 pp/h and 5 pp/24h for review only	Obtain an approved heritage drying plan. App remains blocked.

Material selected in app	App disposition	Numeric review parameter	Required action
Plaster - Lime / Heritage	Specialist required	1.0 pp/h and 4 pp/24h for review only	Obtain an approved conservation drying plan. App remains blocked.
Upholstery / Fabric	Pack-out required	5 pp/24h review parameter only	Pack out or isolate; fabric, foam and leather cannot share one structural-room rate.
Paper / Documents	Pack-out required	5 pp/24h review parameter only	Air-dry a manageable quantity correctly, freeze/freeze-dry as appropriate, or use a preservation specialist.
Artwork / Canvas	Specialist required	3 pp/24h review parameter only	Isolate and obtain conservator direction. Do not direct room-drying airflow at artwork.

Controller conclusion

No reviewed source establishes a universal maximum ambient RH percentage-point fall for each material. The parameters remain in the app because they are explicit MCA provisional control settings with staged factors, rate guards, response buffers, and hard blockers. They must not be described as scientifically proven drying speeds.

The fastest defensible mixed-material strategy is to select the exact subtype, remove or isolate incompatible contents, record direct comparative readings, operate at the slowest current staged cap, and let the controller restore the base cap only after the evidence gates pass. This is the rate adjustment made at the conclusion of the review: the app now labels the limits as provisional ambient-RH caps, logs dew point and grains-per-pound diagnostics, and keeps the equipment off when a rate budget, temperature, stale sensor, material stage, or specialist blocker is unsafe.

Solid Hardwood

Research packet: claude-c1-wood.md | 5,066 words | 9 URL references | The packet is commentary for review, not a certified limit.

Scope: this chapter separates source-supported observations, operational assumptions, unresolved uncertainty, and field verification requirements for this material.

1. Scope and material identification

This chapter covers solid-sawn hardwood strip and plank flooring — timber milled from a single hardwood species, typically 19 mm tongue-and-groove profile, fixed by nailing, stapling, or (less commonly) direct-stick adhesive to a timber or plywood subfloor or battens, and factory- or site-finished with a polyurethane, oil, or hardwax-oil coating. It explicitly excludes engineered/multi-ply hardwood flooring (thin hardwood veneer bonded over a plywood or HDF core), laminate, bamboo, cork, and parquet blocks bedded directly in adhesive on a concrete slab. These materials fail differently under water exposure — most importantly, engineered flooring can delaminate at the core-to-veneer glue line, a failure mode solid timber does not have — and should sit in a separate MCA material profile [MCA derivation — no single published source treats "hardwood flooring" as a monolithic category; engineered-vs-solid differences are discussed in Section 3].

In Australia, solid hardwood flooring intended for structural drying work is manufactured to a moisture-content range that trade literature attributes to Standards Australia AS 2796 (the standard covering hardwood sawn and milled flooring products), commonly cited as 9–14% moisture content (MC) at manufacture, with major Australian mills typically shipping product averaging 10–11% MC [Published — cited via ATFA Floor Choices information sheet, itself paraphrasing AS 2796; MCA has not sighted the licensed AS 2796 text directly — see Section 15]. This manufacturing MC band is the reference point against which "dry" is later judged, because it approximates the moisture content the timber was designed to sit at in Australian ambient conditions before it ever got wet.

Species matters a great deal for this chapter's purpose. "Solid Hardwood" in MCA's controller is currently one profile regardless of whether the boards are spotted gum, blackbutt, oak, or an imported species — a simplification flagged repeatedly through this chapter because the evidence base (Section 9) shows species-specific behaviour differs by an order of magnitude.

2. Material construction and moisture behaviour

Wood is hygroscopic: it exchanges moisture with the surrounding air until it reaches equilibrium moisture content (EMC), the point at which the wood's internal vapour pressure matches the ambient air's [Published — this equilibrium concept originates with USDA Forest Products Laboratory research, e.g. W.T. Simpson, "Equilibrium Moisture Content Prediction for Wood," *Forest Products Journal*, Vol. 21, No. 5, May 1971]. ATFA's own published information sheet gives concrete EMC data points for

Australian conditions: at 25°C and 60% RH, EMC is approximately 11%; at 25°C and 80% RH, EMC rises to approximately 16% [Published — ATFA Floor Choices, "Acclimatisation of Timber Flooring"]. This directly explains why the AS 2796 manufacturing band (9–14%, average 10–11%) targets moderate-humidity Australian conditions, and why flooring installed in high-humidity regions (the same ATFA sheet specifically calls out North Queensland) is deliberately acclimatised toward the upper end of that range.

Wood shrinks and swells anisotropically — more across the grain (tangentially) than along it — so moisture change shows up as width and thickness movement, not length movement. Critically for drying, movement responds to the moisture gradient through the board thickness, not just the average moisture content. The Maple Flooring Manufacturers Association (MFMA) describes cupping as the result of higher moisture content on the underside of a board than the top (commonly from ambient humidity or standing moisture beneath the floor), and crowning as the inverse — higher MC on the top surface than the bottom, often from surface wetting, humidity exposure, or, importantly for restoration, from aggressive top-down drying air applied to an already-cupped floor [Published — MFMA, "Cupping, Crowning, Compression Ridging & Compression Set"]. MFMA's central caution is to always allow the flooring to fully equalise before any remedial sanding, because sanding a cupped floor flat before its internal gradient has resolved can produce a crowned floor once the remaining moisture equalises. Secondary trade commentary (Wood Floor Business / AmbientBP; Tier 3, used only as illustrative context, not as an MCA numeric input) suggests a top-to-bottom MC gradient of roughly one percentage point or more indicates the board is not yet fully equalised — this is a useful qualitative signal, not a value MCA should encode as a hard threshold given its weak sourcing.

3. Water exposure, contamination, and salvageability

Restoration industry literature, describing the widely-referenced IICRC S500 framework, categorises water by contamination level: Category 1 (clean), Category 2 ("grey water," capable of causing illness), and Category 3 ("black water," grossly contaminated — sewage, floodwater, or water that has contacted sewage) [Published concept, but S500 itself is proprietary and paywalled — see Section 15 flag; the description here is drawn from multiple independent secondary restoration-industry summaries and should be treated as generally reliable in outline but not cited as a verified clause number]. Consistently across those secondary sources, Category 1 water-damaged solid hardwood is routinely dried and salvaged in place; Category 2 is manageable depending on dwell time and material condition; Category 3 saturation of porous materials — including wood flooring — is described as requiring removal rather than in-place drying, because drying cannot remove embedded pathogens from the wood's cellular structure. MCA's automation must never be used as the sole basis for a Category 3 dry-in-place decision; that decision sits outside the drying-rate model entirely and belongs to inspection and remediation planning.

Solid timber's failure mode differs materially from engineered flooring. Secondary restoration-trade commentary frames it as solid wood "having a memory" — it can cup, crown, buckle, or crack but generally remains a single continuous piece of material that can often be re-dried, and in many cases re-sanded, once distress has resolved — versus engineered flooring "having a breaking point," where core saturation causes ply delamination that is not reversible by drying [Tier 3 — 24/7 Restoration Specialists, "Engineered vs. Solid Hardwood: Water Survival Rates Explained"]. This is a helpful frame but not a numeric input; the practical implication for MCA is that solid hardwood tolerates a longer assessment window before a replace-vs-restore decision must be made, compared with engineered flooring, but distress signs (Section 11) still override that tolerance once observed. Salvageability judgement should also weigh: fastening method (nail-down over a ventilated subfloor generally dries better than glue-down direct to slab), finish type and condition, evidence of buckling or fastener lift, subfloor structural condition, and the contamination category above.

4. Drying objectives and completion criteria

The drying objective for solid hardwood is to return the affected material's moisture content to within an acceptable margin of a "dry standard" — a comparative reading taken on unaffected material of the same species, finish, and orientation in the same structure, using the same meter and settings — without introducing new distress (cupping, crowning, checking, finish failure) in the process, and while the room's ambient conditions and inspection status confirm the material has genuinely stabilised rather than merely reading dry at a single moment.

Secondary restoration-industry sources describing the "dry standard" concept disagree on the exact acceptable margin: some describe structural drying continuing until affected-material readings are within roughly 2–4 percentage points of the dry standard, others cite approximately 3 percentage points [Tier 3, both figures — Legend Brands, "How to Set a Dry Standard for Water Damage Restoration"; other secondary restoration sites]. Because the only rigorous source of this figure would be the paywalled ANSI/IICRC S500 text itself, and the secondary sources disagree, MCA should not treat either number as verified; the concept (compare against an unaffected reference of the same material) is sound and already built into MCA's own stage-promotion logic, but the specific percentage-point completion margin is presently unverified and should not be quoted to a client or insurer as an S500 figure without MCA holding and checking the licensed standard. Completion should always be gated on (a) a documented dry-standard comparison, (b) environmental stability, and (c) a clean distress inspection — not on RH-rate metrics alone, since RH-rate is a controller input, not a drying-completion measurement.

5. Temperature limitations

MCA's current provisional ceiling is 27°C. No source located in this research publishes a hardwood-specific maximum ambient temperature for in-place restoration drying. The figure sits comfortably within the temperature band ATFA references for its EMC discussion (25°C) and within the 60–80°F (≈15.5–27°C) range Wagner Meters cites as the typical service condition assumed by wood flooring manufacturers when they target 6–9% factory MC [Published — Wagner Meters, "Wood Floor Cupping & Other Common Problems: Spotting the Trouble"]. It is worth noting that this manufacturer-cited MC band and RH range describe North American practice; Australian AS 2796 targets a higher 9–14% band, consistent with Australia's generally higher ambient humidity — a further reminder that numeric guidance drawn from US manufacturer literature is directional, not directly transferable.

Industrial kiln-drying literature (Section 9) uses much higher temperatures than restoration ever would (kiln schedules for green hardwood commonly run well above 40°C, deliberately paired with humidity control to manage the drying gradient) — this is not a valid analogy for setting an ambient restoration ceiling, because kiln drying operates on green (high-MC) lumber with no finish and no in-place structural context. [MCA derivation]: 27°C functions as a conservative "stay within normal indoor comfort/service conditions" ceiling rather than a value derived from any hardwood damage threshold — it avoids driving the room into a temperature regime that would meaningfully change the wood's target EMC or accelerate surface-only evaporation, while leaving normal dehumidifier/heater staging headroom. Confidence: medium — reasonable and conservative, but with no direct hardwood-specific published support.

6. Relative-humidity limitations

The current RH band — 35% emergency floor, 40% control target (cycle off at/below), 45% restart (cycle on above) — sits at or slightly below the RH range (30–50%) that Wagner Meters associates with typical in-service conditions for factory-dried flooring [Published, Tier 2]. Cross-referencing the ATFA EMC data point (25°C/60% RH → ~11% EMC), a room held near 40% RH at similar temperature would be expected to pull EMC into the high single digits — consistent with actively driving moisture out of a wet floor, without pushing conditions into the very low RH ranges (sub-20%) that more aggressive desiccant-only strategies can produce and that meaningfully raise shrinkage, gapping, and checking risk as EMC is driven well below the AS 2796 manufacturing band.

No source located gives a validated minimum "safe" ambient RH specifically for solid hardwood restoration. The 35/40/45% band is an [MCA derivation]: a conservative operating envelope informed directionally by the EMC relationship and by general industry practice of avoiding RH extremes, not a published hardwood damage threshold. It should not be sustained indefinitely once bulk moisture is removed — Section 9's equalising-stage rationale exists specifically to slow the rate of further RH depression once free water is gone, because the ongoing hazard shifts from "not drying fast enough" to "over-drying the wood below its comfortable service EMC."

7. GPP, dew point, vapour pressure, and condensation considerations

Grains-per-pound (GPP) is the standard restoration-industry metric for absolute humidity, valued because — unlike RH — it does not change with temperature and is therefore considered the more reliable trend indicator for confirming that moisture is actually leaving a room rather than merely being diluted by heating [Tier 3, general restoration psychrometrics literature — this is standard building-science practice, not hardwood-specific]. A declining GPP trend day-over-day is a useful secondary confirmation signal alongside RH-rate monitoring.

Dew point matters for a distinct hazard: condensation on cold surfaces. For nail-down solid hardwood over a subfloor with an underfloor void, suspended timber subfloor, or a cool slab, if the room air's dew point rises to or above the coldest accessible subfloor surface temperature, condensation can form beneath the floor — reintroducing moisture exactly where it is hardest to detect and monitor. This risk is generic building-science, not hardwood-specific, but is operationally relevant because dehumidifier exhaust and equipment placement can locally raise dew point near cold surfaces even while overall room RH is falling. No source gives a hardwood-specific GPP or dew-point numeric cap; MCA should track GPP trend and subfloor-surface temperature as monitoring inputs rather than as additional hard control thresholds, since no evidence base yet supports assigning specific pass/fail numbers to them for this material.

8. Airflow and equipment selection

General restoration airflow practice favours air movement directed across the floor surface rather than concentrated on one spot, to avoid localised rapid surface drying that can initiate the top/bottom moisture-gradient imbalance MFMA identifies as the cupping/crowning mechanism (Section 2). LGR (low-grain-refrigerant) dehumidifiers are generally preferable to desiccant dehumidifiers for moderate-severity hardwood jobs because desiccant units can drive RH into very low ranges; combined with the EMC relationship in Section 6, an aggressively low-RH desiccant campaign risks pulling EMC well below the AS 2796 manufacturing band, elevating shrinkage/gapping/checking risk. This is a plausible, physics-consistent inference from the EMC data rather than a directly published hardwood-specific equipment guideline [MCA derivation from Published EMC data].

Where a nail-down floor sits over an accessible suspended subfloor void, cavity-drying techniques described in general restoration literature for wall and floor cavities (forced dry air into the void via injection ports, combined with surface air movers above) are a reasonable extension of standard practice, though none of the sources reviewed specifically validate cavity injection for solid hardwood subfloor voids — this should be treated as a specialist option rather than a default automated pathway. MCA's "controlled" (non-specialist) automation mode should continue to default to moderate LGR dehumidification and directed, non-concentrated airflow, escalating to specialist/pack-out mode for any cavity access, desiccant-driven low-RH strategy, or Category 2/3 contamination.

9. Staged drying strategy

MCA's stage model — assessment → stabilising → bulk → equalising → ready_to_verify → blocked — is an [MCA derivation]; no single source structures a hardwood restoration protocol exactly this way, though the general arc (inspect, dry, monitor, verify) is consistent with the phased approach restoration-industry secondary literature attributes to S500. The rationale for applying the conservative 50% rate factor during assessment, stabilising, and equalising, and the full 100% factor only during bulk, rests on two independent pieces of evidence considered together:

First, kiln-drying literature demonstrates that "safe" material moisture-loss rates vary enormously by hardwood species — from roughly 1.0–3.5%/day MC loss for red oak (lower for lowland-grown stock) up to roughly 6.5%/day for hard maple and 13%/day for soft maple, for green 4/4 lumber under controlled kiln conditions [Published — Woodweb / Dr. Fred M. Lamb, "Drying rates for hardwood lumber — how fast can you dry?"]. This is kiln science for green lumber, not ambient-air restoration of finished in-place flooring, and it measures wood moisture-content loss per day, not ambient room RH percentage-point drop per hour — the two are not interchangeable, and no source bridges them with a conversion factor. What this evidence does responsibly support is the qualitative point that species sensitivity to drying speed varies by an order of magnitude, which argues against treating "Solid Hardwood" as a single risk profile (Section 12).

Second, MFMA's cupping/crowning mechanism is gradient-driven, not rate-driven in an absolute sense: the hazard is a mismatch between top and bottom board moisture, which is more likely to be provoked or worsened by uneven, surface-concentrated drying than by any particular ambient RH-drop number per se. Running full-rate dehumidification during bulk removal (when free/bulk water dominates and the material is furthest from equilibrium) is lower-risk than running the same rate during equalising (when remaining movement is diffusion-limited within the wood and a still-resolving internal gradient is most exposed). This is the specific hazard the 50%/100%/50% staged factor structure is intended to control: cupping, crowning, and finish checking arising from too-rapid reversal of an internal moisture gradient, not a measured material-damage threshold. Uncertainty is high because no source publishes a validated ambient RH-rate-to-gradient-risk relationship for hardwood; the staged factor is a precautionary engineering structure, not a calibrated model.

10. Monitoring, sensor placement, and material readings

Ambient temperature/RH sensors should be sited away from equipment discharge, supply/return vents, and exterior walls, at a height representative of the room rather than immediately adjacent to the floor or ceiling, to avoid local microclimate bias. For material readings, MCA's existing requirement — a baseline reading, a same-meter/scale dry-standard reading on unaffected boards of the same species and finish, and a second comparative reading at least six hours later showing a falling trend — matches the general moisture-meter dry-standard practice described in restoration and flooring-industry literature [Published concept, Wagner Meters and Legend Brands, Tier 2/3]. Non-invasive (pinless/capacitance) moisture meters require a correct species density-correction setting to avoid systematic bias; using the wrong species setting, or comparing readings taken with different meter models or settings, undermines the validity of the dry-standard comparison entirely and should itself be treated as a data-quality failure requiring the reading to be redone rather than accepted. Reading cadence should follow MCA's existing <=24-hour recency and >=6-hour comparative-interval rules; more frequent readings (roughly every 12–24 hours) are advisable during assessment and stabilising, tapering as trend confidence builds. Where accessible, capturing both a top-surface and an underside (or subfloor-adjacent) reading gives a genuine gradient indication rather than relying on a single-face average, directly addressing the cupping/crowning mechanism in Section 2 — this is a recommended field-protocol enhancement, not currently something the app's material-reading model captures.

11. Damage indicators and mandatory stop conditions

Distress indicators that should immediately block automation under MCA's "no distress observed" rule include: cupping beyond what is explainable by normal seasonal movement, crowning, board buckling or tenting (lifting clear of the subfloor), finish crazing, checking or cracking, fastener pop, gapping beyond normal seasonal range, visible mould growth, odour, staining/discolouration, and any softness or give in the subfloor beneath the flooring. A specific and easily-missed trap, drawn directly from MFMA's published guidance, is that a cupped floor which has been sanded flat should not be read as "resolved" evidence of dryness — if that sanding occurred before the internal moisture gradient had fully equalised, the floor can crown once drying completes, meaning a flattened-looking floor may still be actively distressed. Inspectors and any future automated distress-detection logic should treat recent resanding of a previously cupped floor as a flag requiring extended monitoring, not as a clearance.

Category 3 (grossly contaminated) water exposure is a mandatory stop-and-escalate condition regardless of any drying metric, per the general industry description of the S500 approach in Section 3 — MCA's controller should never be relied on to "dry through" a Category 3 exposure on solid hardwood; that decision belongs to inspection and remediation planning, outside the automation loop entirely.

12. Mixed-material implications

MCA's governing-limits model means that in any room containing Solid Hardwood alongside other materials, the shared equipment is throttled to the most conservative limits across all selected materials: the lowest temperature ceiling, the highest RH floor, the lowest RH control ceiling, and the lowest hourly/24-hour rate caps all apply room-wide. Two failure directions follow directly from this. If Solid Hardwood's settings are more conservative than necessary, they will unnecessarily slow drying of every other material in that room, adding cost and dwell time without a corresponding safety benefit. If they are less conservative than the material actually requires — a real risk given the confirmed absence of any published ambient RH-rate standard for hardwood — the hardwood itself is exposed to elevated cupping/crowning/checking risk while other, less sensitive materials in the same room dry at a rate tuned for hardwood rather than for themselves.

Because Section 9's evidence shows an order-of-magnitude spread in species sensitivity, a single flat "Solid Hardwood" profile risks being simultaneously too conservative for robust, fast-equilibrating species and insufficiently conservative for slow, moisture-sensitive species such as some oak grades. The practical implication for the governing-limits model is that MCA should not treat "Solid Hardwood" selection in a mixed room as a fixed, universally-correct constraint — it should be understood as a provisional placeholder pending the species-tagging and field-validation work described in Sections 14–15.

13. Assessment of the current MCA profile

Reviewing every current numeric parameter against the evidence gathered in this research: no source, published or trade, gives a universal ambient-air RH-percentage-point drop rate — per hour or per 24 hours — that is validated as safe or unsafe for solid hardwood flooring. This is confirmed, not merely assumed, following deliberate searching across USDA Forest Products Laboratory research, IICRC-adjacent secondary literature, NWFA/MFMA/ATFA trade publications, and kiln-drying technical literature. The closest analogous figures (Woodweb/Lamb's species-specific safe kiln MC-loss-per-day rates) measure a different quantity in a different physical context and cannot be converted into an ambient RH-drop cap without an unsupported assumption bridging the two. The current 1.0/5.0 pp (conservative stages) and 2.0/10.0 pp (bulk) caps are therefore, and remain, MCA-derived provisional controller settings, not proven material-damage thresholds — exactly as MCA's own policy labelling already states, and this research does not change that labelling.

Indirect evidence does, however, support the general shape of MCA's current design: the EMC relationship (Section 2) supports keeping the RH band within a moderate range rather than driving to extremes; the MFMA cupping/crowning mechanism (Section 2) supports MCA's staged, gradient-conscious approach rather than a flat-rate cap (Section 9); and the wide species-sensitivity spread (Section 9) supports treating the current numbers as a reasonable default average rather than a value tuned to the most sensitive species MCA is likely to encounter. The "controlled," non-specialist automation mode, with an explicit distress-observed override and specialist escalation path, is an appropriate posture given how much of this profile remains unvalidated. No basis was found in this research to recommend loosening any current numeric cap; the main defensible changes are structural (species-awareness, monitoring depth) rather than numeric, as detailed in Section 14.

14. Recommended app parameters

No published source supports changing the core numeric envelope, so the parameter table below is, deliberately, mostly "no change" — the value of this exercise is in making the confidence level and derivation explicit for every number, and in flagging the structural additions (species-awareness, gradient documentation) that the evidence does support.

Parameter	CURRENT	PROPOSED	Confidence	Source / derivation
Control disposition	Controlled (not specialist/pack-out)	No change	Medium	MCA derivation — appropriate given unvalidated numeric base
Maximum temperature	27°C	No change	Medium	MCA derivation, directionally consistent with ATFA's 25°C EMC reference and Wagner Meters' 60–80°F service range
Emergency RH floor	35%	No change	Low–Medium	MCA derivation; no published hardwood-specific ambient RH floor exists
Normal control target RH	40%	No change	Low–Medium	MCA derivation, directionally consistent with EMC relationship (ATFA)
Restart RH	45%	No change	Low–Medium	MCA derivation
Max RH drop, pp/hour	1.0 (conservative stages) / 2.0 (bulk)	No change to values; add optional species-sensitivity override (see note)	Low	MCA derivation — no universal ambient RH-drop-rate published for hardwood (confirmed by this research)
Max RH drop, pp/24h	5.0 (conservative stages) / 10.0 (bulk)	No change; same override note	Low	MCA derivation
Assessment/ stabilising factor	50% of base	No change	Medium	MCA derivation — precautionary, given early-stage trend uncertainty

Parameter	CURRENT	PROPOSED	Confidence	Source / derivation
Bulk factor	100% of base	No change	Medium	MCA derivation — bulk/free water phase judged lowest relative risk
Equalising/ verification factor	50% of base	No change	Medium	MCA derivation — protects diffusion-limited internal gradient equilibration (MFMA mechanism)
Min. environmental history & sampling cadence	Baseline + >=6h comparative + <=24h recency	No change; recommend 12–24h cadence during assessment/stabilising	Medium	MCA derivation, aligned with general dry-standard practice (Wagner Meters, Legend Brands)
Material reading method & dry-standard requirement	Same meter/scale, baseline + dry standard + falling comparative	Add: record species/finish setting used on meter; where accessible, capture top and underside reading to detect gradient	Medium	Published meter-practice principle (Wagner Meters); gradient concept (MFMA)
Warning / shutdown / restart utilisation thresholds	Warn at 90% of rate budget; restart below 60%	No change	Low–Medium	MCA derivation — generic control-theory hysteresis margin, not hardwood-specific

Parameter	CURRENT	PROPOSED	Confidence	Source / derivation
Species-sensitivity override (new)	Not present	Optional low-confidence override: apply 50% factor even during bulk for species flagged high-sensitivity (e.g. oak grades), pending specialist input	Low	MCA derivation, informed by Woodweb/Lamb species MC-loss-rate spread — kiln-drying analogy only, not directly transferable

Claim-to-source mapping:

Numeric claim	Source(s)	MCA derivation?
AS 2796 MC range 9–14%, typical 10–11%	ATFA Floor Choices (secondary description of AS 2796)	No — Published (secondary access; verify against licensed AS 2796)
EMC ≈11% at 25°C/60% RH; ≈16% at 25°C/80% RH	ATFA Floor Choices, "Acclimatisation of Timber Flooring"	No — Published
Factory MC 6–9%, service range 30–50% RH / 60–80°F	Wagner Meters, "Spotting Trouble"	No — Published (US context, directional only for AU)
Species safe kiln MC-loss/day (1.0–13%)	Woodweb / Fred M. Lamb, 2002	No — Published, but context-mismatched (kiln, not ambient restoration)
Cupping/crowning gradient mechanism	MFMA, "Cupping, Crowning, Compression Ridging & Compression Set"	No — Published
27°C max temp	—	Yes — MCA derivation
35/40/45% RH floor/target/restart	—	Yes — MCA derivation
1.0/2.0 pp-h and 5.0/10.0 pp-24h rate caps	—	Yes — MCA derivation (confirmed: no published universal ambient RH-drop rate exists for hardwood)

Numeric claim	Source(s)	MCA derivation?
50%/100%/50% staged factors	MFMA gradient mechanism (context only)	Yes — MCA derivation
90%/60% warning/restart utilisation	—	Yes — MCA derivation
"Dry standard" comparison concept	Wagner Meters; Legend Brands (Tier 3)	No — Published concept; exact completion margin (2–4pp vs 3pp) unverified

15. Evidence gaps, assumptions, and required specialist overrides

The central evidence gap, confirmed rather than assumed by this research, is that no standard, government, peer-reviewed, or trade-body source publishes a universal ambient RH-percentage-point drop rate — hourly or 24-hourly — that is validated as safe for solid hardwood flooring. Every rate-related number in MCA's controller for this material is, and must continue to be labelled as, an MCA-derived provisional engineering judgement.

Before relying operationally or contractually on the numbers in this chapter, MCA should: (1) obtain a licensed copy of AS 2796 and of the current ANSI/IICRC S500 edition and re-verify every claim in this chapter attributed to those standards via secondary sources against the primary text — nothing in this chapter should be represented to a client, insurer, or in legal proceedings as a verified clause citation from either standard, since both are proprietary and were not directly accessible during this research; (2) pursue ATFA's members-only "Water damaged floors" information sheet, which is very likely the single most directly relevant piece of Australian trade guidance for this exact scenario and was not accessible during this research (the page is login-gated); (3) commission a field validation study — instrumenting a representative sample of real jobs with continuous ambient RH/temperature logging alongside repeated same-meter, dry-standard-referenced board moisture readings (ideally including top and underside readings) — to build an empirical, MCA-owned correlation between ambient RH-drop rate and actual material behaviour, which is the only credible path to moving these numbers from "low confidence, MCA derivation" to "validated"; (4) engage a timber-flooring specialist (an ATFA-affiliated installer/inspector, or equivalent) to review the species mix MCA actually encounters in the field and advise on the species-sensitivity override proposed in Section 14; (5) establish a moisture-meter calibration and species-correction-factor procedure, and an annual calibration schedule for ambient temperature/RH sensors, consistent with manufacturer specifications; and (6) retain drying logs, dry-standard readings, distress inspection records, meter calibration records, and this chapter (with version history) as part of MCA's project documentation — for a retention period MCA's legal counsel should specify, since this is a legal/insurance question this chapter does not have standing to answer. Finally, and explicitly: nothing in this chapter or in MCA's controller settings should be represented as compliant with, or certified against, AS 2796, ANSI/IICRC S500, or any other proprietary standard. Where a manufacturer's installation warranty, a specific project specification, a conservation requirement, or a restoration specialist's on-site judgement sets a tighter limit than anything in this chapter or in MCA's controller, that tighter limit governs and overrides the app's automated settings.

16. References

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Engineered Timber

Research packet: claude-c1-wood.md | 4,906 words | 10 URL references | The packet is commentary for review, not a certified limit.

Scope: this chapter separates source-supported observations, operational assumptions, unresolved uncertainty, and field verification requirements for this material.

1. Scope and material identification

This chapter addresses **engineered timber flooring**: a factory-manufactured flooring product consisting of a solid-timber face veneer (lamella/wear layer) bonded under heat and pressure to a dimensionally-stabilising core, most commonly cross-laminated plywood, high-density fibreboard (HDF), or laminated lumber strips [Published — construction generally, ATFA]. It is distinct from (a) solid strip/board hardwood flooring, which is a single homogeneous timber species through its full thickness, and (b) laminate flooring, which has no solid-timber wear layer at all. Within "engineered timber" this chapter treats floating (click-lock, unfixed to subfloor), glued-down (adhesive-bonded to a rigid substrate, typically concrete), and secret-nailed/nail-and-glue installations as materially different for drying purposes, because each installation method changes how water reaches the core and how quickly the assembly can dry [Published, ATFA — installation method affects both damage mechanism and recoverability].

This chapter does not cover bamboo flooring, laminate (photographic-layer) flooring, or solid strip hardwood, all of which the Australasian Timber Flooring Association (ATFA) treats as behaving differently under water exposure [Published, ATFA/Floor Choices]. It also does not extend to the sheet subfloor materials (particleboard, plywood) beneath engineered floors except where their behaviour directly governs the flooring's dryability — those materials are covered by their own Australian Standards (AS/NZS 1859.1 for particleboard specification and AS/NZS 1860.1 for particleboard flooring), which this research did not open in full text (paywalled) and which are flagged here only as existing, not as a source for any numeric limit in this chapter [Published — existence only; not independently verified].

Everywhere in this chapter, a clear line is drawn between **[Published]** statements — traceable to a specific source opened during this research — and **[MCA derivation]** — an engineering judgement, extrapolation, or conservative operational choice made by MCA in the absence of published material-specific guidance. This distinction matters because, as later sections show, no source located in this research publishes a universal, material-specific safe rate of ambient relative-humidity change for engineered timber flooring.

2. Material construction and moisture behaviour

Engineered timber's defining property is a cross-laminated or composite core intended to counteract the seasonal width movement that solid timber exhibits as its moisture content tracks ambient equilibrium moisture content (EMC) [Published, ATFA — "Engineered" technical page]. ATFA states that under wet conditions an engineered floor will expand, and under dry conditions will shrink, but by a smaller amount than an equivalent solid timber floor, because the cross-grain core layers restrain each other's movement [Published, ATFA]. This is the basis of the common industry assumption that engineered timber is "more moisture-tolerant" than solid hardwood — but the evidence gathered here does not support treating that as true without qualification (see Section 3 and Section 11): the same layered construction that restrains *width* movement introduces new failure surfaces — the glue lines — that solid timber does not have.

The core wood substance is fundamentally the same hygroscopic material physics described in the USDA Forest Products Laboratory's *Wood Handbook* (Glass & Zelinka, 2021): wood takes on and releases moisture in response to the surrounding air's relative humidity and temperature, moving toward an equilibrium moisture content that depends on both variables and on the wood's current moisture state (i.e., there is hysteresis between adsorption and desorption) [Published, FPL]. The Wood Handbook chapter establishes the general principles — hygroscopicity, EMC dependence on RH and temperature, the fibre saturation point, and the link between moisture content change and dimensional change (shrinkage/swelling) — but it is written for wood as a generic engineering material and does not publish an engineered-flooring-specific, or even a general wood-flooring-specific, safe *rate* of ambient humidity change [Published — principles only; rate content not found].

Layered on top of this timber physics, engineered flooring adds three moisture-sensitive elements that solid timber does not have: (1) the adhesive glue line(s) bonding veneer to core and core layers to each other; (2) the HDF or particleboard core itself, which — unlike solid wood — can lose structural cohesion (not just dimension) when saturated; and (3) mechanical click-lock or tongue-and-groove joints, which rely on precise tolerances that swelling can destroy [Published, Hardwood Floors Magazine/NWFA — Miller, 2018]. ATFA's acclimatisation guidance explicitly states that solid-timber acclimatisation practice does not apply in the same way to engineered or laminate flooring, because these products move significantly less dimensionally [Published, ATFA/Floor Choices, "Acclimatisation of Timber Flooring"]. That lower *dimensional* movement should not be read as lower *damage risk* overall — it simply relocates the risk from board-width gapping/cupping toward delamination, core swelling, and joint failure.

3. Water exposure, contamination, and salvageability

ATFA's flood-response guidance draws a hard line by installation type. For **floating engineered flooring that has been covered by water**, ATFA states it will generally be necessary to replace the floor [Published, ATFA/Floor Choices, "Flood Inundated Timber Floors"]. **Engineered flooring over sheet**

subfloors (particleboard/plywood) is described as unlikely to be recoverable, with restoration effort shifting to assessing whether the subfloor sheet material itself can be saved [Published, ATFA]. **Engineered flooring glued to concrete slabs** mostly requires replacement due to mud/silt penetration and drying difficulty, though some directly adhesive-fixed floors may be recoverable [Published, ATFA]. This is a materially more pessimistic salvageability profile than solid strip flooring direct-fixed to joists, where ATFA notes there are instances where "greater consideration can be given to saving the floor" [Published, ATFA].

Contamination category (per the general water-damage-restoration framework referenced in the industry, e.g. IICRC S500) matters as much as duration of wetting. Category 1 (clean) water exposure of short duration is the only scenario in which drying-in-place of engineered timber is realistically contemplated; Category 2/3 water (grey/black, or clean water held for extended periods) combined with any standing-water history over an engineered floor should be treated by MCA as presumptively requiring specialist/insurer sign-off on salvage intent before committing drying equipment, given ATFA's default guidance toward replacement [MCA derivation, applying ATFA's published salvageability findings]. Note: the IICRC S500 standard itself (and its Australian-adopted counterpart, AS-IICRC S500:2025, announced by Standards Australia/IICRC in a March 2025 press release) is a **proprietary, paywalled standard**; this research did not access its internal text, and no clause, category, or class number from S500 is cited anywhere in this chapter. Any future reference to S500 by MCA staff requires a licensed copy [Published — existence and paywall status of AS-IICRC S500:2025 confirmed via its own press release; internal content not verified].

Salvageability also depends on moisture meter reliability: ATFA notes that moisture meter readings on particleboard/plywood substrates are unreliable, and that oven-dry testing (available through ATFA) is the accurate method for those substrates [Published, ATFA]. This has a direct operational implication for MCA's material-reading protocol (Section 10): a pin or pinless meter reading taken through an engineered floor's face veneer, if the core is HDF/particleboard, may not be a trustworthy proxy for true core moisture state.

4. Drying objectives and completion criteria

The published target for a *recoverable* engineered timber floor is a return to its pre-incident regional equilibrium moisture content, not an absolute universal number. ATFA gives EMC bands for solid timber flooring that are also the relevant ambient-equilibrium reference for engineered timber's core and veneer: roughly 9–13% for major Australian cities and 13–15% in humid regions, with acclimatisation guidance elsewhere citing 10–11% MC as typical for temperate climates at 50–60% RH and up to 13–14% in tropical/humid north Queensland [Published, ATFA]. These are equilibrium bands for timber moisture content, not ambient air RH-drop-rate limits, and the RATE RULE distinction is important here: MCA's controller manages *ambient room-air RH percentage points per hour/24h*, which is a proxy input, not the material moisture-content endpoint itself [MCA derivation — clarifying the relationship between the controller's control variable and the published material target].

Drying completion criteria for engineered timber should therefore be assessed on: (a) core/veneer moisture content approaching the regional EMC band via a reliable measurement method (Section 10) compared against a same-room, same-material "dry standard" reference; (b) absence of new or worsening distress (Section 11) across at least two readings taken >=6 hours apart; and (c) stabilisation of ambient RH within the controlled band rather than continued rapid RH decline, since ATFA also warns that floors must reach stable moisture content with "minimal residual cupping and gapping" before any resurfacing is attempted — chasing a fast ambient RH drop that outpaces the material's actual moisture release risks locking in cupping/gapping that only becomes apparent after equipment is switched off [Published, ATFA — stabilisation-before-resurfacing principle, extended by MCA to stabilisation-before-shutdown].

5. Temperature limitations

No source located in this research publishes a specific maximum ambient air temperature for drying engineered timber flooring. The Wood Handbook establishes that EMC is a function of both RH and temperature (higher temperature at constant RH generally lowers EMC modestly), and that thermal properties of wood are addressed in general terms [Published, FPL], but it gives no flooring-specific ceiling. The current MCA setting of a 30°C maximum temperature is therefore an **[MCA derivation]**: a conservative ceiling intended to (a) avoid accelerating adhesive softening or cure-state changes in the glue line under sustained heat plus moisture (a known combination that shortens adhesive service life generically, per delamination-failure literature — see Section 11), and (b) avoid pushing the assembly into a temperature/RH combination that drives unusually rapid surface-to-core moisture gradients in the veneer. It is not traceable to a manufacturer or standards-body ceiling; MCA should treat it as a working limit pending a manufacturer-specific technical data sheet for the actual product installed on a given job.

6. Relative-humidity limitations

Published guidance converges on a functional "safe zone" of roughly 35–55% RH for wood flooring generally, with cupping/shrinkage risk escalating at the extremes: NWFA's failure literature attributes dry cupping and, in severe cases, ply-separation to RH remaining below the manufacturer's recommended range for an extended period, while excess RH/moisture drives endlift, swelling and delamination at the other extreme [Published, Hardwood Floors Magazine/NWFA — Miller, 2018]. No source gives a single universal RH floor/ceiling specific to engineered timber that would supersede manufacturer literature for a given product.

Against that backdrop, MCA's current settings — 35% emergency floor, 40% control target, 45% restart — sit inside the commonly-cited 35–55% "safe zone" band and are **[MCA derivation]** operational choices calibrated to that general band rather than to an engineered-timber-specific published ceiling/floor. They are defensible as a conservative interior sub-range of the published safe zone, but they are not themselves published material thresholds, and MCA should not represent them as such in front of a manufacturer, insurer, or in any dispute.

7. GPP, dew point, vapour pressure, and condensation considerations

Grains-per-pound (GPP) is an absolute measure of moisture in air (independent of temperature), and dew point is the temperature at which air becomes saturated; both are standard psychrometric concepts used throughout the structural-drying industry to track whether moisture is actually leaving a space, as opposed to relative humidity, which can fall simply because air is heated without any moisture being removed [Published — general psychrometric concept, restoration-industry secondary sources; Tier 3 context only, not a source of any numeric limit in this chapter]. This distinction matters directly for the RATE RULE governing this chapter: an ambient RH-percentage-point drop can be produced either by genuine dehumidification (falling GPP, falling dew point) or by simple heating with no net moisture removal (falling RH, unchanged or rising GPP). MCA's RH-drop-rate caps (Section 9) are calculated on RH alone; they should be understood as a proxy control on the *rate of environmental change presented to the material*, not a direct measurement of moisture actually being pulled from the timber's core or adhesive layer [MCA derivation — stated explicitly to avoid conflating ambient RH-drop rate with material moisture-content reduction, per the task's rate rule].

Condensation risk on or within an engineered floor arises when a cold surface (e.g. an uninsulated concrete slab under a glued-down floor, or ducted-air outlets aimed directly at the floor) sits below the room's dew point, which can re-wet a boundary layer even while the room's bulk RH reads as falling. No source located here publishes an engineered-timber-specific condensation risk temperature differential; MCA's practical control is to avoid directing high-velocity cold airflow directly onto a glued-down engineered floor over a slab that has not been confirmed dry, and to monitor for surface condensation as a distress indicator (Section 11) [MCA derivation].

8. Airflow and equipment selection

None of the sources reviewed give an engineered-timber-specific airflow velocity or equipment-selection specification. General restoration-industry practice (Tier 3 context) favours low-grain (LGR) refrigerant dehumidification for open, ambient-air-exposed floating and glued floors, reserving desiccant dehumidification and more aggressive floor-drying-mat/injection systems for slab-adhered floors and for cases where deep sub-surface moisture (e.g. beneath a glued-down floor, or within a particleboard subfloor) must be pulled out through a boundary layer that has limited surface permeability [Tier 3 context; not a numeric source]. Because ATFA's flood guidance repeatedly signals that floating and sheet-subfloor engineered installations are frequently not recoverable in place, MCA's default equipment strategy for engineered timber should be calibrated to *controlled ambient conditioning* (temperature/RH control via dehumidification and low-to-moderate air movement) rather than aggressive injection/extraction drying that is more appropriate to solid, direct-fixed timber over accessible subfloor voids [MCA derivation, following from Section 3's salvageability findings]. Any decision to use floor-mat/injection drying systems that directly force air beneath or through an engineered floor's joints should be treated as an escalation requiring manufacturer/specialist sign-off, since it directly stresses the click-lock joints and glue lines identified in Section 11 as failure points.

9. Staged drying strategy

MCA's controller stages engineered timber through assessment → stabilising → bulk → equalising → ready_to_verify → blocked, gated by a baseline reading plus a same-scale "dry standard" comparative reading, a second reading >=6 hours later showing a falling trend, a reading no older than 24 hours, and a "no distress observed" inspection before bulk-stage promotion. This staging logic, and the halving of the RH-drop-rate budget during assessment/stabilising/equalising relative to bulk, is an **[MCA derivation]** — no source located in this research specifies drying "stages" for engineered timber in these terms, or a numeric ratio between conservative and bulk-phase drying rates. The underlying engineering logic is sound and widely used in structural drying generally (start conservative while material response is still unknown, e.g. before two comparative readings confirm a falling trend, then permit a faster rate once trend and dry-standard comparison are established) — but it is a general drying-methodology inference, not a citation to material-specific test data on engineered timber's response curve. As per the rate rule: no published source gives an engineered-timber-specific safe ambient RH-drop rate at all, at any stage, so the entire numeric structure of the staged rate caps in Section 14 is MCA-derived, not verified against a material-damage study.

10. Monitoring, sensor placement, and material readings

Reliable monitoring for engineered timber must reconcile two facts established in Sections 2–3: the wear-layer veneer can be very thin (published NWFA/NOFMA factory-finish veneer minimums run from roughly 2.5 mm for factory-finished smooth product up to 3.2 mm for unfinished smooth product, with general engineered veneers spanning about 0.6–6 mm across the market) [Published, NWFA/NOFMA factory-finished standards], and moisture meter readings taken on or through particleboard/HDF-cored products are described by ATFA as unreliable [Published, ATFA]. Practical implications: (a) a pin-type meter that penetrates the thin veneer risks damaging a wear layer that may have almost no resanding tolerance left, particularly on factory-finished thin-veneer product; (b) a non-invasive/pinless reading calibrated for solid hardwood may misread an HDF or particleboard core; (c) wherever possible, MCA should pair ambient temperature/RH logging with a same-scale comparative "dry standard" reading on an unaffected area of the same product, exactly as the controller's bulk-stage gate already requires, rather than relying on a single absolute moisture-content number [MCA derivation, operationalising ATFA's reliability caveat and the controller's existing dry-standard requirement].

Sensor placement should prioritise: (i) ambient temperature/RH near the floor's mid-room and near any cold surface where condensation risk is elevated (Section 7); (ii) material readings at multiple points including near board ends (where endlift/ski is most visible per Section 11) and near perimeter/expansion gaps (where floating floors are most exposed to standing water ingress); and (iii) documented visual inspection for cupping, gapping, discolouration, or lifting alongside every material reading, since ATFA and NWFA both treat visual distress as at least as diagnostic as a single numeric reading [Published, ATFA; Published, NWFA/Hardwood Floors Magazine]. Reading cadence of >=6 hours between comparative readings, and a maximum reading age of 24 hours before a stage can be considered current, mirrors the controller's existing bulk-promotion gate and is treated in this chapter as the minimum acceptable cadence for engineered timber specifically, given how quickly a misjudged rate can convert a recoverable floor into an unrecoverable one [MCA derivation].

11. Damage indicators and mandatory stop conditions

Published damage indicators for engineered timber, drawn from ATFA's flood guidance and NWFA's failure taxonomy, include: cupping (edges raised relative to centre) followed by shrinkage gapping as the floor over-dries; nail popping/squeaking from fixing movement (relevant to secret-nailed engineered product); discolouration around fasteners; checking/splits at board ends and wall junctions; swelling at particleboard/HDF sheet edges; dry cupping and ply-separation from prolonged low RH; wood shear from stresses exceeding fibre strength; delamination/glue-line separation from manufacturing defects or extended/repeated standing-water exposure; endlift/ski from core layers swelling perpendicular to the face grain; veneer sand-through; and lathe checks (stress fractures in the face veneer) that become visible under humidity fluctuation [Published, ATFA; Published, NWFA/Hardwood Floors Magazine — Miller, 2018].

Any one of these observed and recorded should be treated as **mandatory-stop distress** under the controller's existing rule that any recorded distress blocks automation entirely — this chapter does not propose loosening that rule for engineered timber; if anything, the layered-construction failure modes (delamination, endlift, core swelling) argue for treating engineered timber's stop-list as broader than solid timber's, because several of its failure modes (glue-line separation, core softening) are not readily visible until they are advanced, unlike solid-timber cupping which is usually visible early [MCA derivation]. Given the "no source publishes an ambient RH-drop rate limit" finding, the controller's rate caps should be understood by operators as a *precautionary throttle*, not a *validated safety boundary* — visual/manual inspection remains the primary distress-detection mechanism, and the rate cap is a secondary, conservative control pending better evidence.

12. Mixed-material implications

Under the controller's governing-limits model, an engineered timber floor sharing a room with, say, plasterboard, carpet underlay, or solid hardwood will have its temperature ceiling, RH floor, RH ceiling, and rate caps merged with those materials by taking the most conservative value across all of them. Two failure directions follow. First, if MCA's engineered-timber RH-drop-rate caps are set more conservatively than the evidence actually requires (which, given the total absence of a published material-specific rate limit, is a real risk in either direction), an unnecessarily tight cap will throttle drying of every other material in that room, extending total dry-out time, cost, and secondary-damage exposure (e.g. mould growth risk in adjacent gypsum) without a proven corresponding benefit to the flooring [MCA derivation, following directly from the governing-limits architecture]. Second, if MCA's caps are set too permissively, the shared equipment could run at a rate that is safe for, say, exposed masonry but damaging to the engineered floor's adhesive layer or core, with no other material's limit catching the error. Because engineered timber's temperature/RH working band (30°C max, 35–45% RH band) is already narrower than many masonry, concrete, or plasterboard tolerances, engineered timber is likely to be the *governing* material in most mixed rooms it appears in — meaning errors in this chapter's numbers propagate directly into how fast every other material in the room is allowed to dry [MCA derivation]. This is a strong argument for validating this material's numbers before validating less-restrictive materials, since this one will usually set the room's pace.

13. Assessment of the current MCA profile

The current provisional profile (30°C max temp; 35/40/45% RH floor/target/restart; 1.0 pp/h & 5.0 pp/24h base cap at 50% during assessment/stabilising/equalising; 2.0 pp/h & 10.0 pp/24h at 100% during bulk; controlled automation mode) is internally consistent with the general 35–55% "safe RH zone" literature and with a conventional conservative-then-standard staged-rate structure, but every numeric value in it is an **[MCA derivation]** — none is traceable to a manufacturer technical data sheet, an Australian Standard specific to engineered timber, or a peer-reviewed material-damage study of ambient RH-drop rate. This is not a criticism unique to MCA: the research explicitly confirms that no such published universal rate exists for this material, so any operational drying controller for engineered timber will necessarily rely on derived, not published, rate limits at this time.

Two specific areas of the profile invite calibration once better evidence or manufacturer data is available: (a) the temperature ceiling of 30°C is unreferenced to any adhesive service-temperature specification, and given that adhesive bond degradation under sustained heat-plus-moisture is a documented failure mode (Section 11), MCA should treat 30°C as a placeholder pending a specific adhesive/product data sheet, not as a validated ceiling; (b) the 50%/100% factor split between conservative and bulk stages, while methodologically sound, has no empirical basis for *why* 50% (rather than, say, 33% or 75%) is the right ratio for this specific layered material, and should be flagged internally as an assumption open to revision once field validation data (Section 15) accumulates.

14. Recommended app parameters

The table below separates CURRENT (existing profile) from PROPOSED (this chapter's recommendation). Where this chapter proposes no change, PROPOSED repeats CURRENT — this reflects that the evidence base did not surface a specific reason to move the numeric value, only greater clarity on its derivation and confidence level.

Parameter	CURRENT	PROPOSED	Confidence	Source / derivation
Control disposition	controlled	controlled	Medium	MCA derivation — appropriate given absence of published rate standard and documented failure modes requiring human-in-loop distress checks
Maximum temperature	30°C	30°C (flag as placeholder)	Low	MCA derivation; no manufacturer/adhesive-specific ceiling located
Emergency RH floor	35%	35%	Medium	MCA derivation, positioned at lower bound of published 35–55% "safe zone" (NWFA-adjacent secondary literature)
Normal control target RH	40%	40%	Medium	MCA derivation, interior sub-range of published safe zone
Restart RH	45%	45%	Medium	MCA derivation, interior sub-range of published safe zone

Parameter	CURRENT	PROPOSED	Confidence	Source / derivation
Max RH drop, assessment/stabilising/equalising	1.0 pp/h, 5.0 pp/24h	1.0 pp/h, 5.0 pp/24h (retain, relabel as precautionary throttle)	Unsupported (no published material rate exists)	MCA derivation — no published ambient RH-drop-rate standard for engineered timber found in this research
Max RH drop, bulk	2.0 pp/h, 10.0 pp/24h	2.0 pp/h, 10.0 pp/24h (retain, relabel as precautionary throttle)	Unsupported	MCA derivation, as above
Assessment/ stabilising factor	50% of base	50% of base	Low	MCA derivation; ratio itself unvalidated
Bulk factor	100% of base	100% of base	Low	MCA derivation
Equalising/ verification factor	50% of base	50% of base	Low	MCA derivation
Minimum environmental history / sampling cadence	>=6h between comparative readings; <=24h reading age	Retain; add mandatory dry-standard pairing at every reading, not just at bulk-gate	Medium	Controller design + ATFA reliability caveat on meter readings
Material reading method / dry-standard requirement	Same-scale baseline + dry standard at bulk promotion	Extend dry-standard comparison to every stage; flag HDF/particleboard-core products as meter-unreliable per ATFA	Medium	Published, ATFA (meter reliability caveat)
Warning/ shutdown/restart utilisation thresholds	Warn at 90%, restart below 60%	Retain	Low	MCA derivation; no published basis located

Claim-to-source mapping

Numeric claim	Source or derivation
30°C max temperature	MCA derivation — no source
35% RH emergency floor / 40% target / 45% restart	MCA derivation, informed by general 35–55% wood-flooring "safe zone" reported in secondary/Tier 3 flooring-care literature
1.0/2.0 pp/hour and 5.0/10.0 pp/24h RH-drop caps	MCA derivation in full — no source publishes an engineered-timber ambient RH-drop-rate limit
50%/100% stage factors	MCA derivation in full — no empirical basis located
>=6h comparative reading interval, <=24h reading currency	MCA derivation (controller design choice)
Dry-standard comparative reading requirement	Consistent with, but not directly copied from, ATFA's moisture-meter-reliability caveat on particleboard/plywood substrates
Regional EMC bands (9–13% / 13–15% MC) referenced as drying *endpoint*, not rate	Published, ATFA/Floor Choices ("Flood Inundated Timber Floors"; "Acclimatisation of Timber Flooring")
Warn-at-90%/restart-below-60% utilisation thresholds	MCA derivation — no source
Veneer/wear-layer thickness figures (2.5–3.2mm minimums cited in text)	Published, NWFA/NOFMA factory-finished standards (US-market figures; Australian-market equivalents not separately verified)

15. Evidence gaps, assumptions, and required specialist overrides

The central evidence gap is definitional: **no source located in this research — Australian Standard, IICRC-affiliated publication, ATFA, NWFA, or USDA Forest Products Laboratory — publishes a universal safe ambient relative-humidity drop rate (per hour or per 24 hours) for engineered timber flooring.** This chapter's rate caps are therefore MCA engineering derivations calibrated to general safe-RH-zone literature and staged-drying methodology, not to a validated material-damage threshold. This must be disclosed to any specialist, insurer, or legal reviewer relying on this chapter, and this chapter and its accompanying policy record (MCA-PROV-2026-07-22) should not be represented as compliant with, or derived from, IICRC S500/AS-IICRC S500:2025, since that standard is proprietary and was not opened during this research.

Before MCA relies operationally on the PROPOSED parameters above, the following steps are needed: (1) **manufacturer sign-off** — obtain product-specific technical data sheets (temperature/RH/adhesive limits) for the actual engineered timber products MCA most commonly encounters, and override this chapter's placeholder 30°C ceiling and RH band wherever a manufacturer limit is more restrictive; (2) **specialist/insurer sign-off** on salvage intent before drying-in-place any floating engineered floor that has been covered by standing water, consistent with ATFA's default-to-replacement guidance; (3) **field validation** — a structured internal trial comparing outcomes (visual distress incidence, moisture-content trend, time-to-dry) between the current 50%/100% stage-factor split and at least one alternative ratio, to build MCA's own evidence base where the industry has none; (4) **calibration** of moisture meters/sensors against oven-dry or equivalent reference methods specifically for HDF/particleboard-cored product, given ATFA's reliability caveat; (5) **document retention** — retain this chapter, the underlying source PDFs/pages fetched, and every field-validation dataset as the evidentiary record supporting policy version MCA-PROV-2026-07-22, since in the absence of a published standard, MCA's own derivation-and-validation trail is the only defence of these numbers under specialist or legal review; (6) **licensing** — if MCA wishes to reference IICRC S500/AS-IICRC S500:2025 categories or classes in future revisions of this chapter, MCA must first obtain a licensed copy and re-derive any citation from the primary text, not from secondary paraphrase.

16. References

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Timber Frame

Research packet: claude-c1-wood.md | 5,779 words | 10 URL references | The packet is commentary for review, not a certified limit.

Scope: this chapter separates source-supported observations, operational assumptions, unresolved uncertainty, and field verification requirements for this material.

1. Scope and material identification

This chapter covers structural, load-bearing timber framing in residential and light commercial construction: wall studs, top and bottom plates, noggins, floor joists and bearers, and roof framing members (rafters, ceiling joists, truss chords and webs). It excludes decorative or wear-surface timber (flooring, skirting, external decking), which are treated as separate material profiles in the MCA register, and it treats engineered structural members — laminated veneer lumber (LVL), glued-laminated timber (glulam), and timber I-joists — as a related but materially distinct sub-category flagged separately throughout this chapter, because their manufacturing moisture content, layered construction, and failure modes differ from solid sawn timber.

In Australian residential construction the dominant framing material is softwood, typically plantation radiata pine supplied as machine-graded pine (MGP10/12/15) and frequently treated to Hazard Class H2 (termite protection only, intended for enclosed, dry, above-ground use) or H3 (termite and moderate decay protection, for exposed above-ground use) [Published — general industry description, Tier 3 trade sources; see references]. Hardwood framing is comparatively uncommon in modern project-home construction but persists in older housing stock, some higher-durability or bushfire-rated applications, and heritage renovations, and is noted here because its moisture-response characteristics (density, permeability, shrinkage anisotropy) differ from softwood and are not assumed to be interchangeable with it.

The defining operational constraint for this material, reflected in the current policy note ("Requires cavity access, paired sensing and comparative timber moisture readings"), is that virtually all structural framing in a lined building is physically inaccessible without either demolition of wall/ceiling linings or the use of drilled inspection points and cavity-injection drying methods. This access constraint governs almost every downstream decision in this chapter: it limits how monitoring can occur, it delays confirmation of an actual falling moisture trend, and it means the controller is frequently operating on ambient-air proxies (temperature, RH, RH-drop rate) rather than direct, continuous readings of the timber itself.

2. Material construction and moisture behaviour

Wood is a hygroscopic, anisotropic, cellular material. Below the fibre saturation point (FSP, commonly cited in the timber science literature as roughly 25–30% moisture content on a dry-weight basis), water is held as "bound water" within the cell walls, and changes in bound-water content directly cause dimensional change (shrinkage on drying, swelling on wetting) as well as changes to mechanical properties. Above FSP, additional water exists as "free water" in the cell cavities and its removal has comparatively little effect on dimensions, but it must still be removed before bound-water drying (and associated shrinkage/stress) begins [Published, USDA Forest Products Laboratory Wood Handbook, Chapter 13 — Tier 1].

For seasoned (kiln-dried) structural softwood framing of the kind typically specified under machine-graded pine (MGP) rules, secondary industry guidance describes a target in-service moisture content of around 15% or lower, while unseasoned (green) structural timber can range from roughly 25% up to green/saturated values well above 100% relative to oven-dry weight [Published, secondary interpretation of AS 1684 span-table assumptions — Tier 3; the primary standard AS 1684 is proprietary and MCA does not hold a clause-level licensed copy, so this figure should be treated as indicative, not an authoritative clause citation]. AS 1684 (Residential Timber-Framed Construction) itself explicitly conditions its span-table structural capacities on timber being at "the right moisture content" for its seasoning classification — meaning sustained wetting that pushes seasoned framing back toward unseasoned moisture levels is not simply a drying-time inconvenience, it is a structural-capacity assumption that has been temporarily invalidated until moisture content is restored.

The correct method for establishing actual moisture content in solid sawn timber is described in AS/NZS 1080.1 (Timber — Methods of Test — Method 1: Moisture Content), which sets out an oven-drying reference method plus correction procedures for electrical-resistance and capacitance moisture meters across a wide range of Australian, New Zealand, and imported species, both seasoned, unseasoned, and treated [Published, Tier 1 — standard summary from Standards New Zealand's Building CodeHub; AS/NZS 1080.1 is a proprietary, paywalled standard, and MCA does not currently hold a licensed copy, so species- and meter-specific correction factors cannot be cited at clause level here]. This matters operationally: a resistance moisture meter reading taken on treated pine without the correct species/treatment correction factor can materially misstate actual moisture content, which is directly relevant to any "comparative timber moisture readings" requirement in the app's policy.

Preservative treatment changes decay resistance, not moisture uptake or release behaviour. H2 treatment (termite protection) provides no meaningful improvement in fungal decay resistance and is only rated for continuously dry, enclosed, above-ground service; H3 treatment adds moderate decay resistance for above-ground exposure but is still not rated for ground contact or continuous wetting [Published, Tier 3 trade-body/manufacturer sources — see references]. In practice this means H2-treated internal wall framing that has been saturated by a water event carries essentially the same fungal decay risk profile as untreated equivalent framing, and treatment status should not be used by field technicians or the app as a reason to relax drying targets or timelines.

Engineered structural members behave differently again. LVL and I-joist products are typically manufactured to a much lower moisture content (commonly cited around 5–6% for I-joist/LVL versus roughly 15–19% for kiln-dried sawn lumber), and glulam is commonly around 12% at production [Published, manufacturer technical bulletin — Tier 2]. Because these products are layered (veneers, or flange/web/adhesive assemblies), uneven wetting across the cross-section — one flange or face becoming wetter than the other — can cause cupping in LVL and camber in I-joists even when overall average moisture content looks acceptable [Published, Tier 2 manufacturer technical note]. A peer-reviewed comparative study of moisture- and temperature-induced swelling/shrinkage in softwood and hardwood glulam and LVL found glulam swells/shrinks by roughly 0.24% dimensionally per 1% change in timber moisture content [Published, peer-reviewed, Tier 1] — a useful order-of-magnitude figure, though it was generated under laboratory conditions and has not been validated by MCA against in-situ Australian engineered members after water events. Distress in engineered members (delamination, adhesive bond-line failure, cupping) is a distinct stop condition from the checking/splitting typically discussed for solid sawn timber, and inspectors should not assume the same visual damage indicators apply to both.

3. Water exposure, contamination, and salvageability

Contamination category (broadly, the restoration-industry "clean/grey/black water" framework commonly associated with IICRC S500 — a proprietary standard MCA does not hold a licensed copy of, and which is referenced here only by general industry description, not clause citation) affects salvage strategy for absorbent and porous linings far more directly than it affects solid structural framing, which is denser, less absorbent, and — subject to engineering and hygiene assessment — is frequently retained and dried/disinfected rather than removed, unlike heavily contaminated soft or porous materials.

For salvageability of the framing itself, the most directly usable published benchmark located in this research is from WoodSolutions (Forest and Wood Products Australia), which states in practitioner guidance that timber which reaches below 20% moisture content and is free of mould can generally be reused [Published, Tier 2 industry-technical-body guidance, referencing WoodSolutions Technical Design Guide 12, "Impact and Assessment of Moisture-affected, Timber-framed Construction"]. This is consistent with — though not identical to — the widely cited decay-science threshold (see Section 11) that sustained moisture content above roughly 20% is a necessary condition for fungal decay to be sustained in already-colonised wood, and above roughly 24–31% for decay fungi to newly establish [Published, USDA Forest Products Laboratory-sourced research — Tier 1]. The same WoodSolutions guidance identifies bottom plates immediately above slabs, and the lowest portions of studs, as the areas most prone to retained moisture and therefore highest salvage risk — directly relevant to sensor and inspection-point placement (Section 10).

Salvageability judgment should also weight exposure duration and prior condition: the WoodSolutions guidance and general restoration literature both note that assessment cannot rely on a single simple rule — species, treatment, protection from sun/wind, contamination, and duration of wetting all affect the individual case, and each event needs individual technical assessment rather than a blanket time- or moisture-based cutoff [Published, Tier 2]. Framing subjected to prolonged wetting (multiple days to weeks, per Section 11) before drying commenced carries materially higher decay and structural risk than framing wetted briefly and dried within the IICRC-recommended 24–48 hour window, even if both eventually reach the same moisture content endpoint.

4. Drying objectives and completion criteria

The app's current promotion logic requires a baseline reading, a comparative "dry standard" (unaffected reference) reading on the same meter/scale, a second reading >=6 hours later showing a falling trend, a most-recent reading <=24 hours old, and a "no distress observed" inspection before advancing into "bulk" stage automation. This structure closely mirrors the dry-standard philosophy underpinning the IICRC S500 approach as described in secondary trade literature: establishing pre-loss/unaffected moisture content in the same structure as the reference point, then drying affected materials toward that reference rather than toward an arbitrary universal number, with a commonly cited goal of returning wood framing to within roughly 2–4 percentage points of the dry standard, or below approximately 16–20% moisture content, whichever is the controlling constraint [Published, Tier 3 trade/practitioner summaries of a proprietary Tier 1 standard MCA does not hold a licensed copy of].

It is critical to state plainly, per the rate rule governing this chapter: ambient room-air relative-humidity percentage-point drop per hour or per 24 hours is not the same measurement as, and does not move in lockstep with, timber moisture-content reduction. Wood is a slow-diffusing hygroscopic solid; its internal moisture content lags substantial ambient RH changes by hours to days depending on member thickness, species, grain orientation, and whether it is exposed or still enclosed behind lining remnants or insulation. No source located in this research publishes a rate of ambient-air RH change that is validated as safe (or unsafe) specifically for structural framing timber drying — this is an MCA-derived controller convenience metric, not a materials-science threshold, and it should never be treated as a proxy for confirmed material dryness. The only defensible drying-completion criterion is a direct, comparative moisture-content reading of the timber itself against a dry standard — exactly the requirement the current promotion logic already builds in, and which this chapter's recommendations (Section 14) seek to reinforce rather than relax.

5. Temperature limitations

The current 32°C maximum temperature ceiling is an MCA-derived operational choice, not a figure drawn from a structural-timber-specific published limit. General drying-industry and psychrometric practice favours elevated air temperature (commonly in the 25–35°C band) because higher air temperature increases the air's moisture-holding capacity and vapour-pressure differential, accelerating evaporation, without commonly being described in restoration literature as being high enough on its own to induce serious defects in already-installed, in-situ framing (as distinct from actively kiln-drying green sawn stock, where much higher temperatures combined with aggressive schedules are the norm) [Published, general drying-industry description — Tier 3].

The relevant physical hazard the ceiling is meant to guard against is uneven or excessive drying stress: USDA Forest Products Laboratory guidance on wood drying describes checking, splitting, and warping as consequences of moisture-induced stress exceeding the wood's tensile strength perpendicular to grain, driven by uneven shrinkage as different regions of a piece dry (and therefore shrink) at different rates [Published, Tier 1]. This mechanism is temperature-and-humidity-driven in industrial kiln drying of green/high-moisture stock, and the same underlying physics applies qualitatively to in-situ framing, but the FPL literature located in this research describes kiln-drying schedules for green lumber, not restoration-drying schedules for previously seasoned, already-installed framing that has been re-wetted — a materially different starting condition (lower average moisture content, thinner wetted zone, shorter exposure) for which no directly applicable published temperature ceiling was found. MCA's 32°C ceiling should therefore be understood as a precautionary engineering choice informed by this general mechanism, not a citation-backed limit, and it is additionally conservative with respect to adhesive bond-lines in any co-located engineered members, for which no manufacturer thermal limit specific to restoration drying was located in this research (flagged as a gap, Section 15).

6. Relative-humidity limitations

The RH floor (30%, emergency OFF), control target (35%, cycles OFF at/below), and restart threshold (45%, cycles ON above) are, like the temperature ceiling, MCA-derived provisional controller settings. No source located in this research publishes a minimum safe ambient relative humidity specifically for drying in-situ structural framing timber. The closest published analogue found relates to industrial timber kiln drying of green sawn logs, where allowing kiln-chamber RH to fall below roughly 40–50% while internal log moisture content remains high (above ~25%) is described as risking a defect called "cementation," and where allowing chamber RH below roughly 45% generally is associated with increased log-splitting failure rates [Published, Tier 3, patent/technical literature on log-drying kilns]. This is offered here only as a cautionary physical analogue — it describes a fundamentally different process (drying green logs from a very high starting moisture content inside a sealed, high-temperature industrial kiln) and must not be read as a validated ambient-RH floor for restoration drying of already-seasoned, re-wetted framing in an occupied building. MCA's 30%/35%/45% values sit comfortably above this industrial cautionary zone, which supports (without proving) that they carry a reasonable margin.

Separately, published equilibrium moisture content (EMC) data indicate that softwood framing held at roughly 20°C and 50% RH will equilibrate to approximately 9% moisture content [Published, Tier 3 trade summary of IICRC/FPL sorption data]. This confirms that the app's 35–45% RH control band is well below the EMC that would correspond to a "wet" framing condition, and is consistent with — though not a substitute for — direct material moisture readings when judging whether framing is actually dry.

7. GPP, dew point, vapour pressure, and condensation considerations

Drying is driven by vapour-pressure differential: wetter materials have locally higher vapour pressure than the surrounding air, and evaporation continues only while that differential is maintained (i.e., the surrounding air is drier, in absolute terms, than the material's internal vapour pressure) [Published, general psychrometric restoration-industry description — Tier 3]. Grains-per-pound (GPP), an absolute-humidity measure, is described in restoration trade literature as a required daily monitoring parameter alongside temperature, RH, and material moisture content, precisely because RH alone (a relative measure that changes with temperature) can be misleading about the true drying potential of the air [Published, Tier 3 trade-magazine description of IICRC S500 Chapter 12 monitoring practice].

The specific condensation hazard relevant to cavity-enclosed framing is dew-point crossing: if a cold interior surface (the back of remaining plasterboard, a cold water pipe, an external-wall vapour-permeable membrane) falls below the dew point of the air inside the cavity, moisture will condense on that surface, potentially re-wetting adjacent framing even as the bulk of the cavity air appears to be drying [Published, general building-science description — Tier 3]. This is a specific mechanism supporting the app's "controlled" automation mode and its emphasis on paired sensing: reducing ambient RH lowers the dew point and reduces this risk, but an operator relying solely on a fast ambient RH drop as evidence of progress, without confirming actual framing moisture content, could be operating in a room where a localised cold surface is still actively condensing. This reinforces, from a different angle, the Section 4 point that ambient RH-drop metrics are a control convenience and not a moisture-content proxy.

8. Airflow and equipment selection

Because most structural framing is enclosed, effective drying access typically requires either full lining removal (baseboard/plasterboard removal exposing studs directly to room air movers) or cavity-injection systems that force dry, moving air into the wall cavity through drilled or existing penetrations, creating positive pressure that pushes humid air and moisture out of otherwise-inaccessible zones [Published, general restoration-industry description — Tier 3]. Trade-literature guidance on general structural drying (not framing-specific) describes air-mover placement density of roughly one unit per 50–70 square feet of wet floor and one per 100–150 square feet of wet wall or ceiling surface above two feet, with airflow velocity around the wetted surface commonly targeted near 600 feet per minute during the initial "constant rate" drying phase, tapering to roughly 150 feet per minute alongside increased dehumidification once the material enters a "falling rate" drying phase [Published, Tier 3 trade/practitioner paraphrase of proprietary S500 structural-drying guidance]. These figures are general water-damage-restoration airflow conventions, not structural-framing-specific engineering values, and MCA should treat them as a starting reference for equipment layout planning rather than as inputs to the automated control logic itself, which operates on ambient temperature/RH/rate rather than airflow velocity.

LGR (low-grain refrigerant) dehumidification is generally preferred over desiccant dehumidification for in-cavity/whole-room drying in temperature ranges compatible with refrigerant systems, because LGR units perform well at the moderate RH bands the app targets; desiccant units become comparatively more valuable at lower temperatures or where very low absolute humidity is required. No source located in this research specifies an equipment-selection rule unique to structural timber framing as distinct from other porous building materials; equipment choice should follow standard restoration-industry sizing practice rather than a timber-specific protocol.

9. Staged drying strategy

The app's six-stage model (assessment → stabilising → bulk → equalising → ready_to_verify → blocked) maps reasonably well onto the general dry-standard-driven philosophy described in Section 4, with the 50%-of-base-cap restriction during assessment/stabilising/equalising and 100% during bulk representing an MCA-derived risk-graduated approach: caps are loosened only once a baseline, a dry-standard comparator, a confirmed falling trend, recency, and a clean distress inspection have all been satisfied. This is a sound structural principle — it prevents the controller from running at full aggressiveness before there is direct evidence the framing is actually responding — but the specific numeric factors (50%/100%) are not derived from any published material-specific data; they are a proportional throttling convention applied uniformly regardless of material, and their timber-specific fitness has not been separately validated.

Given the structural/durability stakes described in the background (moisture content has load-bearing and durability significance for framing, not merely a cosmetic one) and the decay-colonisation timeframes discussed in Section 11, this chapter recommends (Section 14) treating "bulk" stage promotion for Timber Frame specifically as requiring a longer confirmed-falling-trend window than the current generic 6 hours, given that ambient RH can fall quickly while stud-core moisture content lags — meaning a 6-hour ambient confirmation window is more likely to reflect air-conditions momentum than confirmed material response for this particular material.

10. Monitoring, sensor placement, and material readings

Direct material moisture readings for framing require either drilled inspection access or lining removal, and should use a resistance or capacitance moisture meter with the correct species/treatment correction factor as described in AS/NZS 1080.1 methodology (oven-drying is the accepted reference/arbitration method but is destructive and impractical for routine field monitoring) [Published, Tier 1, standard description only — MCA does not hold a licensed copy for clause-level correction tables]. Readings should be taken at consistent, marked, and photographed locations to allow trend comparison over time, a practice explicitly recommended in secondary IICRC S500 trade guidance [Published, Tier 3].

Priority inspection/sensor locations, informed by WoodSolutions field guidance, are bottom plates directly above slabs and the lowest 300–600mm of studs, which retain moisture longest and are most prone to wicking from slab-edge or capillary sources [Published, Tier 2]. The dry-standard comparator reading should be taken from the same species, same treatment class, same member type and orientation, and ideally the same wall assembly, in an unaffected part of the structure — matching meter, matching correction factor — to be a valid comparator; a mismatch here (e.g., comparing treated pine framing against an untreated hardwood window lintel) would produce a misleading baseline.

Ambient paired sensing (room-air temperature/RH plus, where practical, in-cavity temperature/RH via a probe through a drilled access point) supports the dew-point and vapour-pressure reasoning in Section 7 and gives the controller a proxy signal between the less-frequent direct material readings, but per Section 4 it must never be treated as a substitute for the material reading itself when the app makes stage-promotion or completion decisions.

11. Damage indicators and mandatory stop conditions

Published decay science indicates the minimum moisture content permitting new fungal colonisation is variously estimated at 24–31%, while previously colonised brown-rot fungi can sustain active decay down to roughly 20% moisture content, and meaningful decay progression generally requires moisture content sustained above roughly 20–25% for a prolonged period rather than a brief exposure [Published, USDA Forest Products Laboratory-sourced research — Tier 1]. Separately, mould (a surface/health hazard, distinct from structural decay fungi) is widely reported in restoration literature to be capable of visible establishment within 24–72 hours of sustained wetting, with deeper material colonisation reported within one to two weeks under continued wet conditions [Published, Tier 3 restoration-industry sources] — meaning mould risk timelines are materially faster than structural decay-fungus timelines, and the two should not be conflated when assessing "distress."

Mandatory stop/distress conditions that should block automated cycling and force specialist/human review include: visible checking, splitting, or warping of exposed framing; cupping or camber in engineered members (LVL, I-joist) suggesting differential-face wetting or possible bond-line compromise; visible fungal growth, fruiting bodies, or musty/earthy odour; fastener corrosion staining, visible fastener loosening, or connection movement; and any structural racking or deflection beyond what was present pre-loss. Repeated wetting/drying cycling is also independently documented in peer-reviewed research to reduce nail withdrawal capacity and accelerate corrosion-driven degradation of the wood immediately around fasteners [Published, peer-reviewed — Tier 1], which supports treating fastener-related observations as a first-class distress indicator rather than a secondary cosmetic note, and supports avoiding unnecessary wet/dry cycling of framing beyond what is needed to reach the dry standard.

12. Mixed-material implications

Under the app's governing-limits model, the lowest temperature ceiling, highest RH floor, lowest RH ceiling, and lowest rate cap across all materials selected for a room govern the shared equipment. Timber Frame's current settings (32°C, 30% floor, 35% target, 45% restart, 2.5/10 pp base caps at 50%) are moderate rather than extreme in either direction relative to other material profiles MCA is likely to register (e.g., gypsum-based linings typically tolerate faster RH swings; some flooring materials may warrant tighter caps). The practical risk cuts both ways, as flagged in the background: if Timber Frame's cap is set more conservatively than is actually necessary, it can needlessly throttle the drying of co-located, faster-tolerant materials in a mixed room; if set more aggressively than warranted, it risks the specific structural hazards in Section 11 for the framing itself, while framing is frequently the last material to fully dry because it sits deepest in the assembly and behind other materials that dry faster.

Because Timber Frame is very often present in the same room as multiple other governed materials (linings, flooring, insulation), and because its access constraint (cavity-only monitoring) makes its actual drying state harder to verify in real time than the room's ambient conditions, this chapter recommends that any change to Timber Frame's numeric caps be evaluated specifically for its knock-on effect on shared-equipment behaviour in mixed rooms, not considered in isolation — a governing-limits sensitivity check is listed as a required validation step in Section 15.

13. Assessment of the current MCA profile

The stage-gating architecture (baseline + dry standard + >=6h falling-trend re-check + <=24h recency + distress-free inspection before "bulk," and a hard distress block on automation) is well aligned with the general dry-standard-comparator philosophy found in secondary IICRC S500 practitioner literature, even though the specific numeric moisture-content endpoint used by that literature (roughly 16–20% MC, or within 2–4 percentage points of dry standard) is not currently encoded as an explicit target inside the app's promotion logic as described to this researcher — it is implied by the comparative-reading requirement but not stated as a numeric gate. This is a reasonable design choice given the access constraints described in Section 1, but it does mean the app currently leans on a qualitative "falling trend vs dry standard" test rather than a quantitative MC-percentage endpoint.

The temperature ceiling (32°C) and RH band (30%/35%/45%) are plausible, moderate, precautionary settings with no direct evidence of being unsafe in either direction, but neither is supported by a Timber-Frame-specific published source — both are MCA engineering derivations, consistent with the general drying-industry conventions described in Sections 5–6. The RH-drop-rate caps (2.5/10 pp during conservative stages, 5.0/20 pp during bulk) are, as required to be stated plainly by this chapter's brief, entirely MCA derivations: no source located in this research publishes a universal safe ambient-RH-drop rate for structural framing timber, and this research did not find one. The 50%/100% stage-factor structure is a sound risk-graduated pattern in principle but is a generic proportional convention, not evidence that 50% and 100% (rather than, say, 40%/90%) are the objectively correct multipliers for this specific material.

The single area where this chapter recommends a concrete strengthening, rather than merely re-labelling confidence, is the promotion-into-bulk falling-trend window: given that ambient RH responds faster than stud-core moisture content (Section 4, Section 7), and given the higher consequence of premature promotion for a load-bearing material (Section 11), a 6-hour confirmation window is arguably too short specifically for Timber Frame, even though it may be appropriate for faster-responding materials.

14. Recommended app parameters

Parameter table — CURRENT vs PROPOSED (Timber Frame)

Parameter	CURRENT	PROPOSED	Confidence	Basis
Control disposition	Automation mode: controlled	Unchanged: controlled	Medium	MCA derivation; no evidence found to loosen to "automatic" or tighten to "manual-only" given cavity-access constraint
Maximum temperature	32°C	Unchanged: 32°C	Medium	MCA derivation; consistent with general 25–35°C restoration-drying convention; no timber-framing-specific ceiling published
Emergency RH floor	30%	Unchanged: 30%	Low–Medium	MCA derivation; sits above the ~40–45% cautionary zone seen in industrial kiln-drying literature (different process, analogue only)

Parameter	CURRENT	PROPOSED	Confidence	Basis
Normal control target RH	35%	Unchanged: 35%	Low	MCA derivation; below EMC-implied "wet" thresholds but not framing-specific
Restart RH	45%	Unchanged: 45%	Medium	MCA derivation; provides hysteresis band against short-cycling
Max RH drop (pp/hour) — conservative stages	2.5	Unchanged: 2.5	Unsupported	No published universal ambient RH-drop rate exists for timber framing; retained as a precautionary MCA convention pending field validation
Max RH drop (pp/24h) — conservative stages	10.0	Unchanged: 10.0	Unsupported	As above
Max RH drop (pp/hour) — bulk stage	5.0	Unchanged: 5.0	Unsupported	As above
Max RH drop (pp/24h) — bulk stage	20.0	Unchanged: 20.0	Unsupported	As above
Assessment/ stabilising/ equalising factor	50% of base	Unchanged: 50%	Low	Generic proportional convention; not material-validated

Parameter	CURRENT	PROPOSED	Confidence	Basis
Bulk factor	100% of base	Unchanged: 100%	Low	Generic proportional convention; not material-validated
Minimum falling-trend confirmation window (promotion into bulk)	>=6 hours	>=12 hours (Timber Frame-specific override)	Low–Medium	MCA derivation: stud-core MC change lags ambient RH change; a longer window reduces risk of premature promotion for a load-bearing material without a published numeric basis for the exact figure
Maximum reading age for promotion	<=24 hours	Unchanged: <=24 hours	Medium	Consistent with dry-standard-comparator recency conventions in secondary S500 literature
Material reading method / dry-standard requirement	Baseline + same-meter dry standard, falling trend, distress-free	Unchanged, plus: require matched species/treatment-class dry standard and record moisture-meter correction factor used	Medium	AS/NZS 1080.1 requires species/treatment correction factors for meter accuracy; current policy does not explicitly require the comparator to be matched on treatment class

Parameter	CURRENT	PROPOSED	Confidence	Basis
Warning/ shutdown/restart utilisation thresholds	Warn at 90%, restart below 60% (rate budget)	Unchanged	Medium	Inherited controller-wide convention, not material-specific; no timber evidence to justify a different threshold
Target completion moisture content (advisory, not currently a hard gate)	Not explicitly encoded	Add advisory target: <=~20% MC or within ~2–4 pp of dry standard, whichever is tighter	Medium	Published secondary S500 practitioner guidance and WoodSolutions "below 20% and mould-free" reuse benchmark; advisory only, requires direct meter reading, not ambient-RH inference

Claim-to-source mapping table

Numeric claim	Source / derivation
~15% seasoned framing MC benchmark; 25–100%+ unseasoned	Secondary interpretation of AS 1684 span-table assumptions (Tier 3) — AS 1684 itself proprietary, not verified at clause level
AS/NZS 1080.1 oven-drying reference method + meter correction factors	AS/NZS 1080.1 standard summary (Tier 1 description) — proprietary, not verified at clause level
Decay fungi colonisation ~24–31% MC; sustained decay down to ~20% MC	USDA Forest Products Laboratory-sourced research on wood decay (Tier 1)
"<20% MC and mould-free generally reusable"	WoodSolutions / Forest and Wood Products Australia, referencing TDG-12 (Tier 2)
Mould visible in 24–72h; deeper colonisation 1–2 weeks	General restoration-industry sources (Tier 3)

Numeric claim	Source / derivation
Checking/splitting mechanism (uneven shrinkage stress > transverse tensile strength)	USDA FPL Wood Handbook, Ch. 13 (Tier 1)
Kiln RH <40–50% + high internal MC risks cementation/splitting (industrial kiln analogue)	Log-drying kiln technical/patent literature (Tier 3) — different process, analogue only
Softwood EMC ~9% at 20°C/50%RH	Secondary trade summary of FPL/IICRC sorption data (Tier 3)
S500 dry-standard goal: within 2–4pp of unaffected reference, or <16–20% MC	Secondary IICRC S500 practitioner/trade summaries (Tier 3) — S500 itself proprietary
LVL/I-joist manufactured MC ~5–6%; glulam ~12%	Manufacturer technical bulletin, Roseburg (Tier 2)
Glulam swelling/shrinkage ~0.24%/1% MC change	Peer-reviewed swelling/shrinkage study (Tier 1)
Repeated wetting/drying reduces nail withdrawal capacity, accelerates corrosion	Peer-reviewed nail withdrawal/corrosion study (Tier 1)
All RH-drop-rate caps (2.5/10, 5.0/20 pp) and 50%/100% stage factors	MCA derivation — no published universal ambient RH-drop rate for timber framing was found
32°C temperature ceiling; 30/35/45% RH band	MCA derivation, informed by general drying-industry convention and EMC data, not a timber-framing-specific published limit
Proposed >=12h falling-trend window for bulk promotion	MCA derivation, informed by qualitative MC-lag reasoning (Section 4, Section 7); no published numeric basis for the specific figure

15. Evidence gaps, assumptions, and required specialist overrides

No source located in this research publishes a universal ambient-air relative-humidity drop-rate limit for structural framing timber drying; this is a confirmed gap, not an oversight, and all four rate-cap values in the current profile remain MCA engineering derivations pending either (a) commissioning of MCA's own field-correlation data between ambient RH-drop rate and measured stud-core moisture-content change, or (b) a future published source this research did not locate. AS 1684, AS/NZS 1080.1, and IICRC S500 are all proprietary, paywalled standards; MCA does not currently hold licensed copies, and nothing in this chapter should be read as a clause-level compliance claim against any of them — before relying on this chapter's numeric proposals in a legal, insurance, or engineering-liability context, MCA should obtain licensed copies of AS 1684, AS/NZS 1080.1, and the current IICRC S500 edition and have a suitably qualified person verify clause-level detail directly.

Other unresolved gaps: no Australian-conditions field data was found correlating ambient RH-drop rate with actual measured framing MC change during restoration drying (as distinct from laboratory or kiln settings); no manufacturer-published thermal or drying-rate limit specific to LVL/glulam/I-joist bond-line integrity under restoration-drying conditions was found; hardwood framing moisture-response data specific to Australian species was not separately located and should not be assumed identical to the softwood data cited here; and no quantified decay-risk timeline specific to H2/H3-treated pine under restoration-drying delay scenarios was found (treatment-class decay resistance is qualitatively described but not time-quantified in the sources reviewed).

Before MCA relies on this chapter's proposed parameters operationally, the following steps are recommended: (1) engineering/specialist sign-off from a structural or timber engineer, or a WoodSolutions/industry technical advisory contact, on the proposed >=12-hour bulk-promotion window and the advisory <=20% MC / within-2–4pp completion target; (2) moisture-meter calibration against manufacturer specification and, where feasible, cross-check against AS/NZS 1080.1 oven-drying reference readings on sacrificial samples; (3) a pilot-job field validation phase logging paired ambient-RH and direct stud-core MC readings to test whether the RH-drop-rate caps and the proposed dwell-time change actually track real material drying behaviour before removing human review from any promotion decision; (4) a governing-limits sensitivity check confirming how any proposed Timber Frame parameter change affects shared-equipment behaviour in realistic mixed-material rooms (Section 12); (5) document retention of all moisture-meter readings, calibration certificates, dry-standard comparator photographs, and distress inspection logs for the life of the file, given the load-bearing/durability (not merely cosmetic) significance of this material and the corresponding legal exposure if drying decisions are later challenged.

16. References

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1. Roseburg Forest Products, "Technical Note: Effects of Moisture on I-joists and LVL," https://www.roseburg.com/resources/technical-note-effects-of-moisture-on-i-joists-and-lvl/. Accessed 22 July 2026. Tier 2.
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Carpet & Underlay

Research packet: claude-c2-floor-coverings.md | 3,928 words | 8 URL references | The packet is commentary for review, not a certified limit.

Scope: this chapter separates source-supported observations, operational assumptions, unresolved uncertainty, and field verification requirements for this material.

1. Scope and material identification

This profile covers the generic "Carpet & Underlay" selection in the MCA app: a textile floor covering (broadloom or, less commonly, carpet tile) installed over a separate cushion/underlay layer, typically on a concrete or timber subfloor. The profile is deliberately generic — it is used when the technician has not yet, or cannot, distinguish fibre type (wool, wool-blend, or synthetic) or underlay construction (rebonded polyurethane foam, waffle rubber, felt, or fibre). The app policy note attached to this profile in migration `0006_history_aware_drying.sql` records that the generic profile "uses the slower wool rate," i.e. it is intentionally the more conservative of the two carpet profiles in the app (the other being "Carpet - Synthetic," covered as Profile 2 below). This profile should be treated as a holding classification: it is appropriate for initial assessment and for wool, wool-blend, or mixed-composition carpet, but a technician who has confirmed a 100% synthetic (nylon, polyester, polypropylene/olefin, or triexta) face fibre with a closed-cell foam or rubber underlay should consider whether the Carpet - Synthetic profile better reflects the material's actual heat and moisture tolerance.

Carpet construction relevant to drying comprises: (a) the face fibre (wool, nylon, polyester, polypropylene, triexta, or blends); (b) the primary backing, into which fibre tufts are anchored; (c) a latex adhesive coating that locks the tufts in place; (d) a secondary backing (jute, woven synthetic, or fibreglass-reinforced) laminated to the primary backing with more latex; and (e) a separate underlay/cushion beneath the carpet, most commonly rebonded polyurethane foam ("rebond"), though waffle rubber, prime urethane, and needle-punched felt are also used in Australia. Each of these five components has a different moisture-holding capacity and a different drying rate, and the underlay is consistently the slowest-drying and highest-risk component of the assembly.

2. Material construction and moisture behaviour

Wool fibre is strongly hygroscopic. CSIRO's published wool-science work records a standard moisture regain for wool of approximately 17% at 20°C and 65% RH, rising to a saturation regain of approximately 35% at 100% RH (CSIROpedia, "Objective measurement of wool" — published fact, Tier 1). This means wool carpet face fibre can hold a substantial mass of water without visibly dripping, and ambient RH strongly influences how much residual moisture the fibre retains at equilibrium. Synthetic fibres such as nylon, polyester, and polypropylene are essentially non-absorbent at the fibre level; any water present in a synthetic-face carpet is held mechanically between filaments and in the backing/underlay rather than absorbed into the fibre itself, so synthetic-face carpet drains and surface-dries faster than wool for a given extraction effort (general fibre-science distinction, corroborated by carpet-industry fibre guides — Tier 3, used here only to explain mechanism, not to set a limit).

The primary and secondary backings are held together by a styrene-butadiene latex adhesive. Aggregator sources reviewing carpet-industry material describe that this latex loses mechanical strength while wet and regains it on drying, and that the calcium-carbonate filler commonly used in the latex softens under prolonged saturation (Tier 3, corroborates a widely cited restoration-industry mechanism but is not a primary manufacturer specification). This is the basis for treating wet carpet gently — pulling, folding, or aggressively walking on saturated carpet can shear the latex bond before it has re-cured, producing delamination that would not have occurred from the water alone.

The underlay is the component of greatest concern. Restoration-industry sources describe carpet cushion — particularly rebonded polyurethane foam — as holding water long after the visible carpet face feels dry, with one restoration-industry account citing a cushion still registering roughly 40% moisture content three days after a loss even though the carpet surface felt dry (Tier 3, illustrative rather than a verified controlled measurement). Whether or not that specific figure generalises, the underlying mechanism it illustrates — that a foam or rubber underlay is a reservoir that face-fibre surface-dryness does not reveal — is consistent with the IICRC's long-standing "in-place drying" guidance discussed in Section 3, which explicitly treats pad and carpet as separately assessed layers.

3. Water exposure, contamination, and salvageability

The IICRC's water-category framework governs whether carpet and underlay may be dried in place at all. The IICRC's Technical Advisory on "In-Place" Drying, adopted 18 July 2004, states that in-place drying of Category 1 (clean-water-source) losses by a qualified and competent restorer can reduce the need to disengage carpet, remove pad, dispose of debris, replace pad, and reinstall carpet and mouldings (IICRC Technical Advisory on In-Place Drying, 2004 — published fact, Tier 1, publicly mirrored via SCRT). This advisory is specific to Category 1 water and to carpet and pad found, on inspection, to be free of pre-existing contamination.

For Category 2 (grey) water, restoration-industry summaries of the S500 standard consistently describe carpet pad as being removed even when the carpet face fibre itself may be salvaged, because the pad's absorbency and long moisture-retention time make it a disproportionate contamination and microbial risk relative to its replacement cost (Tier 2, standard-summary sources; not independently verified against a licensed S500 copy by this report). For Category 3 (grossly contaminated/black) water, the same class of sources describes both carpet and pad as required to be removed and discarded, with no in-place drying option, because porous materials cannot be reliably decontaminated (Tier 2). MCA has not reviewed a licensed copy of ANSI/IICRC S500 (4th or 5th edition) directly; the Australian adoption of this standard is confirmed by the IICRC's own publication notice (AS-IICRC S500, published March 2025

— Tier 1), but section-level detail should be verified by a technician against a licensed copy before being used to justify a salvage decision in a report intended for legal or insurance reliance.

The Carpet and Rug Institute's consumer/trade guidance is unambiguous that heavily soiled or sewage-contaminated carpet should not be attempted for restoration: CRI states that highly absorbent materials contaminated by sewage cannot reliably be disinfected by washing, even at elevated temperature, and recommends professional disposal rather than restoration in that case (Carpet and Rug Institute, "Cleaning and Maintenance," carpet-rug.org — published fact, Tier 1). CRI also states that extraction and fan-assisted drying should begin, ideally, within 24 hours of a clean-water loss, and separately notes that wet cushion/pad is difficult to dry adequately even where the carpet itself is salvageable (CRI, same source — published fact, Tier 1). Practically, this profile's "controlled" automation mode should be understood as applying to Category 1 losses where the technician has confirmed the underlay does not require removal; where pad removal is warranted, drying reverts to drying the exposed subfloor rather than the carpet assembly.

4. Drying objectives and completion criteria

There is no single published dry-standard percentage for carpet or carpet cushion moisture content analogous to the timber or gypsum dry-standard figures used elsewhere in this manual, because carpet drying goals are conventionally expressed by comparison to an unaffected reference area of the same carpet and underlay in the same building, rather than by an absolute moisture-content number (consistent with the general S500 structural-drying principle summarised by Tier 2 sources as returning affected materials to within a small margin of an unaffected reference reading). The MCA app's existing "dry standard" model — entering a comparative reading from an unaffected area on the same meter and scale — is directly applicable to carpet and is the correct completion-criterion mechanism for this material; no numeric override is proposed here.

In practice a drying goal for this profile should be established from (a) a moisture-meter comparative reading of the carpet face fibre and backing at an unaffected reference point, and (b) where the underlay was not removed, a separate check that the underlay itself no longer registers materially wetter than a reference point, since the underlay is both slower-drying and less visible to a surface inspection than the face fibre. No source located in this research publishes an underlay-specific numeric moisture target; this is an evidence gap addressed in Section 15.

5. Temperature limitations

Wool fibre wet-felting is the dominant temperature-related mechanism specific to this profile. Textile-care sources describe wool felting as the combined product of moisture, heat, and mechanical agitation: heat opens the fibre's outer scale structure, water acts as a lubricant allowing scales to interlock, and the resulting shrinkage/matting is irreversible (general textile-science consensus — Tier 3, but consistent across independent sources and matching well-established wool-science understanding). Because wet wool carpet is by definition already in the "moisture present" condition, elevated drying-air temperature is the remaining lever that must be kept conservative to avoid accelerating felting, particularly if any foot traffic or air-mover-induced fibre movement occurs during drying.

The latex backing adhesive is the second temperature-sensitive component: it is described in restoration-industry material as regaining strength once dry but as vulnerable to disruption while still wet, and prolonged elevated temperature while saturated is generally treated by the industry as a factor that can accelerate delamination risk (Tier 3, mechanism-level corroboration, no manufacturer-specified numeric ceiling located). No manufacturer or standards source located in this research publishes an explicit maximum air temperature for drying wet carpet. The current MCA maximum of **32°C** for this profile is therefore an **MCA derivation**: it sits comfortably below the temperatures at which synthetic fibres begin to soften (Section 6 of the "Carpet - Synthetic" profile below) and is conservative enough to avoid compounding wool-felting risk, while still being warm enough to support normal LGR/air-mover drying. It is retained as-is in this report's recommended parameters.

6. Relative-humidity limitations

No source located in this research publishes a material-specific safe ambient RH range for drying wet carpet. The commonly cited general indoor-comfort/mould-control range of 30–50% RH (attributed in aggregator sources to US EPA general guidance, Tier 2/3) is a whole-building comfort and mould-prevention recommendation, not a carpet-drying-specific control band, and should not be treated as validating a carpet drying limit on its own. The current MCA policy for this profile — a 30% emergency floor, 35% control target, and 45% restart point — sits inside that general comfort band and is consistent with, but not derived from, it.

The MCA app's static informational reference card for this material (`lib/guide-references.ts`) currently displays a different RH band — 40% floor to 55% ceiling — than the live database control policy of 30% floor to 60% ceiling set by migration `0006_history_aware_drying.sql`. Both numbers cannot be simultaneously "the" MCA position on this material; this is flagged as an evidence/consistency gap in Section 13 and Section 15 rather than resolved unilaterally in this report, because resolving it requires deciding which figure reflects current engineering intent.

7. GPP, dew point, vapour pressure, and condensation considerations

Grains per pound (GPP) and dew point apply to this profile in the same physical sense as to any porous material: drying proceeds when the vapour pressure at the wet carpet/underlay surface exceeds the vapour pressure of the surrounding air, and that differential collapses as ambient GPP rises. No source located in this research publishes a carpet-specific GPP target; the general structural-drying practice of maintaining a measurable grain depression across the dehumidifier (entering GPP minus leaving GPP) as evidence that moisture is being actively removed, referenced in the app's own guide page, is directly applicable here and is not disputed by anything found in this research.

The condensation risk specific to carpet and underlay is under-slab or on-slab surface condensation: if a concrete slab beneath the carpet is significantly cooler than the dew point of the room air (for example, an on-ground slab in a cool climate zone, or a slab still cooling from recent water contact), moisture can condense at the carpet/slab interface even while the room's ambient RH is being actively reduced. This is a known general psychrometric risk rather than a carpet-specific published finding, and is best addressed by monitoring slab or subfloor surface temperature relative to calculated dew point, consistent with the cross-cutting psychrometrics guidance referenced elsewhere in this research programme (see Gemini G4).

8. Airflow and equipment selection

No carpet-specific airflow-rate standard was located. General restoration-industry guidance summarised in Tier 2 sources places commercial air movers at a density of roughly one mover per 12–16 linear feet of wall for structural drying generally; this is not carpet-specific and is offered as context only. For carpet and underlay specifically, the practical airflow objective is to disturb the boundary layer at the carpet face while also promoting airflow beneath the carpet where the underlay is left in place — commonly achieved by lifting and propping carpet edges (without breaking the latex bond at seams) or using specialised low-profile air movers designed to direct air into the carpet/underlay interface. LGR dehumidification is the general-purpose choice for typical Australian ambient temperature ranges; desiccant dehumidification may be warranted where ambient temperature must be kept low for wool-felting-risk reasons while a very low GPP target is still required, since desiccant units achieve low absolute humidity without the ambient temperature dependence of LGR refrigerant units.

9. Staged drying strategy

The app's general staged-drying model (assessment → stabilising → bulk → equalising → ready-to-verify → blocked), defined in `lib/material-drying-stage.ts`, applies to this profile without modification, since nothing in the evidence reviewed here suggests carpet and underlay need a materially different staging logic from other controlled profiles. The assessment stage (no linked comparative reading yet) and stabilising stage (readings exist but have not yet demonstrated a falling trend over the required 6-hour minimum) are both appropriately conservative for a material whose underlay reservoir effect (Section 2) means early readings of the carpet face fibre alone can understate how much moisture remains in the assembly. The equalising-stage trigger (20% or less of original excess remaining) is a generic, non-material-specific rule; nothing found in this research argues for a carpet-specific override of that fraction.

One carpet-specific addition worth flagging for specialist consideration: because the underlay is the slowest-drying and least-visible component, a technician relying solely on a face-fibre comparative reading to advance from stabilising to bulk could be misled by a carpet that reads dry at the surface while the underlay beneath it remains wet. This is not a defect in the app's staging logic — the logic already requires a linked comparative reading rather than time alone — but it is a material-handling point that should be reflected in field procedure: where practical, the comparative reading taken for this profile should include or be corroborated by an underlay-level reading, not the face fibre alone.

10. Monitoring, sensor placement, and material readings

Non-invasive (capacitance/scanning) moisture meters are the practical first tool for mapping the extent of a carpet-and-underlay loss, because they can be swept across the surface without penetrating the carpet backing; pin-type meters, where used, should be applied with the understanding that a reading taken through the carpet face alone will not characterise the underlay. Sources describing in-place drying procedures reference the use of a moisture probe to establish the perimeter of moisture migration in carpet and pad before deciding on a drying-in-place versus removal strategy (IICRC Technical Advisory on In-Place Drying, 2004 — published fact, Tier 1). Ambient thermo-hygrometer readings at multiple heights in the room, plus a slab/subfloor surface-temperature reading where accessible, complete the minimum monitoring set. The app's system-wide minimum of five valid environmental readings spanning at least 30 minutes before a rate guard becomes active (from `lib/material-automation.ts`) applies to this profile without a carpet-specific adjustment; nothing in the sources reviewed argues that carpet needs a faster or slower sampling cadence than other controlled materials.

11. Damage indicators and mandatory stop conditions

Drying must stop and the material must be reassessed for removal where any of the following are observed: visible delamination of the primary and secondary backing (bubbling, ridging, or separation felt underfoot); persistent musty odour after 48–72 hours of active drying, which is treated across restoration-industry sources as an indicator of bacterial or fungal activity in the pad or subfloor rather than the carpet face; any staining consistent with dye bleed or colour transfer from the underlay into the carpet backing; and visible microbial growth on the carpet back, underlay, or exposed subfloor. Consistent with CRI guidance (Section 3), sewage or other Category 3 contamination discovered mid-drying is an immediate stop-and-remove condition regardless of how the drying has progressed. Where the underlay is being left in place, a technician who cannot obtain a representative underlay reading (for example, because the carpet cannot safely be lifted without breaking a seam) should treat that as a monitoring gap requiring the conservative stabilising-stage rate, not as grounds to assume the underlay is dry.

12. Mixed-material implications

Carpet and underlay are almost always laid over a structural subfloor — most commonly a concrete slab in Australian construction, occasionally particleboard or timber sheet flooring — and the drying campaign for the room is governed by whichever material has the slowest safe rate and lowest safe temperature, per the app's existing governing-limits logic in `lib/material-automation.ts`. Where the subfloor is bare or covered concrete, Section 7's slab-condensation risk becomes materially more important, because a slab that is itself still curing moisture out from a prior pour, or that has not yet reached the covering manufacturer's acceptance criterion under ASTM F2170/AS 1884-style testing (discussed under the Vinyl/LVT profile below, and equally applicable to a carpeted slab), may continue to emit moisture into the underlay long after the carpet's own water event has been resolved. Where timber-frame subfloor sheeting is present beneath the carpet, its drying goal (a timber moisture-content dry standard, materially slower than carpet) will typically become the governing rate for the room, consistent with how the app's governing-limits function already treats multi-material selection.

13. Assessment of the current MCA profile

The current profile's automation mode ("controlled"), temperature ceiling (32°C), and RH band (30% floor / 60% ceiling per the live database policy) are all defensible as conservative provisional settings: the temperature ceiling sits below every synthetic-fibre softening threshold identified in this research and is conservative against wool-felting risk; the RH band sits inside the general comfort/mould-control range cited by aggregator EPA-attributed sources. However, this research identified two consistency issues that a specialist review should resolve rather than this report unilaterally correcting:

First, the informational reference card for this material in `lib/guide-references.ts` shows an RH band of 40–55%, which does not match the live governing policy of 30–60% set in the database by migration `0006_history_aware_drying.sql`. A technician reading the in-app guide page for context could form an incorrect impression of the material's actual control envelope.

Second, the profile remains generic across wool, wool-blend, and any synthetic-face carpet a technician has not yet distinguished from the dedicated "Carpet - Synthetic" profile (Profile 2 below). This is an appropriate conservative default, but it means a technician who has, in fact, confirmed a 100% synthetic face fibre with synthetic underlay is likely leaving usable drying-rate headroom on the table by remaining on this profile rather than switching to Profile 2, whose evidence base supports faster safe rates. Neither of these is a defect in the underlying automation logic; both are data-quality and UI-consistency points for specialist and product review.

14. Recommended app parameters

No evidence located in this research supports changing the current numeric envelope for this profile; the recommendation is to retain it as a labelled provisional MCA setting and to correct the informational-card mismatch identified in Section 13.

Parameter	Current (live policy)	Proposed	Confidence	Source / derivation
Control disposition	Controlled	Controlled (unchanged)	Medium	MCA derivation — Category 1 in-place drying supported by IICRC Technical Advisory (2004)
Maximum temperature	32°C	32°C (unchanged)	Medium	MCA derivation — conservative against wool felting and latex softening mechanisms; no manufacturer ceiling published
Emergency RH floor	30%	30% (unchanged)	Low	MCA derivation — no material-specific floor published
Normal control target RH	35%	35% (unchanged)	Low	MCA derivation
Restart RH	45%	45% (unchanged)	Low	MCA derivation
Max RH drop, per hour (bulk)	5.0 pp/h	5.0 pp/h (unchanged)	Unsupported (rate rule)	MCA provisional controller setting — no source publishes a universal carpet ambient RH-drop rate
Max RH drop, per 24h (bulk)	20.0 pp/24h	20.0 pp/24h (unchanged)	Unsupported (rate rule)	MCA provisional controller setting
Assessment / stabilising factor	0.5	0.5 (unchanged)	Medium	App-wide staging rule (`lib/material-drying-stage.ts`), not material-specific

Parameter	Current (live policy)	Proposed	Confidence	Source / derivation
Bulk factor	1.0	1.0 (unchanged)	Medium	App-wide staging rule
Equalising / verification factor	0.5	0.5 (unchanged)	Medium	App-wide staging rule
Min. environmental history / cadence	>=5 readings over >=30 min	Unchanged	Medium	App-wide rule (`lib/material-automation.ts`), not material-specific
Material reading method / dry standard	Comparative meter reading vs. unaffected reference, same scale	Add: where underlay is retained, corroborate with an underlay-level reading, not face fibre alone	Low	Section 9/11 mechanism finding — evidence gap, not a published standard
Warning / shutdown / restart utilisation	75% / 90% / 60%	Unchanged	Medium	App-wide rule, not material-specific
Confidence (overall)	Provisional	Provisional	—	No universal rate source located
Informational RH band shown in guide UI	40–55% (`lib/guide-references.ts`)	Align to live policy (30–60%) or explicitly label as a distinct "informational safe zone"	—	Section 13 consistency finding

15. Evidence gaps, assumptions, and required specialist overrides

No source located in this research publishes: a universal ambient RH-drop rate for carpet or carpet underlay (addressed by the rate rule and the "unsupported" confidence rating above); a numeric moisture-content dry standard for carpet cushion/underlay analogous to timber or gypsum dry standards; or a manufacturer-specified maximum drying-air temperature for wet carpet. This report assumes that a technician selecting this profile has confirmed the water category (Category 1) and has not identified pre-existing contamination, consistent with the scope of the IICRC in-place-drying advisory relied on in Section 3; the app does not currently capture water category as a discrete field, which this report flags as a candidate app enhancement rather than implementing directly, since the assigned scope of this report is research, not application code changes. A restoration specialist with a licensed copy of ANSI/IICRC S500 should confirm the category-based salvage guidance summarised in Section 3 against the current edition text before it is relied on in a legal or insurance context. The RH-band inconsistency identified in Section 13 requires a specialist or product-owner decision, not a research-agent correction.

16. References

1. IICRC, *Technical Advisory on "In-Place" Drying*, adopted 18 July 2004. https://www.scrt.org/scrt-free-reports/42-technical-advisory-on-in-place-drying/file — Tier 1, published fact. Accessed 22 Jul 2026.
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3. Carpet and Rug Institute, "Cleaning and Maintenance," undated (accessed 22 Jul 2026). https://carpet-rug.org/carpet-for-homes/cleaning-and-maintenance/ — Tier 1, published fact.
4. Standards Australia, *AS 2455.1:2019 — Textile floor coverings*, *Installation practice*, *Part 1: General* (product/scope listing). https://store.standards.org.au/product/as-2455-1-2019 — Tier 1, paywalled; MCA has reviewed only the public scope description, not the full clause text.
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6. US EPA, *Water Damage Table — Mold Prevention, Mold Remediation in Schools and Commercial Buildings* (EPA 402-K-01-001). https://www.epa.gov/mold/water-damage-table-mold-prevention-mold-remediation-schools-and-commercial-buildings — Tier 1, government agency; general 24–48 hour drying-window guidance, not carpet-underlay-specific numeric limits.
7. CSIRO, "Objective measurement of wool," CSIROpedia (accessed 22 Jul 2026). https://csiropedia.csiro.au/objective-measurement-of-wool/ — Tier 1, government research body; wool moisture-regain context.
8. Carpet Institute of Australia, *Technical Specification of Contract Carpets*, Version 1.1, 2018. https://www.carpetinstitute.com.au/wp-content/uploads/2014/12/Carpets146_Technical_Specification_v4pdf.pdf — Tier 1, recognised trade body; general carpet-construction context.

Carpet - Synthetic

Research packet: claude-c2-floor-coverings.md | 2,929 words | 8 URL references | The packet is commentary for review, not a certified limit.

Scope: this chapter separates source-supported observations, operational assumptions, unresolved uncertainty, and field verification requirements for this material.

1. Scope and material identification

This profile covers carpet whose face fibre is confirmed 100% synthetic — nylon (polyamide), polyester (PET), polypropylene/olefin, or triexta — installed with a compatible synthetic underlay (closed-cell or bonded foam, or synthetic-fibre pad), as distinct from the generic, wool-inclusive Profile 1 above. It was added to the app in migration `0007_material_drying_stages.sql` specifically to give synthetic carpet a faster provisional rate than the generic profile, on the documented basis that synthetic fibre and non-hygroscopic underlay tolerate more aggressive drying conditions than wool. This profile does not cover carpet tile with bitumen or PVC-backed tiles set in adhesive over concrete — those installations introduce an adhesive-moisture-sensitivity consideration closer to the Vinyl/LVT profile (Profile 3) than to broadloom carpet, and should be assessed individually.

Construction is the same five-layer model as Profile 1 (face fibre, primary backing, latex, secondary backing, underlay), with the material difference concentrated in the face fibre and, usually, the underlay composition. The damage-risk label already recorded against this profile in the database (`damage_risk`: "Backing delamination / underlay hydrolysis") correctly identifies that even with a moisture-tolerant face fibre, the backing and underlay remain the components most likely to fail under aggressive or prolonged drying — hydrolysis of certain polyurethane foam underlay chemistries under sustained warm, humid conditions is a recognised failure mode in the broader flooring-underlay literature, though this report did not locate a synthetic-carpet-specific numeric threshold for it (see Section 15).

2. Material construction and moisture behaviour

Nylon and polyester fibres absorb negligible water into the fibre itself; nylon's moisture regain is commonly cited in textile-science literature as roughly 4% at standard conditions, far below wool's ~17% (general textile-fibre-science distinction; the wool figure is the CSIRO-sourced Tier 1 figure from Profile 1, the nylon figure is common textile-industry knowledge used here for contrast rather than as a separately sourced numeric control input). Polypropylene/olefin is effectively non-absorbent and is widely marketed on that basis: consumer-flooring sources describe olefin as wicking moisture along the fibre surface rather than absorbing it, and as inherently unfavourable to mould and mildew growth because it provides the fungus no digestible substrate and little retained moisture (HowStuffWorks, "Choosing Carpet Fiber: Olefin (Polypropylene)" — Tier 3, consumer-education source, mechanism-level only). This means bulk water in a synthetic-face carpet assembly is overwhelmingly held in the backing, latex, and underlay rather than the fibre — the same components of concern as in Profile 1 — while the face fibre itself dries essentially as fast as it can be exposed to airflow.

The practical consequence is that a synthetic-face carpet with a synthetic underlay presents a lower fibre-level moisture reservoir and a lower risk of the wool-specific felting mechanism described in Profile 1, which is the documented basis in the migration script for giving this profile a higher rate. It does not, however, eliminate the latex-backing and underlay-hydrolysis risks common to all carpet constructions.

Polyester (PET) sits between nylon and polypropylene on absorbency but is, like both, classed as a non-hygroscopic synthetic for practical drying purposes; general textile-industry material treats all three synthetics as behaving similarly to water exposure at the fibre level, with the meaningful differences between them (recovery from crushing, colourfastness, static behaviour) being irrelevant to drying rather than to moisture retention. Triexta (PTT), a newer synthetic increasingly used in residential carpet, is likewise treated in industry literature as a non-absorbent thermoplastic fibre for the purposes of this distinction, though this report did not locate triexta-specific restoration guidance and treats it as falling within the same general synthetic-fibre category as nylon and polyester rather than as materially different. This grouping is a reasonable simplification for a single app profile: the drying-relevant property that differentiates this profile from Profile 1 is "hygroscopic natural fibre versus non-hygroscopic synthetic fibre," not the finer distinctions between individual synthetic polymer types.

3. Water exposure, contamination, and salvageability

The same IICRC water-category framework and CRI guidance discussed in Profile 1, Section 3 applies without material change: Category 1 losses are the appropriate scope for in-place drying under this profile; Category 2 losses typically require pad replacement even where the synthetic face fibre is salvaged; and Category 3 losses require removal of both carpet and pad. Nothing located in this research suggests fibre type changes the category-based salvage framework — the category framework governs contamination risk to occupants and structure, which is independent of face-fibre chemistry. Synthetic fibre's non-absorbency does mean visual/tactile "looks dry" assessment of the face fibre is even less reliable as a proxy for underlay dryness than with wool, because a synthetic face fibre will appear and feel dry very quickly regardless of how saturated the underlay beneath it remains.

4. Drying objectives and completion criteria

As with Profile 1, no numeric moisture-content dry standard specific to synthetic carpet or its underlay was located; the applicable completion method remains a comparative reading against an unaffected reference area using the app's existing dry-standard mechanism. Because synthetic face fibre surface-dries faster than wool, the specific risk noted in Section 3 — a technician mistaking early face-fibre dryness for assembly dryness — is, if anything, more pronounced for this profile than for Profile 1, and reinforces the Section 9 recommendation (below) that a linked comparative reading for synthetic carpet should not rely on face-fibre readings alone where the underlay has been left in place.

5. Temperature limitations

Polymer physical-property data locate polypropylene's glass transition temperature at roughly -10°C to 0°C — well below room temperature — meaning polypropylene fibre is already in its rubbery (not glassy) state at any normal drying condition and derives its dimensional stability from crystallinity rather than avoiding the glass transition (Jiga, "Polypropylene Glass Transition Temperature" — Tier 3, standard polymer-physics reference data). Its melting point is commonly cited at roughly 160–170°C, far above any restoration drying condition. Nylon's glass transition is cited in the range of roughly 40–80°C depending on grade and moisture content, with melting around 220–260°C (EuroPlas, "Nylon Melting Point" — Tier 3, standard polymer-physics reference data). Both figures indicate that the synthetic face fibres themselves have very wide safety margins relative to any temperature a room-drying campaign would realistically reach; fibre softening is not the limiting mechanism for this profile.

The limiting mechanism, as with Profile 1, is the latex backing adhesive and underlay foam chemistry rather than the face fibre. No manufacturer or standards source located in this research publishes an explicit maximum drying-air temperature for synthetic carpet. The current MCA maximum of **38°C** for this profile is therefore an **MCA derivation**, set higher than Profile 1's 32°C specifically because the wool-felting mechanism does not apply and because the fibre-softening thresholds identified above sit far above 38°C; it remains conservative relative to the underlay-hydrolysis concern noted in Section 1, which the evidence located in this research could not quantify with a specific temperature threshold.

6. Relative-humidity limitations

As with Profile 1, no material-specific safe ambient RH range for drying wet synthetic carpet was located. The current MCA policy — 30% floor, 35% target, 45% restart — is numerically identical to Profile 1's RH band; only the temperature ceiling and rate caps differ between the two carpet profiles. This is consistent with the evidence: RH-band risk in carpet is driven primarily by the backing/underlay and by general building mould-control considerations, both of which are largely independent of face-fibre chemistry, whereas temperature and rate risk are more fibre- and underlay-chemistry-dependent, which is exactly where this profile diverges from Profile 1.

7. GPP, dew point, vapour pressure, and condensation considerations

The physical mechanisms are identical to those described in Profile 1, Section 7: drying proceeds on the vapour-pressure differential between the wet assembly and the surrounding air, GPP-based grain depression across the dehumidifier remains the correct evidence of active moisture removal, and subfloor/slab surface-temperature-versus-dew-point condensation risk applies equally to carpet over a cool slab regardless of face-fibre type. No synthetic-carpet-specific GPP or dew-point finding was located in this research.

One point of emphasis specific to this profile: because a synthetic face fibre releases its (small) fibre-level moisture quickly, the ambient GPP trace for a synthetic-carpet room can flatten sooner than the underlying assembly is actually dry, since the ongoing evaporative load at that point is coming almost entirely from the backing and underlay rather than the fibre. A technician reading a flattening GPP or grain-depression trend as "job largely finished" for this profile should cross-check that impression against an underlay-level reading before reducing equipment, for the same reason given in Sections 4 and 9 — the ambient psychrometric trend and the assembly's actual moisture state can decouple sooner here than in Profile 1.

8. Airflow and equipment selection

Airflow guidance is unchanged from Profile 1: boundary-layer disruption at the carpet face, combined with airflow at the carpet/underlay interface where the underlay is retained, remains the objective. Because synthetic face fibre dries quickly, there is a practical risk of a technician concluding the drying campaign is complete based on rapid visible/tactile surface drying while the underlay remains wet; this reinforces rather than changes the equipment-selection guidance, and is primarily a monitoring-discipline point (Section 10) rather than an equipment-selection one. LGR dehumidification remains the general-purpose choice; no evidence located in this research suggests synthetic carpet specifically requires desiccant drying.

9. Staged drying strategy

The app's generic staging model (assessment → stabilising → bulk → equalising → ready-to-verify → blocked) applies unchanged. The higher bulk-stage rate cap for this profile (8.0 pp/h / 30.0 pp/24h versus Profile 1's 5.0/20.0) is the primary mechanism by which the app already differentiates synthetic carpet's faster, evidence-consistent drying tolerance from wool-inclusive carpet, and nothing in this research argues that the staging *logic* itself (as opposed to the rate values it applies) needs to differ between the two carpet profiles. The same underlay-reservoir caution flagged in Profile 1, Section 9 applies here, arguably with greater force, precisely because the face fibre gives a falsely reassuring dry impression sooner.

10. Monitoring, sensor placement, and material readings

Monitoring guidance is unchanged from Profile 1, Section 10, with one addition specific to this profile: because synthetic face fibre reaches apparent surface dryness faster and more uniformly than wool, a technician should place more weight on underlay-level or subfloor-level readings, and less on face-fibre "looks/feels dry" assessment, when judging whether this profile's faster bulk-stage rate remains appropriate for the specific installation. The app's system-wide five-reading/30-minute minimum sampling requirement (`lib/material-automation.ts`) applies without a synthetic-carpet-specific adjustment.

11. Damage indicators and mandatory stop conditions

The stop conditions described in Profile 1, Section 11 — backing delamination, persistent musty odour past 48–72 hours, visible microbial growth, and Category 3 contamination discovered mid-drying — apply equally here. One condition specific to this profile's higher rate cap: because the profile is deliberately run faster and warmer than the wool-inclusive default, a technician who observes any backing delamination, bubbling, or underlay odour change should treat that as a signal to reduce to Profile 1's more conservative envelope (or to the manual/blocked state) rather than assuming the faster profile's parameters remain appropriate, since backing/underlay hydrolysis (Section 1) was specifically flagged in the app's own damage-risk field for this profile and this research could not locate a quantified early-warning threshold for it.

12. Mixed-material implications

As with Profile 1, the governing-limits logic in `lib/material-automation.ts` will apply the most conservative temperature and rate figures among all materials selected for a room. Because this profile's caps are the least conservative of the two carpet profiles, a room containing both a synthetic-carpet area and a wool/generic-carpet area (for example, an open-plan living/bedroom split) will correctly be governed by Profile 1's lower caps under the app's existing "lowest cap governs" rule; no change to that logic is proposed. Subfloor considerations (concrete slab curing/testing, timber-frame drying goals) are identical to Profile 1, Section 12.

Carpet tile with a synthetic face fibre, where the backing is bitumen or PVC rather than the woven/latex construction assumed above, introduces a mixed-material question this profile does not fully resolve: a bitumen-backed carpet tile behaves, at the backing layer, more like the adhered-installation concern described for Vinyl/LVT (Profile 3, Section 2) than like broadloom carpet, because the backing itself is a moisture-trapping, low-permeability layer rather than a woven, air-permeable secondary backing. A technician working with synthetic carpet tile on a bitumen or PVC backing should weigh whether the Vinyl/LVT profile's subfloor-focused monitoring guidance (Profile 3, Sections 4 and 9) is more applicable to the installation than this profile's carpet-assembly-focused guidance, particularly where the tiles are fully adhered rather than loose-laid.

13. Assessment of the current MCA profile

The rationale documented in the app's own migration script — that synthetic fibre and underlay justify a faster provisional rate than the generic wool-inclusive profile — is consistent with the fibre-science evidence located in this research: synthetic fibres have negligible hygroscopic moisture regain and very high glass-transition/melting temperatures relative to any realistic drying condition, so the primary risk drivers shift almost entirely to the backing and underlay, which this profile's temperature ceiling (38°C) and rate caps (8.0/30.0 pp bulk) do not directly evidence-test but do keep well below the fibre-damage thresholds identified.

The most significant gap identified for this profile is that it currently has **no entry at all** in the app's informational reference card set (`lib/guide-references.ts` — confirmed by inspection: the file defines cards for "Carpet & Underlay" and "Vinyl / LVT" under the flooring category, but none for "Carpet - Synthetic"). A technician selecting this material in a job and then visiting the in-app Guide page to understand the reasoning behind its limits will find no card, mechanism explanation, or reference list for this specific profile, even though the live database policy (added in a later migration than the reference-card file) is fully configured and actively governs automation. This is a genuine content gap rather than a numeric-parameter issue, and is flagged for product/documentation follow-up rather than corrected in this research file, per this report's file-scope restriction.

14. Recommended app parameters

Parameter	Current (live policy)	Proposed	Confidence	Source / derivation
Control disposition	Controlled	Controlled (unchanged)	Medium	MCA derivation, consistent with IICRC Category 1 in-place drying advisory
Maximum temperature	38°C	38°C (unchanged)	Medium	MCA derivation — far below fibre Tg/melting thresholds; underlay-hydrolysis ceiling not quantified in evidence located
Emergency RH floor	30%	30% (unchanged)	Low	MCA derivation
Normal control target RH	35%	35% (unchanged)	Low	MCA derivation
Restart RH	45%	45% (unchanged)	Low	MCA derivation
Max RH drop, per hour (bulk)	8.0 pp/h	8.0 pp/h (unchanged)	Unsupported (rate rule)	MCA provisional controller setting; no universal source
Max RH drop, per 24h (bulk)	30.0 pp/24h	30.0 pp/24h (unchanged)	Unsupported (rate rule)	MCA provisional controller setting

Parameter	Current (live policy)	Proposed	Confidence	Source / derivation
Assessment / stabilising factor	0.5	0.5 (unchanged)	Medium	App-wide staging rule
Bulk factor	1.0	1.0 (unchanged)	Medium	App-wide staging rule
Equalising / verification factor	0.5	0.5 (unchanged)	Medium	App-wide staging rule
Min. environmental history / cadence	>=5 readings over >=30 min	Unchanged	Medium	App-wide rule, not material-specific
Material reading method / dry standard	Comparative meter reading vs. unaffected reference	Add: weight underlay-level readings over face-fibre-only readings (Section 9/10)	Low	Mechanism finding — evidence gap
Warning / shutdown / restart utilisation	75% / 90% / 60%	Unchanged	Medium	App-wide rule
Confidence (overall)	Provisional	Provisional	—	No universal rate source located
Guide-page reference card	None exists	Add a "Carpet - Synthetic" card distinguishing it from "Carpet & Underlay"	—	Section 13 content-gap finding

15. Evidence gaps, assumptions, and required specialist overrides

No source located in this research quantifies a temperature or duration threshold for polyurethane-foam underlay hydrolysis, despite this being the risk explicitly named in the profile's own `damage_risk` field; this is the most material evidence gap for this profile and should be a priority for specialist manufacturer-literature review (underlay manufacturers such as Dunlop Flooring, Interface, or specific foam-chemistry suppliers may publish maximum-exposure-time or maximum-temperature guidance not captured by this research's general sources). This report assumes the technician has positively confirmed 100% synthetic face fibre and a synthetic (non-fibre, non-wool-blend) underlay before selecting this profile; no in-app field currently captures that confirmation as a discrete, auditable data point, which is flagged as a candidate app enhancement rather than implemented here. As with Profile 1, water-category confirmation (Category 1 only) is assumed but not currently captured as a discrete field.

16. References

1. IICRC, *Technical Advisory on "In-Place" Drying*, adopted 18 July 2004. https://www.scrt.org/scrt-free-reports/42-technical-advisory-on-in-place-drying/file — Tier 1. Accessed 22 Jul 2026.
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Vinyl / LVT

Research packet: claude-c2-floor-coverings.md | 3,486 words | 9 URL references | The packet is commentary for review, not a certified limit.

Scope: this chapter separates source-supported observations, operational assumptions, unresolved uncertainty, and field verification requirements for this material.

1. Scope and material identification

This profile covers resilient sheet vinyl, vinyl composition tile (VCT), and luxury vinyl tile/plank (LVT/LVP), including rigid-core (SPC/WPC) click-lock products, as selected in the MCA app. These are non-porous or minimally porous synthetic floor coverings, typically PVC-based, installed either fully adhered to a subfloor (sheet vinyl, VCT, glue-down LVT) or floating with a locking mechanism (click-lock LVT/LVP over an underlayment). The critical distinction for drying purposes is that the vinyl/LVT wear layer itself does not meaningfully absorb water; the drying-relevant risk sits almost entirely in (a) the subfloor beneath it (concrete slab or timber-based sheet flooring) and (b) the adhesive bond line in adhered installations. This profile is not applicable to vinyl products installed before roughly 1980 without a prior asbestos assessment: VCT and its adhesive from that era commonly contain asbestos, and disturbing, cutting, or otherwise damaging suspect pre-1980 vinyl or its mastic without testing is a recognised safety hazard independent of the water-drying question (general asbestos-safety consensus reflected across flooring-industry sources — Tier 3, safety caution rather than a drying-parameter finding, but included here because it is a mandatory stop-and-test condition, addressed further in Section 11).

2. Material construction and moisture behaviour

PVC-based resilient flooring is a synthetic thermoplastic and does not absorb water into its structure; any moisture associated with a "wet vinyl floor" event is present as (a) surface/standing water that can simply be extracted, (b) moisture trapped beneath the flooring at the adhesive or click-lock interface, or (c) moisture within the subfloor itself, which the vinyl layer, being close to impermeable, can trap and prevent from evaporating upward. This trapping behaviour is the central moisture-behaviour fact for this material: vinyl is not a drying problem in itself, but it can convert a subfloor moisture problem into a much slower and less visible one by sealing moisture beneath an impermeable skin. RFCI's Recommended Work Practices materials, published by the Resilient Floor Covering Institute, exist specifically to address maintenance and moisture-related handling of resilient flooring, confirming the trade body's own recognition that moisture management for this category is materially about the substrate/adhesive system rather than the visible wear layer (RFCI, "Recommended Work Practices," rfci.com — Tier 1, trade body; general orientation, not quoted for specific numeric content). RFCI also publishes a specific technical paper, "Moisture and Resilient Floor Covering" (dated 29 September 2022), whose existence and title were confirmed via direct retrieval, but whose full numeric content could not be extracted as readable text in this research; it is listed in Section 16 as a source requiring direct specialist reading rather than being relied on for any number in this report.

3. Water exposure, contamination, and salvageability

Vinyl and LVT's non-porous nature means the water-category framework (Category 1/2/3) is materially less consequential for the visible flooring layer itself than for carpet or gypsum — a non-porous material presents a much lower contamination-retention risk — but the framework remains fully applicable to whatever is beneath the vinyl. Adhered installations over a Category 2 or 3 loss should be assessed for whether the adhesive bond line itself has been compromised (loss of adhesion allowing contaminated water to track beneath planks or tiles), in which case removal, decontamination of the subfloor, and reinstallation is the appropriate response regardless of the vinyl's own inertness. Click-lock floating LVT/LVP over any water category should be lifted for inspection wherever water is suspected to have reached the underlayment or subfloor, since the floating installation method makes it comparatively easy to lift and relay without adhesive removal, and inspection is cheap relative to the risk of trapped, unassessed subfloor moisture. Neither the general vinyl/LVT industry sources nor the standards scope pages reviewed in this research publish a category-specific salvage rule unique to vinyl; the general IICRC category framework, discussed under Profile 1, Section 3, is the applicable reference, subject to the same caveat that MCA has not reviewed a licensed copy of the full S500 text.

4. Drying objectives and completion criteria

The drying objective for this profile is overwhelmingly a subfloor/substrate objective, not a vinyl-layer objective. Where the subfloor is concrete, the relevant completion criterion is the covering manufacturer's or project specification's acceptance value under a recognised in-situ test method — ASTM F2170 (relative humidity via in-situ probes at 40% slab depth) or, historically, ASTM F1869 (calcium chloride surface vapour emission rate), with ASTM's own standards-store material confirming F2170 as the currently preferred method and F1869/calcium-chloride testing as measuring only the near-surface layer and therefore less reliable alone (ASTM International, F2170 and related standards-store listings — Tier 1, paywalled; scope confirmed via store/reference pages, full clause text not reviewed). ASTM F710 governs the broader practice of preparing a concrete floor to receive resilient flooring, including the requirement to test moisture and pH regardless of slab age (ASTM International, F710-21 — Tier 1, paywalled; scope confirmed). In Australia, AS 1884 (Floor coverings — Resilient sheet and tiles — Installation practices, 2021 edition) covers the equivalent installation-practice ground, explicitly excluding textile floor coverings from its scope, confirming it as the correct Australian standards reference for this profile specifically rather than for carpet (Standards Australia, AS 1884:2021 — Tier 1, paywalled; scope confirmed via public listing, full clause text not reviewed).

Critically, none of these standards' acceptance criteria are expressed as an ambient room-air RH percentage — they are in-slab or at-surface measurements of the concrete itself, measured with dedicated probes or calcium-chloride domes, not the room's air. This is the single most important completion-criterion distinction for this profile relative to the other two materials in this report: ambient RH reduction, and therefore the app's rolling RH-rate guard, is a proxy for room-air drying progress and is explicitly not evidence that the slab beneath a vinyl or LVT floor has met its covering-specific acceptance criterion. This point is already correctly reflected in the existing MCA parameter register's treatment of Concrete Slab and Concrete - Bare profiles, and applies with equal force here because the vinyl/LVT drying goal is, in substance, a slab-drying goal with a vinyl covering on top of it.

5. Temperature limitations

PVC-based resilient flooring is thermoplastic and subject to thermal expansion; industry sources describing radiant-heating compatibility (a different application context, but informative on the material's heat tolerance) cite manufacturer surface-temperature limits typically in the 27–29°C (80–85°F) range specifically for sustained radiant in-floor heating exposure, and describe thermal expansion on the order of up to roughly 1/4 inch per 100 feet of run per 20°F (approximately 11°C) of temperature rise (industry flooring-installation sources — Tier 3, radiant-heating context rather than restoration-drying context, but the underlying thermoplastic expansion mechanism is directly relevant). Separately, rigid-core (SPC) LVP products are marketed as substantially more dimensionally stable and cupping-resistant than timber-look laminate or hardwood specifically because their stone-polymer-composite core is hydrophobic and does not respond to humidity the way a wood-fibre core does (flooring-industry marketing sources — Tier 3, manufacturer-marketing framing, included for mechanism context only, not as an independent numeric limit).

No manufacturer or standards source located in this research publishes a drying-air temperature ceiling specific to water-damage restoration of vinyl/LVT (as distinct from the radiant-heating-compatibility figures above, which address a different, sustained-operating-condition scenario rather than a short-term restoration drying campaign). The current MCA maximum of **35°C** for this profile is an **MCA derivation**: it sits above the radiant-heating sustained-exposure figures cited above (which are conservative by design for permanent installations) while remaining well below PVC's actual softening range, and is intended to control thermal-expansion-driven buckling risk at seams and edges during an active drying campaign rather than to reflect a documented restoration-specific ceiling.

6. Relative-humidity limitations

No ambient-air RH range specific to vinyl/LVT drying was located, for the reason given in Section 4: the material's own moisture-relevant acceptance criteria are slab/substrate-based, not ambient-air-based. The current MCA policy — 35% floor, 40% target, 48% restart — is an MCA derivation consistent with the general comfort/mould-control range discussed under Profile 1, and is not derived from any vinyl-specific source. As with the RH band for Carpet & Underlay, this report notes for specialist attention that the app's informational reference card for this material (`lib/guide-references.ts`) currently shows a different RH band — 30% floor to 60% ceiling — than the live governing policy of 35% floor to 65% ceiling set in migration `0006_history_aware_drying.sql`, the same category of inconsistency identified for Profile 1 and flagged for the same reason in Section 13 below.

7. GPP, dew point, vapour pressure, and condensation considerations

The dew-point/condensation risk is more acute for this profile than for carpet or many other materials, because an impermeable vinyl skin over a cool or still-curing concrete slab is a textbook condensation trap: if the slab surface temperature (which the vinyl layer will tend to track, given its thinness and thermal conductivity relative to the slab mass) sits below the dew point of air that has, even briefly, contacted the underside of a lifted plank or an unsealed seam, condensation will form at exactly the interface the drying campaign is trying to dry. ARDEX Australia's technical bulletin on moisture barrier systems, cited elsewhere in the app's existing evidence base, makes the general point that concrete moisture must be tested and interpreted for the intended flooring system rather than assumed from apparent surface dryness (ARDEX Australia, "Moisture Barrier Systems," TB192.004 — Tier 1, manufacturer technical bulletin), which is directly applicable here: a slab that "feels dry" under a lifted vinyl plank is not evidence that it has met the ASTM F2170 or AS 1884 acceptance criterion for that covering system, and elevated ambient GPP monitoring is a room-air-drying proxy, not a substrate-acceptance measurement.

8. Airflow and equipment selection

For adhered vinyl and VCT, airflow objectives centre on the exposed subfloor perimeter and any lifted/removed sections rather than the vinyl face itself, since the vinyl face does not need boundary-layer disruption to release moisture it never absorbed. For click-lock floating LVT/LVP, lifting affected planks (which the locking mechanism is specifically designed to permit without adhesive damage) to expose the underlayment and subfloor to direct airflow and dehumidified air is both the most effective and the most commonly described restoration approach in industry sources reviewed (general restoration-industry consensus — Tier 2/3, consistent across multiple sources, no single authoritative numeric standard located). LGR dehumidification paired with air movers directed along the exposed subfloor is the general-purpose equipment configuration; where the concrete slab itself requires accelerated drying to meet a covering-specific acceptance criterion under time pressure, desiccant dehumidification or specialised slab-drying equipment (heat plus vapour barrier systems) may be warranted, consistent with the app's existing Concrete Slab/Concrete - Bare profile guidance.

9. Staged drying strategy

The app's generic staging model applies to this profile, but with an important interpretive point: because the drying-relevant target is the subfloor, not the vinyl, the "material reading" that should govern stage advancement for this profile is, in substance, a concrete or timber-subfloor moisture reading (or, once available and appropriate, an ASTM F2170-style in-situ RH reading) taken after the vinyl has been lifted or through an access point, rather than any reading taken at or through the vinyl surface itself. This is consistent with, and reinforces, the point already made in the existing MCA parameter register for Concrete Slab and Concrete - Bare that ambient RH alone cannot determine slab completion. Nothing located in this research suggests the app's generic assessment/stabilising/bulk/equalising staging fractions need a vinyl-specific numeric override; the correction needed is in what reading is fed into the staging logic, not the logic itself.

10. Monitoring, sensor placement, and material readings

Where the installation is adhered (sheet vinyl, VCT, glue-down LVT), representative monitoring generally requires either removing a section to expose the subfloor directly or relying on indirect indicators (adhesive bond integrity, edge lifting, visible telegraphing of subfloor unevenness) until such a section can safely be removed. Where the installation is floating click-lock LVT/LVP, lifting a representative plank for direct subfloor/underlayment measurement is comparatively low-cost and should be the default monitoring approach rather than an exception. For concrete subfloors, ASTM F2170-style in-situ RH probes (inserted to 40% of slab depth per the method's own scope, as confirmed via ASTM's public standards-store listing) are the currently preferred test method; calcium-chloride (ASTM F1869-style) testing measures only the near-surface layer and should not be relied on alone (ASTM International standards-store and industry moisture-testing sources — Tier 1/Tier 2 respectively). The app's system-wide five-reading/30-minute sampling minimum for the RH-rate guard applies to ambient monitoring as usual, but this report emphasises that ambient sampling cadence is not a substitute for a discrete subfloor-acceptance test at the appropriate point in the drying campaign.

11. Damage indicators and mandatory stop conditions

Drying must stop and the installation must be reassessed where any of the following are observed: bond-line failure (planks or tiles lifting, bubbling, or separating from the substrate); visible or measured cupping, curling, or edge-peaking inconsistent with normal thermal expansion tolerances; persistent musty odour or visible microbial growth at or beneath the flooring; and, as a mandatory, safety-driven stop condition independent of moisture progress, any indication that the material may be a pre-1980 VCT or associated mastic that has not been tested for asbestos content. Sources describing asbestos risk in older VCT are consistent that such material should not be sanded, cut, scraped, or otherwise disturbed until tested, and that any doubt should be resolved by treating the material as potentially asbestos-containing until laboratory results confirm otherwise (general flooring-industry asbestos-safety guidance — Tier 3, but a well-established occupational-safety consensus; MCA has not independently reviewed the specific regulatory citation and this report does not assert one). This is a stop-and-test condition for personnel safety, not a moisture-drying parameter, and should be treated as an absolute gate ahead of any drying activity that would disturb the material.

12. Mixed-material implications

Where vinyl/LVT is installed over a concrete slab that is itself a selected material in the job (Concrete Slab or Concrete - Bare), the app's governing-limits logic will apply the more conservative of the two profiles' temperature and rate caps, which is appropriate; however, as discussed in Section 9, the more important mixed-material implication for this profile is procedural rather than a rate-governance question — the actual completion evidence for the room should come from the concrete profile's dry-standard/slab-test mechanism, with the vinyl/LVT profile's role being primarily to bound temperature (thermal-expansion risk) and to flag the trapped-moisture and asbestos-caution points specific to the covering itself. Where vinyl/LVT sits over timber-based sheet flooring rather than concrete, the timber sheet's drying goal (moisture-content dry standard) becomes the governing completion criterion in the same way, and the timber profile's typically lower temperature ceiling will usually govern the room.

13. Assessment of the current MCA profile

The current profile's "low risk" damage-risk label (per `lib/guide-references.ts`) and its position as one of the least restrictive controlled profiles in the app (35°C, 5.0/20.0 pp bulk rate) are broadly consistent with the evidence: the vinyl/LVT wear layer itself is genuinely low-risk from ambient drying conditions, and the real risk sits in a substrate layer that ambient RH control does not directly measure. The profile's numeric envelope is therefore reasonably calibrated to the visible material's actual risk profile, but this research identified the same category of RH-band inconsistency flagged for Profile 1: the informational reference card shows 30–60% RH while the live governing policy is 35–65% RH, and this should be reconciled by specialist/product review rather than by this report.

More substantively, this research's evidence review reinforces a point already present in the app's existing register for concrete profiles but not explicitly carried into the Vinyl/LVT profile's own guidance: because the actual drying-completion evidence for this material is a slab or subfloor test, not an ambient reading, a technician relying on this profile's automation status (RH within band, rate guard satisfied) alone could reasonably but incorrectly conclude the floor system is complete, when in fact only the room-air envelope has been satisfied. This is not a flaw in the automation logic — the app's automation was never designed to certify subfloor dryness — but it is a documentation and workflow gap worth flagging for the guide page and for job-completion checklists specific to this profile.

14. Recommended app parameters

Parameter	Current (live policy)	Proposed	Confidence	Source / derivation
Control disposition	Controlled	Controlled (unchanged)	Medium	MCA derivation — vinyl/LVT wear layer itself is low ambient-drying risk
Maximum temperature	35°C	35°C (unchanged)	Low–Medium	MCA derivation — conservative against PVC thermal-expansion/buckling risk; not a documented restoration-specific ceiling
Emergency RH floor	35%	35% (unchanged)	Low	MCA derivation
Normal control target RH	40%	40% (unchanged)	Low	MCA derivation
Restart RH	48%	48% (unchanged)	Low	MCA derivation
Max RH drop, per hour (bulk)	5.0 pp/h	5.0 pp/h (unchanged)	Unsupported (rate rule)	MCA provisional controller setting; no universal source; ambient rate is not a substrate-acceptance measure
Max RH drop, per 24h (bulk)	20.0 pp/24h	20.0 pp/24h (unchanged)	Unsupported (rate rule)	MCA provisional controller setting
Assessment / stabilising factor	0.5	0.5 (unchanged)	Medium	App-wide staging rule
Bulk factor	1.0	1.0 (unchanged)	Medium	App-wide staging rule

Parameter	Current (live policy)	Proposed	Confidence	Source / derivation
Equalising / verification factor	0.5	0.5 (unchanged)	Medium	App-wide staging rule
Min. environmental history / cadence	>=5 readings over >=30 min	Unchanged	Medium	App-wide rule, not material-specific
Material reading method / dry standard	Comparative meter reading	Redirect to a subfloor/substrate reading (lifted plank or exposed section), consistent with ASTM F2170/AS 1884 acceptance-testing principle, not a vinyl-surface reading	Low–Medium	Section 4/9 mechanism finding, informed by Tier 1 standard scope (full clause text not reviewed)
Warning / shutdown / restart utilisation	75% / 90% / 60%	Unchanged	Medium	App-wide rule
Confidence (overall)	Provisional	Provisional	—	No universal rate source located
Informational RH band shown in guide UI	30–60% (`lib/guide-references.ts`)	Align to live policy (35–65%) or explicitly label as distinct	—	Section 13 consistency finding

15. Evidence gaps, assumptions, and required specialist overrides

MCA has not reviewed the full clause text of ASTM F710, ASTM F2170, or AS 1884 — all three are paywalled and this report relied on publicly available scope/summary material only; a specialist with licensed copies of these documents should confirm the specific acceptance-value figures (e.g., the applicable %RH threshold for a given covering system) before those figures are used in a client-facing completion report, since the correct acceptance value in practice is set by the flooring manufacturer's or project specification, not by a single universal number. RFCI's "Moisture and Resilient Floor Covering" technical paper (29 September 2022) is listed as a source but its content could not be extracted as readable text in this research; a specialist should obtain and read this document directly. No source located in this research quantifies a restoration-specific drying-air temperature ceiling for vinyl/LVT; the current 35°C figure is an MCA derivation as noted in Section 5. This report assumes a technician confirms pre-1980 asbestos status for any suspect VCT or mastic before disturbing it; the app does not currently capture that confirmation as a discrete field, which is flagged as a candidate app/workflow enhancement rather than implemented here.

16. References

1. Resilient Floor Covering Institute (RFCI), "Recommended Work Practices," undated (accessed 22 Jul 2026). https://rfci.com/recommended-work-practices/ — Tier 1, trade body; general orientation.
2. RFCI, "Moisture and Resilient Floor Covering," 29 September 2022 (existence and date confirmed by direct retrieval; content not extractable as text in this research). https://rfci.com/wp-content/uploads/2026/04/Moisture-and-Resilient-Floor-Covering_09_29_2022_Final.pdf — Tier 1, trade body technical paper; flagged for specialist direct review.
3. ASTM International, *F710-21 — Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring* (product/scope listing). https://store.astm.org/f0710-21.html — Tier 1, paywalled; scope only.
4. ASTM International, *F2170-19a — Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes* (product/scope listing). https://store.astm.org/f2170-19a.html — Tier 1, paywalled; scope only.
5. Standards Australia, *AS 1884:2021 — Floor coverings, Resilient sheet and tiles, Installation practices* (product/scope listing). https://store.standards.org.au/product/as-1884-2021 — Tier 1, paywalled; scope only.
6. ARDEX Australia, "Moisture Barrier Systems," Technical Bulletin TB192.004. https://ardexaustralia.com/pdf/tech%20bulletins/TB192.004_MoistureBarrierSystems_W300_FLC.pdf — Tier 1, manufacturer technical bulletin. Accessed 22 Jul 2026.
7. IICRC, *AS-IICRC S500 Published Press Release*, March 2025. https://iicrc.org/wp-content/uploads/2025/04/AS-IICRC-S500-Published-Press-Release_March-2025.pdf — Tier 1; scope confirmation only. Accessed 22 Jul 2026.
8. US EPA, *Water Damage Table — Mold Prevention, Mold Remediation in Schools and Commercial Buildings* (EPA 402-K-01-001). https://www.epa.gov/mold/water-damage-table-mold-prevention-mold-remediation-schools-and-commercial-buildings — Tier 1, government agency; general context only.
9. FlooringClarity, "Does VCT Tile Contain Asbestos and How to Test or Remove It," undated (accessed 22 Jul 2026). https://www.flooringclarity.com/does-vct-tile-contain-asbestos-how-test-remove-it/ — Tier 3, safety-caution context for pre-1980 VCT; general industry consensus, no specific regulatory citation asserted.

Concrete Slab

Research packet: claude-c3-concrete-tile.md | 5,286 words | 10 URL references | The packet is commentary for review, not a certified limit.

Scope: this chapter separates source-supported observations, operational assumptions, unresolved uncertainty, and field verification requirements for this material.

1. Scope and material identification

This profile covers a cast-in-place or pre-cast concrete floor slab that is intended to receive a floor covering (tile, resilient sheet/tile, timber, or carpet) once dry, and that is currently sealed, coated, polished, or otherwise treated on its exposed face. It sits in the app's `flooring` category alongside Vinyl/LVT, Carpet & Underlay, and Tiles/Grout, and is distinct from the "Concrete - Bare" profile (Profile 2, below), which is reserved for an unsealed, exposed structural slab not imminently receiving a covering. The distinction matters because a sealed or polished slab has a restricted number of drying faces (typically only the exposed top face, since the underside is against soil, a membrane, or a suspended void), while a bare slab may have additional drying surfaces or may be undergoing surface preparation work concurrently with drying.

Concrete is a composite of Portland cement paste, aggregate, and water. A conventional 100 mm residential slab contains far more total water by mass than the paint, timber, or plasterboard around it, but the great majority of that water is either chemically bound in cement hydration products or held in a pore network so fine that evaporation from the surface is a slow, diffusion-limited process rather than a simple free-water drain-off. This is the central fact that governs every other heading in this chapter: a wet slab is not "dry" in the sense a restorer means for timber or plasterboard once its surface feels dry to the touch or its ambient RH cycle has stabilised. Internal slab moisture can remain elevated for weeks after the room's ambient RH has recovered, because the rate-limiting step is diffusion of moisture through the slab's internal pore structure to the surface, not evaporation of surface water into the room air (ASTM International, *F2170-19a Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes*, 2020; American Concrete Institute, *ACI 302.1R-04 Guide for Concrete Floor and Slab Construction*, Foreword and Section 3.2.3). This profile therefore sits at the intersection of two different professional disciplines: water-damage restoration drying (returning the room and the slab's surface region toward an unaffected condition) and concrete-moisture testing for flooring acceptance (a separate, more stringent, in-situ measurement discipline governed by ASTM F2170 and, in Australia, AS 1884).

2. Material construction and moisture behaviour

Concrete's pore structure is created by capillary channels left behind as excess mix water not consumed in hydration migrates and eventually evaporates. Once cured, a slab reaches an equilibrium moisture condition that depends on its thickness, water-cement ratio, age, ambient conditions, and — critically — whether its underside is in contact with damp soil, a vapour retarder, or a ventilated void. A slab cast directly on grade without a functioning vapour retarder is understood in the industry to never fully dry, because damp soil beneath a slab is treated as an effectively saturated, continuous moisture source: soil relative humidity beneath a slab is commonly near 100%, so moisture wicks upward through the slab by capillary action indefinitely unless a vapour barrier intervenes (Wagner Meters, "Old Wet Concrete Slab: What to Do & How to Overcome," accessed 22 July 2026; Wagner Meters, "How to Control Moisture Coming Up Through the Concrete Floor," accessed 22 July 2026 — both manufacturer technical-literature tier). A water-damage event superimposes free liquid water on top of this baseline condition, and it is this excess (the delta above the slab's own unaffected baseline) that restoration drying targets, not an absolute zero-moisture state.

Because drying is intrinsically top-down (the sealed or polished top face is the only realistic evaporation surface) while the base often remains moist, a moisture gradient forms through the slab's thickness during any drying process, restoration or otherwise. ACI 302.1R states that because "the drying and cooling rates at the top and bottom of the slab will never be the same, the shrinkage will vary throughout the depth, causing the as-cast shape to be distorted" (ACI 302.1R-04, Foreword). This differential shrinkage is the mechanism behind slab curling, discussed further under heading 11.

3. Water exposure, contamination, and salvageability

Concrete itself is essentially always salvageable from a structural standpoint: it is inorganic, does not support mould growth on its own body, and is not degraded by clean water exposure. The IICRC's widely used water-category framework (Category 1 clean water, Category 2 significantly contaminated "grey" water, Category 3 grossly contaminated "black" water) governs decontamination and personal-protective requirements rather than whether the slab must be replaced (ANSI/IICRC S500 *Standard for Professional Water Damage Restoration*, 5th ed., 2021 — the full standard is a paywalled, proprietary publication that MCA has not reviewed from a licensed copy for this report; the category framework is referenced here from the standard's public scope description and secondary trade summaries only, and any category-specific procedural obligation must be confirmed against a licensed copy before reliance). For Category 2 or 3 events, the primary salvage question is not the slab itself but the porous materials sitting on or bonded to it — carpet, timber, adhesives, and grout — which cannot be reliably decontaminated and are typically removed regardless of the slab's own condition.

The genuine salvageability risk specific to *this* profile is a sealed or polished finish trapping contaminated moisture against the slab surface, promoting biofilm or odour beneath the coating, and a coating or floor covering bonded to the slab that fails adhesively if elevated moisture persists after re-covering (see heading 4). Salvageability of the slab is therefore rarely in question; salvageability of what sits on it, and the durability of what will be re-installed on it, is the real technical issue.

4. Drying objectives and completion criteria

This is the heading where the profile's two disciplines diverge most sharply, and where the current app model needs the most careful explanation. Restoration drying, in the S500 tradition applied to other materials in this register, defines "dry" as a return to a value close to an unaffected baseline reading taken with the same comparative meter and method — commonly summarised in trade literature as being within a small margin (on the order of a few percentage points) of that unaffected reference reading (secondary trade-press paraphrase of the S500 structural drying goal; e.g. Restoration & Remediation Magazine/Accuserve, "Setting Drying Targets Utilizing the New S500," Ed Jones, 17 November 2025 — MCA has not verified this margin figure against a licensed S500 copy and it is flagged accordingly). That comparative approach is exactly the model the app already implements in `lib/material-drying-stage.ts`: a linked, comparative material reading against an entered "unaffected dry standard" on the same scale and method.

Concrete-flooring acceptance, by contrast, is governed by a completely separate, quantitative, standardised procedure: ASTM F2170 in-situ RH probes placed at 40% of the slab's depth (the depth shown by research to best predict the slab's final equilibrium condition once sealed), read after an equilibration period, at a minimum of three test locations for the first 1,000 ft² of floor area and at least one additional location per additional 1,000 ft² (ASTM International, F2170-19a, 2020, Scope and Significance). A widely cited, though not universally fixed, acceptance threshold is an in-situ RH of 75% or below, or whatever a specific floor-covering manufacturer's technical data sheet specifies instead (Wagner Meters, "What is the Acceptable Moisture Level in Concrete," Jason Spangler, updated 9 July 2026; consistent with the pre-existing in-app claim in `lib/guide-references.ts` citing ASTM F2170 and AS 1884 for the same 75% figure). The companion calcium-chloride moisture-vapour-emission-rate (MVER) test, ASTM F1869, measures the mass of moisture emitted from the slab surface over 24 hours per 1,000 ft² using anhydrous calcium chloride, but industry commentary notes this method has fallen out of favour over the last decade because it does not reliably predict the moisture the floor covering will actually be exposed to once sealed (ASTM International, F1869-22, 2022, Scope; Wagner Meters/WJGrosvenor Flooring Distribution trade commentary, accessed 22 July 2026 — secondary tier, flagged as a documented limitation rather than a numeric control value).

In Australia, AS 1884:2021 *Floor coverings — Resilient sheet and tiles — Installation practices* adopted the ASTM F2170 in-situ RH probe as the sole normative concrete-moisture test for resilient flooring, withdrew the previously accepted surface "hood" test (ASTM F2420), and reduced the required probe equilibration period from 72 hours to 24 hours (ATTAR, "AU Standards for Moisture Testing Concrete Floors," 28 June 2021, discussing the AS 1884:2021 revision — trade-body explainer tier; the full AS 1884:2021 text is a paywalled Standards Australia publication MCA has not reviewed and must retain a licensed copy of before relying on its normative clauses). **MCA derivation for this app**: because the app has no field for an ASTM F2170/AS 1884 in-situ probe reading and no default numeric dry standard for the "concrete" material type (`lib/material-standards.ts`, `DEFAULT_DRY_STANDARDS_PCT.concrete`

`= null`), the app's comparative-meter "dry standard" workflow can validly track restoration-drying *progress* toward an unaffected baseline using a relative (non-invasive) or pin-type moisture meter, but it **cannot** and does not claim to satisfy the ASTM F2170/AS 1884 in-situ RH acceptance test required before a new floor covering is installed. That separate test must be performed and interpreted by a qualified technician using a licensed copy of the applicable standard before any covering is re-laid, regardless of what the app's stage engine reports.

5. Temperature limitations

Concrete is dense, thermally stable, and chemically unaffected by the air temperatures used in structural drying; there is no equivalent to plasterboard's calcination risk or timber's checking risk from heat alone. The temperature risk for this profile is indirect: it comes from (a) accelerating the top-of-slab moisture gradient described under heading 2, increasing curling risk (see heading 11), and (b) risk to floor-covering adhesives and thin, temperature-sensitive finishes bonded to the slab, some of which are formulated for service temperatures under roughly 49–66°C (120–150°F) in general trade commentary on thin-set and tile-adhesive products (general trade/manufacturer product-page commentary on adhesive temperature ratings, accessed 22 July 2026 — secondary tier, product-specific, and explicitly not verified against a specific manufacturer's technical data sheet retained by MCA; flagged as a gap under heading 15).

The current app profile sets a 45°C material ceiling for Concrete Slab (`drizzle/0006_history_aware_drying.sql`, `scripts/migrate-005-and-seed.mjs`). **Important assessment note carried through to heading 13**: the controller's actual operative temperature ceiling is not this 45°C figure. `lib/material-automation.ts::temperatureCutoffs` takes the minimum of the material ceiling minus a 1.5°C warning margin (43.5°C here), a global hard cascade ceiling of 38°C (`CASCADE_HARD_MAX_C`), and, for desiccant units, a 35°C soft ceiling (`DESICCANT_SOFT_MAX_C`). Because 38°C is lower than 43.5°C, the material's own 45°C figure never actually governs equipment shutdown for this profile under the present code — the global 38°C cascade ceiling always binds first. This is not wrong from a safety standpoint (38°C is a reasonable, conservative ceiling for restoration-grade equipment generally), but it means the Concrete Slab profile's distinctive 45°C figure is currently inert and should not be represented to a technician as the material's real operating limit.

6. Relative-humidity limitations

No reviewed source specifies a minimum "safe" ambient RH floor for a concrete slab as a function of avoiding concrete damage — concrete is not desiccation-sensitive in the way gypsum or timber is. The app's 30% RH emergency floor for this profile is therefore an **MCA conservative operational choice** carried over from the room-level overdry-protection logic shared across the flooring-category profiles, intended to protect other, more sensitive materials and finishes that may share the same room (adhesives, sealants, adjoining timber trims) rather than the concrete itself. The 70% RH ceiling, 35%

control target, and 45% restart point in the current profile likewise have no material-specific published derivation for concrete; they are consistent with the pattern used for the other flooring profiles in the register and should be read as room-comfort/room-drying-envelope settings, not concrete-specific damage thresholds.

The one place ambient RH matters mechanistically for concrete is as a driver of the vapour-pressure gradient between the slab's internal pore moisture and the room air (see heading 7): lower ambient RH increases the gradient and therefore the *rate* of surface-level moisture loss, which is precisely why an aggressive, fast ambient RH reduction is the practice most associated with curling risk (heading 11), not a specific RH floor value in isolation.

7. GPP, dew point, vapour pressure, and condensation considerations

Drying concrete, like drying any wet material, depends on maintaining a vapour-pressure gradient from the material's internal moisture to the surrounding air, most practically tracked in restoration practice via grains-per-pound (GPP) or an equivalent absolute-humidity measure rather than RH alone, since RH is temperature-dependent and can mask whether the air is actually able to accept more moisture. For this profile specifically, the more distinctive and well-documented psychrometric hazard is not drying-side vapour pressure but condensation-side: "sweating slab syndrome," in which the slab surface temperature falls below the dew point of the ambient air and moisture condenses directly onto (or into) the slab, re-wetting it regardless of how dry the bulk room air is (Wagner Meters, "The Dangers of Concrete That Sweats," Jason Spangler, updated 8 July 2026). This occurs because concrete's large thermal mass causes the slab's temperature to lag air-temperature changes by a substantial margin — commentary in the same source describes a lag on the order of weeks — so a slab can remain cold and prone to condensation even after the room air has warmed. The same source offers a practical field diagnostic: if an infrared-measured slab-surface temperature is within about 5°F (≈2.8°C) of the calculated ambient dew point, condensation risk should be treated as active. The source also flags a related and directly relevant chemical hazard it terms "alkali attack": condensed water combining with alkaline salts drawn out of the slab can elevate surface pH, which is the same mechanism separately documented as a cause of flooring-adhesive bond failure at high in-situ slab RH (Wagner Meters, "Moisture's Effect on Adhesive Bonding in Concrete Floors," accessed 22 July 2026, describing pH elevation from alkali salts in solution at internal RH levels of roughly 85% and above as a documented adhesive-degradation mechanism).

MCA derivation: the app currently has no logic that compares a slab or floor surface temperature to the calculated dew point of the room air; it only tracks room-air RH and temperature at the sensor location. For this profile, an unmonitored condensation event on the slab surface would not be distinguishable from a normal RH plateau in the app's current data model — this is a genuine monitoring gap, not merely a theoretical one, and is carried forward to heading 15.

8. Airflow and equipment selection

Three dehumidification approaches are used on wet slabs in general drying and construction-drying practice: refrigerant (condensation) dehumidification, heat-based (drying) dehumidification, and desiccant dehumidification (general industry commentary synthesised across Wagner Meters and Polygon Group construction-drying technical pages, accessed 22 July 2026 — secondary/trade tier). Heat-based approaches raise the air's moisture-holding capacity and accelerate surface-level evaporation, but the same commentary explicitly cautions that standard direct-fired construction heaters can add combustion moisture to the space, working against the drying objective unless indirect or electric heat sources are used. High-powered air movers and increased air velocity across the slab surface are consistently identified as accelerating evaporation, but the same body of commentary also identifies wind/airflow-driven temperature differentials between the slab's surface and interior as a contributor to curling and warping risk in thick pours, alongside the day/night thermal-gradient mechanism (Paul Davis Restoration Corporate, "Drying Water-Damaged Concrete Slabs Should Be Easy, But It's Not," accessed 22 July 2026 — restoration-franchise corporate blog, secondary/context tier only, no numeric thresholds given).

For a slab that is going to receive a floor covering, aggressive equipment selection aimed purely at fast ambient RH recovery is a documented false economy: because the covering acceptance test is an in-situ probe measurement of the slab's internal condition, not the room's ambient RH, over-driving the room's air conditions does not shorten the time to a passing ASTM F2170/AS 1884 result and increases curling risk for no compensating benefit (synthesis of ACI 302.1R-04 curling mechanism and ASTM F2170 in-situ measurement scope, both cited above — this synthesis linking the two documents is an **MCA engineering derivation**, not a direct quotation from either source).

9. Staged drying strategy

Applying the app's generic five-stage model (assessment → stabilising → bulk → equalising → ready-to-verify) to a concrete slab is directionally sound but the timescales involved are materially different from a wall lining or a carpet. The **assessment** stage should include establishing whether a functioning under-slab vapour retarder exists (because its absence means the slab will never reach a stable, fully dry baseline — see heading 2) and beginning water extraction from any standing water. The **stabilising** stage should confirm a genuinely falling trend on a comparative meter reading, recognising that concrete's slow internal diffusion means day-to-day changes can be small relative to typical meter noise. The **bulk** stage is where sustained, moderate ambient RH reduction does the most good, but given the diffusion-limited physics described under heading 2, bulk-stage duration for a slab is realistically measured in many days to weeks for anything beyond a shallow, recent, clean-water wetting — far longer than the timescales implied by the same-named stage for plasterboard or carpet. The **equalising** and **ready-to-verify** stages for this profile should explicitly gate on, or at minimum flag the need for, a formal ASTM

F2170/AS 1884 in-situ test before any floor covering is reinstated, since the app's comparative-meter "ready to verify" signal is not equivalent to that acceptance test (heading 4).

10. Monitoring, sensor placement, and material readings

Two distinct instrument classes are relevant and must not be confused. First, restoration-style comparative moisture meters (non-invasive/relative "scanning" meters or pin-type meters used on a fixed, consistent scale against an unaffected reference reading) track *relative progress* and are appropriate for the app's existing dry-standard/material-reading workflow. Trade-press commentary from an IICRC-approved instructor specifically cautions that "most electrical moisture meters are not calibrated for drywall, plaster, concrete, etc." (Restoration & Remediation Magazine/Accuserve, Ed Jones, 17 November 2025), meaning readings are useful comparatively (same meter, same method, same location series) but are not a calibrated absolute percentage for concrete the way a pin meter is calibrated for wood. Second, the ASTM F2170 in-situ RH probe is a completely separate, invasive, sealed-hole instrument system read at 40% slab depth after an equilibration period, used specifically for floor-covering acceptance, not for day-to-day restoration progress tracking (ASTM International, F2170-19a, 2020).

For sensor and reading placement, an unaffected reference area of the same slab (same age, same finish, same sun/soil exposure where possible) should be established for the comparative baseline, consistent with the app's existing "unaffected dry standard" field. **Operational flag for this profile**: the app's stage engine (`lib/material-drying-stage.ts`, `MATERIAL_READING_STALE_MS`) reverts a material to the conservative stabilising rate factor if the latest linked reading is more than 24 hours old. Given how slowly a slab's internal moisture changes and how labour-intensive a careful comparative concrete reading can be relative to a quick plasterboard or timber check, a technician on a normal daily rounds cadence is at real risk of tripping this staleness gate for a concrete profile specifically, which would silently and repeatedly cap the room at the 50% stabilising rate even though the slab is genuinely drying on schedule. This is a monitoring-cadence risk worth flagging to the field team, not a defect in the underlying rule.

11. Damage indicators and mandatory stop conditions

The principal, well-documented damage mode specific to this profile is **slab curling**: differential shrinkage between a drier top face and a moister base causes edges and joints to lift, and if the induced tensile stress exceeds the concrete's tensile strength, cracking follows (ACI 302.1R-04, Foreword, and the discussion of curling stresses from non-uniform moisture/temperature distribution through slab thickness). ACI 302.1R's mitigation guidance for new construction — a well-drained granular base layer beneath the slab to relieve trapped sub-slab moisture, and, where the top is well sealed, allowing more uniform curing/drying through the depth (ACI 302.1R-04, Section 3.2.2) — is written for original construction rather than post-loss restoration drying, but the underlying mechanism (a steep top-to-bottom moisture gradient driving differential shrinkage) is the same mechanism a restoration crew should watch for if aggressive desiccant drying or high-velocity, high-heat airflow is applied directly and continuously to one small area of slab.

Mandatory stop/re-assessment indicators for this profile include: visible new cracking, especially radiating from slab joints or corners; audible or visible curling/lifting at joints; unexplained plateau or reversal in the comparative moisture trend (which may indicate a continuing hidden moisture source, such as an undetected plumbing leak or a failed vapour retarder, rather than a drying failure); efflorescence or salt bloom at the surface, which indicates active moisture and salt transport and should prompt investigation before any coating or covering is applied (see also heading 7's alkali-attack discussion); and any condensation observed on the slab surface, which should trigger investigation of a dew-point exceedance rather than being treated as a simple RH-rate anomaly.

12. Mixed-material implications

Concrete slabs are almost never drying in isolation. Because the slab is frequently the substrate for carpet, vinyl/LVT, timber flooring, or tile, and because those coverings each have their own, generally faster and lower-tolerance drying and RH requirements (see the corresponding entries in the existing register), a mixed-material room governed by the app's "lowest current cap governs the room" logic (`lib/material-automation.ts::computeGoverningLimits`) will, in most realistic combinations, have its ambient RH and rate caps set by the more sensitive covering material, not by the concrete slab itself. This is generally appropriate, since the slab's own tolerance for room-air conditions is wide, but it means the room-level controller settings displayed to a technician will rarely reflect this profile's own figures once any covering material is also selected for the same room. Where the covering has already been removed and the room contains bare, exposed slab plus, for example, exposed masonry or exposed timber framing, this profile's comparatively high ceiling and RH tolerance will more often be the governing (least restrictive) input, and the framing or masonry profile will set the room's real limits.

13. Assessment of the current MCA profile

The current profile (45°C max; 30% floor; 35% target; 45% restart; 5.0 pp/h and 20.0 pp/24h base caps at the bulk stage, halved at assessment/stabilising/equalising) is internally consistent with the pattern used across the register's other flooring profiles and is a reasonable, conservative starting point for room-air control. Three specific findings from this review should inform any specialist sign-off:

First, as set out under heading 5, the profile's distinctive 45°C ceiling is not currently the operative temperature limit for this material under the present controller code; the global 38°C cascade ceiling always binds first. If 45°C was intended to give concrete slabs materially more thermal headroom than more heat-sensitive materials, that intent is not currently realised in the running system.

Second, as set out under heading 4, the profile's "ready to verify" stage and its underlying comparative dry-standard mechanism are not equivalent to, and should not be represented as satisfying, the ASTM

F2170/AS 1884 in-situ RH acceptance test required before floor-covering reinstatement. The existing rate-limit note in the migration ("Generic profile uses the slower polished or sealed rate. Completion requires an applicable slab test.") already gestures at this distinction; this report recommends making it explicit and prominent in technician-facing guidance rather than only in an internal database comment.

Third, the universal, non-material-specific stage-timing constants in `lib/material-drying-stage.ts` (a minimum of two comparative readings at least 6 hours apart to progress out of stabilising, and reversion to stabilising after 24 hours without a fresh reading) were evidently designed with faster-drying, faster-responding materials in mind. Given concrete's diffusion-limited physics (heading 2) and the realistic weeks-scale bulk-drying timeframe for anything beyond shallow, recent wetting (heading 9), these generic timing constants are unlikely to cause unsafe over-drying of the slab itself, but they may produce noisy, frequently-reverting stage transitions that do not usefully reflect the slab's true, slow progress. This is flagged as an evidence gap requiring specialist input under heading 15, not resolved in this report.

14. Recommended app parameters

Parameter	Current MCA value	Proposed value	Confidence	Source / derivation
Control disposition	Controlled	Controlled (unchanged)	Medium	Concrete is not desiccation- or heat-sensitive in itself; MCA derivation from ASTM F2170/ACI 302.1R material behaviour
Maximum temperature (material profile)	45°C	Retain 45°C as a documented ceiling, but flag to specialists that it is currently superseded in practice by the 38°C global cascade ceiling (`CASCADE_HARD_MAX_C`)	Low (as an *operative* limit) / Medium (as a material-tolerance statement)	No published concrete-specific thermal-damage limit found; global cascade constant is an MCA engineering setting (`lib/material-automation.ts`)

Parameter	Current MCA value	Proposed value	Confidence	Source / derivation
Emergency RH floor	30%	Retain 30%	Unsupported as a concrete-specific figure; MCA conservative operational choice for shared-room protection	No source found; carried over from flooring-profile pattern
Normal control target RH	35%	Retain 35%	Unsupported as a concrete-specific figure; MCA conservative operational choice	No source found
Restart RH	45%	Retain 45%	Unsupported as a concrete-specific figure; MCA conservative operational choice	No source found
Max RH drop, pp/h	5.0 (bulk) / 2.5 (assessment, stabilising, equalising)	Retain, with explicit "provisional, not a damage threshold" labelling in any technician-facing view	Unsupported as a material-damage threshold	No published universal ambient-RH-drop rate for concrete found in any reviewed source; MCA provisional controller setting only
Max RH drop, pp/24h	20.0 (bulk) / 10.0 (assessment, stabilising, equalising)	Retain, same labelling as above	Unsupported as a material-damage threshold	Same as above
Assessment/ stabilising factor	0.5× base cap	Retain, but flag the 6-hour/24-hour stage timing constants as generic, not concrete-specific	Medium	`lib/material-drying-stage.ts` universal constants; MCA engineering setting

Parameter	Current MCA value	Proposed value	Confidence	Source / derivation
Bulk factor	1.0× base cap	Retain	Medium	Same as above
Equalising/verify factor	0.5× base cap	Retain, but add an explicit gate/flag requiring ASTM F2170/AS 1884 in-situ testing before floor-covering reinstatement, separate from the app's own "ready to verify" signal	High (that the two tests are not equivalent)	ASTM F2170-19a; AS 1884:2021 per ATTAR summary
Minimum environmental history / sampling cadence	5 valid readings over >=30 minutes (shared controller constant)	Retain for ambient control; separately recommend a longer minimum interval (multi-day) between comparative *material* readings for this profile, given diffusion-limited drying physics	Medium	MCA engineering derivation from ACI 302.1R/ASTM F2170 diffusion-limited drying description
Material reading method / dry-standard requirement	Comparative meter reading vs entered unaffected dry standard, no default numeric value (`material-standards.ts`)	Retain the comparative model for progress tracking; add explicit technician guidance distinguishing it from the ASTM F2170/AS 1884 acceptance test	High	ASTM F2170-19a; Ed Jones/Accuserve, 17 Nov 2025, on meter calibration limits for concrete

Parameter	Current MCA value	Proposed value	Confidence	Source / derivation
Warning / shutdown / restart utilisation thresholds	75% / 90% / 60% of rate budget (shared controller constants)	Retain	Medium	MCA engineering setting, not material-specific
Confidence (overall)	—	Medium for RH/temperature band placement; Low for the specific pp/h and pp/24h numeric values; High for the completion-criteria distinction in heading 4	—	—

15. Evidence gaps, assumptions, and required specialist overrides

No source reviewed publishes a universal ambient RH drop-rate limit for concrete in pp/h or pp/24h; the app's rate figures for this profile remain MCA provisional controller settings pending specialist review, exactly as the existing register states. No source reviewed gives a concrete-specific ambient-temperature damage threshold; the 45°C figure is an MCA conservative ceiling, and, as noted under headings 5 and 13, it is not currently the binding limit in the running controller. The app has no dew-point/slab-surface-temperature comparison logic, despite "sweating slab syndrome" being a documented, named, and mechanistically explained condensation risk specific to concrete's thermal mass (heading 7); this is flagged as a monitoring capability gap for specialist and engineering consideration, not resolved in this report. The app's comparative material-reading model is not equivalent to, and does not claim to satisfy, the ASTM F2170/AS 1884 in-situ probe acceptance test required before floor-covering reinstatement; this report assumes that a qualified technician will perform that separate test using calibrated equipment before any covering decision is made, regardless of the app's own stage status. This report also assumes that where an under-slab vapour retarder is absent or unknown, a specialist assessment of realistic drying-endpoint expectations (heading 2) is obtained before an unattended drying plan is finalised for a bare-soil-contact slab. Finally, this report did not locate or review a numeric MVER (ASTM F1869) pass/fail threshold from a primary source and does not assert one; any MVER-based decision must be referred to the specific floor-covering manufacturer's technical data sheet for the job.

16. References

Claim / parameter	Source (issuer, title, date)	URL	Source tier
ASTM F2170 in-situ RH probe method, 40% depth, hole-count schedule	ASTM International, *F2170-19a Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes*, last updated 9 Jan 2020	https://store.astm.org/f2170-19a.html	1 (Standards body)
ASTM F1869 calcium-chloride MVER method, scope and limitations	ASTM International, *F1869-22 Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride*, 2022	https://store.astm.org/f1869-22.html	1 (Standards body)
Slab curling mechanism; base-layer and moisture-protection guidance	American Concrete Institute, *ACI 302.1R-04 Guide for Concrete Floor and Slab Construction*, Foreword and Sections 3.2.2–3.2.3	https://archive.org/stream/aci-302.1-r-04-guide-for-concrete-floor-and-slab-construction-my-civil.ir/ACI%20302.1R-04%20Guide%20for%20Concrete%20Floor%20and%20Slab%20Construction-MyCivil.ir_djvu.txt	1 (Industry technical guide)
AS 1884:2021 adoption of ASTM F2170, withdrawal of hood test, 24-hour equilibration	ATTAR, "AU Standards for Moisture Testing Concrete Floors," 28 June 2021	https://www.attar.com.au/updates-to-as-1884-and-as-2455/	2 (Trade-body explainer of a standard; full AS 1884:2021 text is paywalled and not independently reviewed by MCA)

Claim / parameter	Source (issuer, title, date)	URL	Source tier
75% in-situ RH as a commonly cited flooring acceptance threshold	Wagner Meters, "What is the Acceptable Moisture Level in Concrete," Jason Spangler, updated 9 July 2026	https://www.wagnermeters.com/concrete-moisture-test/concrete-info/acceptable-concrete-moisture/	3 (Manufacturer/instrument-vendor technical literature)
Adhesive pH/alkali-attack bond-failure mechanism at high internal slab RH	Wagner Meters, "Moisture's Effect on Adhesive Bonding in Concrete Floors," accessed 22 July 2026	https://www.wagnermeters.com/concrete-moisture-test/concrete-info/floor-adhesive/	3 (Manufacturer technical literature)
Sweating slab syndrome, dew-point mechanism, 5°F field diagnostic, "alkali attack"	Wagner Meters, "The Dangers of Concrete That Sweats," Jason Spangler, updated 8 July 2026	https://www.wagnermeters.com/concrete-moisture-test/concrete-info/concrete-chemistry/the-dangers-of-concrete-that-sweats/	3 (Manufacturer technical literature)
No under-slab vapour retarder means the slab may never fully dry; soil-contact moisture source	Wagner Meters, "Old Wet Concrete Slab: What to Do & How to Overcome," accessed 22 July 2026	https://www.wagnermeters.com/concrete-moisture-test/concrete-info/old-concrete-slab/	3 (Manufacturer technical literature)
Restoration dehumidification methods; direct-fired heater combustion-moisture caution; wind/thermal curling risk	Paul Davis Restoration Corporate, "Drying Water-Damaged Concrete Slabs Should Be Easy, But It's Not," accessed 22 July 2026	https://pauldavis.com/blog/drying-water-damaged-concrete-slabs-should-be-easy-but-its-not/	3 (Restoration-franchise corporate blog, context only)
S500 comparative structural-drying-goal framing (paraphrase; not independently verified against a licensed copy)	Restoration & Remediation Magazine / Accuserve, "Setting Drying Targets Utilizing the New S500," Ed Jones, 17 November 2025	https://www.accuserve.com/blog/setting-drying-targets-utilizing-the-new-s500	2 (Trade press, IICRC-approved-instructor commentary; underlying S500 not reviewed from a licensed copy)

Claim / parameter	Source (issuer, title, date)	URL	Source tier
"Most electrical moisture meters are not calibrated for drywall, plaster, concrete, etc."	Restoration & Remediation Magazine / Accuserve, Ed Jones, 17 November 2025 (same article as above)	https://www.accuserve.com/blog/setting-drying-targets-utilizing-the-new-s500	2 (Trade press)

All sources accessed 22 July 2026. Full ANSI/IICRC S500 and AS 1884:2021 texts are proprietary, paywalled publications; MCA must retain a licensed copy of each before relying on any specific clause number.

Concrete - Bare

Research packet: claude-c3-concrete-tile.md | 3,435 words | 8 URL references | The packet is commentary for review, not a certified limit.

Scope: this chapter separates source-supported observations, operational assumptions, unresolved uncertainty, and field verification requirements for this material.

1. Scope and material identification

This profile covers exposed, unsealed structural concrete — a bare slab, footing, tank, or structural element not currently coated, polished, or scheduled to imminently receive a floor covering. It is distinguished in the app from the "Concrete Slab" profile by its wider RH tolerance and higher base rate caps (`drizzle/0006_history_aware_drying.sql`: RH floor 25% vs 30%, base caps 8.0/30.0 pp/h and pp/24h vs 5.0/20.0), reflecting that a bare, uncovered surface has an unobstructed evaporation path and no adhesive bond, coating, or covering to protect from a faster ambient drying regime. The seeded `damage_risk` note for this profile, "Surface stress / substrate remains wet" (`drizzle/0006_history_aware_drying.sql`), captures the two distinct risks that recur throughout this chapter: a surface-level physical-stress risk (curling/cracking, shared with Profile 1) and a deeper, easily overlooked risk that the ambient room recovers to a comfortable RH while the slab's substrate and any sub-slab or embedded materials remain wet.

This profile is the appropriate choice where a slab is exposed for inspection, exposed after covering removal during restoration, or was always an exposed structural or utility surface (a garage floor, plant-room floor, external-facing footing, or similar). It should not be used where a floor covering is scheduled for imminent reinstatement — Profile 1 is the correct choice in that case, precisely because Profile 1's tighter caps and the completion-criteria discussion under its heading 4 are written for that handover.

2. Material construction and moisture behaviour

The material physics are identical to Profile 1 (Portland-cement paste, aggregate, and a fine capillary pore network; diffusion-limited internal moisture transport; a persistent soil-contact moisture source in the absence of a functioning vapour retarder) — see Profile 1, heading 2, for the underlying mechanism, which is not repeated in full here. What differs for a bare slab is the number and character of active drying faces. An uncovered slab may be drying from the top face only (as for Profile 1) or, where accessible, from an exposed edge, an exposed underside (suspended slabs, undercroft spaces), or a freshly exposed surface after a covering, screed, or coating has been stripped away as part of the restoration works. Each additional genuinely open drying face changes the effective diffusion path length and therefore the realistic drying timeframe, which is a site-specific assessment a technician must make rather than something the app can infer from a single material selection.

Where a slab's surface has been mechanically prepared (ground, shot-blasted, or otherwise abraded) as part of the restoration or renovation scope, the exposed pore structure at the very surface is more open than an intact power-trowelled or sealed finish, which generally increases the *rate* of near-surface moisture release relative to Profile 1's sealed/polished condition, without changing the underlying bulk diffusion-limited physics deeper in the slab (**MCA engineering derivation** from the general pore-structure and evaporation-surface principles in ACI 302.1R-04 and ASTM F2170's own rationale for measuring at 40% depth rather than at the surface; no source reviewed gives a bare-vs-sealed comparative drying-rate multiplier, and none should be assumed).

3. Water exposure, contamination, and salvageability

As with Profile 1, the concrete itself is essentially always structurally salvageable and is not degraded by clean-water exposure; the IICRC water-category framework (Category 1/2/3) principally governs decontamination requirements for the concrete surface and any porous materials on or embedded in it, not slab replacement (ANSI/IICRC S500, 5th ed., 2021 — paywalled, not independently reviewed by MCA from a licensed copy for this report). A bare slab specifically raises two salvageability questions Profile 1 does not: embedded services and penetrations (drains, conduits, embedded fixings) that can trap contaminated water in inaccessible voids, and, where the slab is a structural element rather than a simple floor, whether reinforcing steel near the surface has been exposed to contaminated or salt-laden water for long enough to raise a corrosion concern that is outside the scope of drying and requires a structural assessment rather than a drying decision.

Efflorescence and salt-related surface deposits (see heading 11) are typically more visible and more informative on a bare slab than a sealed one, because nothing masks the surface; a bare slab therefore offers better, not worse, visual evidence of ongoing moisture and salt transport, which should be used to advantage during routine inspection rounds.

4. Drying objectives and completion criteria

Because this profile is, by definition, not headed for an imminent floor-covering handover, the ASTM F2170/AS 1884 in-situ acceptance-testing discipline discussed at length under Profile 1, heading 4, is not the immediate completion criterion here — though it remains the correct test to specify later if and when a covering decision is eventually made. The completion objective for a bare slab under active restoration is the same comparative-baseline model the app already implements: a return of comparative moisture readings toward an entered unaffected dry standard for the same slab, taken with a consistent meter and method (`lib/material-drying-stage.ts`).

The existing migration's rate-limit note for this profile — "Bare unsealed slab only. Ambient RH cannot determine slab completion; use the applicable in-slab or covering test" (`drizzle/0006_history_aware_drying.sql`) — correctly anticipates that a technician may still need to specify and apply an in-slab test (ASTM F2170) if a covering decision follows the bare-slab drying phase, and this report's assessment (heading 4 of Profile 1) of the gap between the app's comparative model and that formal test applies equally here.

5. Temperature limitations

The same absence of a concrete-specific thermal-damage threshold documented under Profile 1, heading 5, applies here. The profile's material ceiling is also 45°C (unchanged from Profile 1's seeded value; `drizzle/0006_history_aware_drying.sql` INSERT statement), and the same controller behaviour applies: the global 38°C cascade ceiling (`CASCADE_HARD_MAX_C`, `lib/material-automation.ts`) governs equipment shutdown before the material's own 45°C figure would ever bind, for the same reason set out under Profile 1, heading 13. Because a bare slab has no bonded covering or adhesive to protect, there is, if anything, less material-specific justification for keeping this ceiling especially conservative than for Profile 1 — but no source reviewed identifies a higher safe ceiling either, so this report does not recommend a change.

6. Relative-humidity limitations

The profile's 25% RH emergency floor, 35% control target, and 45% restart point have no bare-concrete-specific published derivation and are, as with Profile 1, best understood as MCA conservative operational choices calibrated to the flooring-category pattern used across the register, with a somewhat lower floor (25% rather than 30%) reflecting the absence of a bonded covering or adhesive that might otherwise be put at risk by very low ambient RH. The wider tolerance relative to Profile 1 is consistent with — though not derived from — the general industry observation that bare, uncoated concrete has no coating, adhesive, or finish layer to protect from an aggressive ambient drying regime, unlike Profile 1's sealed or polished condition (**MCA engineering derivation**, not a direct published figure).

7. GPP, dew point, vapour pressure, and condensation considerations

The sweating-slab-syndrome mechanism described under Profile 1, heading 7, applies identically to a bare slab; if anything, a bare slab's directly exposed thermal mass makes surface-temperature lag against ambient air temperature changes more immediately visible to the naked eye (visible surface dampness or a visibly cooler surface to touch) than a sealed or polished slab, since there is no coating obscuring the surface condition (Wagner Meters, "The Dangers of Concrete That Sweats," Jason Spangler, updated 8 July 2026). The same gap identified under Profile 1 — the app has no dew-point-versus-surface-temperature comparison logic — applies equally here, and is not restated as a separate finding in headings 13/15 below to avoid duplication; refer to Profile 1's treatment.

8. Airflow and equipment selection

The same three dehumidification approaches described under Profile 1, heading 8 (refrigerant, heat-based, desiccant), apply to a bare slab, with one material difference worth noting: because there is no adhesive or coating layer to protect, higher air velocity and more aggressive heat can be used with less concern for adhesive-bond degradation specifically, though the curling-risk mechanism (heading 11) is unchanged and remains the governing physical constraint on how aggressively the surface layer should be dried relative to the slab's interior. Direct, sustained, high-velocity, high-heat airflow concentrated on a single small area of exposed slab remains the highest-risk equipment configuration for inducing a steep local moisture and temperature gradient, and general trade commentary consistently recommends broad, rotating, or multi-point airflow coverage over static, spot-focused airflow for exactly this reason (general restoration-industry air-mover placement guidance, synthesised from Paul Davis Restoration Corporate and Wagner Meters technical pages cited under Profile 1 — secondary/trade tier, no numeric velocity or spacing figure verified).

9. Staged drying strategy

The same generic five-stage model discussed under Profile 1, heading 9, applies, with the practical difference that a bare slab's assessment stage should additionally record which faces are genuinely open to drying (heading 2) and whether any structural, corrosion, or embedded-services concerns (heading 3) require a specialist referral before drying proceeds. Because this profile's base rate caps are higher than Profile 1's (8.0/30.0 pp/h and pp/24h at bulk versus 5.0/20.0), and because a bare slab has no adhesive layer to protect, the bulk stage can reasonably run at a faster ambient RH recovery pace than Profile 1 without the adhesive-specific risk discussed there — but the same curling-risk ceiling (heading 11) still applies regardless of covering status, since curling is a function of the slab's internal moisture gradient, not of what sits on top of it.

10. Monitoring, sensor placement, and material readings

The same instrument-class distinction discussed under Profile 1, heading 10 (comparative restoration meters versus the invasive ASTM F2170 in-situ probe), applies here, with the same IICRC-instructor caution that general electrical moisture meters are not calibrated for concrete and should be used comparatively rather than as an absolute percentage (Restoration & Remediation Magazine/Accuserve, Ed Jones, 17 November 2025). A bare slab offers materially easier and more representative reading locations than a covered one, since there is no covering, adhesive, or coating between the meter and the concrete surface, and multiple representative locations across the exposed area (rather than a single spot) should be used to account for the localised drying-rate variation the profile's own construction and moisture-behaviour discussion (heading 2) would predict. The same 24-hour reading-staleness reversion behaviour flagged under Profile 1, heading 10, applies identically here and carries the same operational risk of unnecessarily perpetuating the conservative stabilising rate factor if comparative readings are not taken on at least a near-daily cadence.

11. Damage indicators and mandatory stop conditions

Slab curling and cracking (Profile 1, heading 11) remain the primary physical-stress damage mode and apply identically to a bare slab. Efflorescence is, as noted under heading 3 above, typically more visible and more informative on an uncoated surface, and should be treated as an active indicator of ongoing moisture and salt transport warranting investigation, not merely a cosmetic issue — the same underlying mechanism (soluble salts transported to the surface by evaporating moisture, leading to surface crystallisation pressure and potential exfoliation of any future applied finish) is documented in general concrete-technology and moisture-testing trade literature (synthesis consistent with the efflorescence mechanism discussed for Profile 1, heading 11, and Profile 3, heading 2, below — **MCA engineering derivation** connecting documented efflorescence chemistry to a stop/investigate rule, since no single source reviewed frames it as a restoration stop-condition in those terms). Additional bare-slab-specific stop conditions include: any new spalling or delamination of the surface (which may indicate reinforcing-steel corrosion beneath the surface and should trigger a structural referral, not a drying-parameter adjustment); visible standing water re-appearing in low spots or at penetrations after apparent surface drying (which strongly suggests an unresolved active water source rather than normal residual moisture); and any condensation observed on the exposed surface, for the same dew-point reasons discussed under heading 7.

12. Mixed-material implications

The room-level "lowest current cap governs" logic (`lib/material-automation.ts::computeGoverningLimits`) means that in a room where a bare slab is exposed alongside other, more sensitive materials — exposed masonry undergoing its own drying, exposed timber framing, or salvageable contents left in place — this profile's comparatively wide tolerance will rarely be the binding constraint on the room, and the more sensitive co-located material will generally set the room's actual operating envelope. Where a bare slab is the *only* selected material for a room (a genuinely empty, stripped-back space), this profile's own figures will govern directly, and the assessment under heading 13 applies without the moderating effect of a more conservative co-selected material.

13. Assessment of the current MCA profile

This profile's wider RH tolerance and higher rate caps relative to Profile 1 are a reasonable, internally consistent reflection of the absence of a bonded covering or adhesive layer to protect, and this report does not identify a basis to recommend narrowing them. The same three findings raised under Profile 1, heading 13, apply here without material change: the 45°C material ceiling is currently superseded in practice by the global 38°C cascade ceiling; the app's comparative-reading model, while appropriate for tracking this profile's own drying progress, is not a substitute for a formal ASTM F2170/AS 1884 in-situ test if the room's use later changes to require a floor covering; and the universal (non-material-specific) stage-timing constants in `lib/material-drying-stage.ts` were not designed with concrete's diffusion-limited physics in mind and may produce stage transitions that do not usefully track this profile's true, comparatively slower progress.

One point specific to this profile: because its `damage_risk` field ("Surface stress / substrate remains wet") already names the "substrate remains wet" risk explicitly, this report recommends that any technician-facing summary for this profile foreground that risk directly — specifically, that a comfortable, stable room ambient RH reading is not evidence that the slab's substrate (or the soil beneath it, or embedded services) has reached an equivalent condition, for exactly the reasons set out under headings 2 and 4.

14. Recommended app parameters

Parameter	Current MCA value	Proposed value	Confidence	Source / derivation
Control disposition	Controlled	Controlled (unchanged)	Medium	Same rationale as Profile 1
Maximum temperature (material profile)	45°C	Retain 45°C, with the same flag that the 38°C global cascade ceiling is currently the real operative limit	Low (as an operative limit) / Medium (as a tolerance statement)	Same as Profile 1, heading 13
Emergency RH floor	25%	Retain 25%	Unsupported as a bare-concrete-specific figure; MCA conservative operational choice, slightly wider than Profile 1 to reflect absence of adhesive/coating	No source found
Normal control target RH	35%	Retain 35%	Unsupported figure; MCA conservative choice	No source found

Parameter	Current MCA value	Proposed value	Confidence	Source / derivation
Restart RH	45%	Retain 45%	Unsupported figure; MCA conservative choice	No source found
Max RH drop, pp/h	8.0 (bulk) / 4.0 (assessment, stabilising, equalising)	Retain, with explicit "provisional, not a damage threshold" labelling	Unsupported as a material-damage threshold	No published universal ambient-RH-drop rate for bare concrete found; MCA provisional controller setting
Max RH drop, pp/24h	30.0 (bulk) / 15.0 (assessment, stabilising, equalising)	Retain, same labelling	Unsupported as a material-damage threshold	Same as above
Assessment/ stabilising factor	0.5× base cap	Retain, same generic-constant flag as Profile 1	Medium	`lib/material-drying-stage.ts`
Bulk factor	1.0× base cap	Retain	Medium	Same as above
Equalising/verify factor	0.5× base cap	Retain; add technician guidance that a later covering decision requires a separate ASTM F2170/AS 1884 test regardless of this profile's stage status	High (that a later covering decision needs the separate test)	ASTM F2170-19a; AS 1884:2021 (ATTAR summary)

Parameter	Current MCA value	Proposed value	Confidence	Source / derivation
Minimum environmental history / sampling cadence	5 valid readings over >=30 minutes (shared constant)	Retain for ambient control; recommend more frequent comparative material readings than a purely daily cadence where feasible, given the 24-hour staleness reversion behaviour	Medium	MCA engineering derivation
Material reading method / dry-standard requirement	Comparative meter reading vs entered unaffected dry standard, no default numeric value	Retain; recommend multiple representative surface locations given exposed-face variability (heading 2)	High	ASTM F2170 depth/location rationale (by analogy); Ed Jones/Accuserve meter-calibration caution
Warning / shutdown / restart utilisation thresholds	75% / 90% / 60% of rate budget (shared constants)	Retain	Medium	MCA engineering setting
Confidence (overall)	—	Medium for RH/temperature band placement; Low for the specific pp/h and pp/24h numeric values; High for the "ambient RH does not equal substrate dryness" completion-criteria caution	—	—

15. Evidence gaps, assumptions, and required specialist overrides

The same core evidence gaps identified under Profile 1, heading 15, apply here: no universal ambient RH drop-rate limit for concrete was located; no concrete-specific ambient-temperature damage threshold was located; the app has no dew-point/surface-temperature condensation-monitoring capability; and no numeric bare-vs-sealed comparative drying-rate multiplier was located to justify this profile's specific 8.0/30.0 figures relative to Profile 1's 5.0/20.0 beyond the qualitative "no adhesive to protect" rationale set out under heading 6. This report assumes a technician will assess and record which faces of the slab are genuinely open to drying (heading 2) before an unattended drying plan is finalised, since the app cannot infer this from the material selection alone. This report also assumes that any indication of reinforcing-steel exposure, corrosion, or structural distress (heading 11) is referred to a structural specialist rather than treated as a drying-parameter matter, and that a covering decision, if one is later made for a currently bare slab, triggers the same specialist-testing requirement discussed under Profile 1.

16. References

This profile's underlying concrete-science evidence base is shared with Profile 1, but the table below reproduces, directly in this chapter block, the specific subset of that evidence relied upon for this profile's own bare-slab claims, so that this chapter does not depend on a cross-reference to be independently sourced.

Claim / parameter	Source (issuer, title, date)	URL	Source tier
No under-slab vapour retarder means a slab may never fully dry; soil-contact moisture source (heading 2)	Wagner Meters, "Old Wet Concrete Slab: What to Do & How to Overcome," accessed 22 July 2026	https://www.wagnermeters.com/concrete-moisture-test/concrete-info/old-concrete-slab/	3 (Manufacturer technical literature)
Slab curling mechanism from top-to-bottom differential shrinkage; applies identically to an exposed bare slab (heading 11)	American Concrete Institute, *ACI 302.1R-04 Guide for Concrete Floor and Slab Construction*, Foreword and Sections 3.2.2–3.2.3	https://archive.org/stream/aci-302.1-r-04-guide-for-concrete-floor-and-slab-construction-my-civil.ir/ACI%20302.1R-04%20Guide%20for%20Concrete%20Floor%20and%20Slab%20Construction-MyCivil.ir_djvu.txt	1 (Industry technical guide)

Claim / parameter	Source (issuer, title, date)	URL	Source tier
ASTM F2170 in-situ RH probe method remains the correct substrate test if a covering decision later follows bare-slab drying (headings 4, 9, 10)	ASTM International, *F2170-19a Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes*, last updated 9 Jan 2020	https://store.astm.org/f2170-19a.html	1 (Standards body)
AS 1884:2021 adoption of the ASTM F2170 in-situ probe as the sole normative concrete-moisture test in Australia (heading 4)	ATTAR, "AU Standards for Moisture Testing Concrete Floors," 28 June 2021	https://www.attar.com.au/updates-to-as-1884-and-as-2455/	2 (Trade-body explainer; full AS 1884:2021 text is paywalled and not independently reviewed by MCA)
Sweating-slab-syndrome dew-point condensation mechanism, applying identically to an exposed bare slab (heading 7)	Wagner Meters, "The Dangers of Concrete That Sweats," Jason Spangler, updated 8 July 2026	https://www.wagnermeters.com/concrete-moisture-test/concrete-info/concrete-chemistry/the-dangers-of-concrete-that-sweats/	3 (Manufacturer technical literature)
Restoration dehumidification methods; direct-fired heater combustion-moisture caution; wind/thermal-gradient contribution to curling risk (heading 8)	Paul Davis Restoration Corporate, "Drying Water-Damaged Concrete Slabs Should Be Easy, But It's Not," accessed 22 July 2026	https://pauldavis.com/blog/drying-water-damaged-concrete-slabs-should-be-easy-but-its-not/	3 (Restoration-franchise corporate blog, context only)
General electrical moisture meters not calibrated for concrete; comparative-only reading discipline (heading 10)	Restoration & Remediation Magazine / Accuserve, "Setting Drying Targets Utilizing the New S500," Ed Jones, 17 November 2025	https://www.accuserve.com/blog/setting-drying-targets-utilizing-the-new-s500	2 (Trade press, IICRC-approved-instructor commentary)

Claim / parameter	Source (issuer, title, date)	URL	Source tier
IICRC water-category framework (Category 1/2/3) governing decontamination of embedded services, penetrations, and porous materials on or in a bare slab (heading 3)	ANSI/IICRC S500 *Standard for Professional Water Damage Restoration*, 5th ed., 2021 (public scope only; full text paywalled and not independently reviewed by MCA)	https://iicrc.org/s500/	1 (Standards body — flagged paywalled, unverified clause-level detail)

All sources accessed 22 July 2026 unless otherwise dated above. Full ANSI/IICRC S500 and AS 1884:2021 texts are proprietary, paywalled publications; MCA must retain a licensed copy of each before relying on any specific clause number. This table reproduces the subset of Profile 1's reference set (heading 16 above) most directly relevant to this profile's own bare-slab claims; it does not add sources beyond that set, consistent with this profile's findings being engineering derivations from the same underlying evidence rather than claims requiring separate citation.

Tiles / Grout

Research packet: claude-c3-concrete-tile.md | 3,845 words | 5 URL references | The packet is commentary for review, not a certified limit.

Scope: this chapter separates source-supported observations, operational assumptions, unresolved uncertainty, and field verification requirements for this material.

1. Scope and material identification

This profile covers a finished ceramic, porcelain, or quarry-tile floor or wall system: the fired tile body, the grout filling the joints between tiles, and the adhesive (thin-set mortar) bed bonding the tiles to their substrate. It sits in the app's `flooring` category. The critical scope point, already correctly identified in the app's own existing technical notes (`lib/guide-references.ts`), is that the tile body itself is essentially non-porous to weakly porous and is not the material of restoration-drying concern; the grout and the adhesive bed beneath the tile are the porous, moisture-retaining components that actually govern this profile's drying behaviour (existing in-app note citing IICRC S500 Section 13 on non-porous materials, itself flagged in the app's own source as needing verification against a licensed copy of S500 — a flag this report repeats and does not resolve). Tile classification by water absorption under ASTM C373 — impervious (<=0.5% absorption, typical of porcelain), vitreous (>0.5–3.0%, typical of quarry tile), semi-vitreous (>3.0–7.0%), and non-vitreous (>7.0–20.0%) (ASTM International, *C373 Standard Test Method for Water Absorption... of Fired Whiteware Products*, *Ceramic Tiles*, *and Glass Tiles*, editions 2014/2017) — determines how much moisture the tile body itself can hold, but even a non-vitreous glazed wall tile typically holds far less water by mass than the grout joints and adhesive bed beneath a comparable floor area.

2. Material construction and moisture behaviour

A tiled floor or wall is a layered assembly: substrate (commonly a concrete slab, screed, or cement-fibre sheet over timber or steel framing), adhesive bed (commonly a Portland-cement-based thin-set mortar, though epoxy and other reactive adhesives are also used), tile body, and grout (commonly a Portland-cement-based cementitious grout, though epoxy grouts are also used). Water intrusion into this assembly does not primarily wet the tile body — which, per heading 1's ASTM C373 classification, is designed to resist water absorption — but travels through the grout joints (which are deliberately more porous than the tile to allow some vapour permeability and to accommodate movement) and can saturate the cement-based adhesive bed beneath, particularly where the substrate itself (commonly concrete) is also wet and in direct contact with the adhesive. Grout discoloration is frequently the first visible sign of a moisture problem on a tile floor, because grout is more porous than the tile and therefore provides an easier pathway for moisture to reach and mark the surface (Wagner Meters, "Grout Problems? Can Concrete Moisture Taint Your Grout?," Jason Spangler, updated 26 June 2026).

The same source notes that moisture reaching the grout can soften it, increasing susceptibility to crumbling and physical damage, and describes efflorescence on grout by the same soluble-salt-transport mechanism documented for bare concrete (heading 11, Profile 2, and Wagner Meters' own cross-reference to concrete efflorescence in the same article).

Because the tile substrate is very often concrete, this profile's moisture behaviour is frequently governed by Profile 1's or Profile 2's underlying concrete physics (diffusion-limited internal transport, a potential persistent soil-contact moisture source, and the ASTM E1745 below-slab vapour-retarder consideration the same Wagner Meters article flags as relevant to tile installations specifically) rather than by anything unique to the tile or grout materials themselves.

3. Water exposure, contamination, and salvageability

The tile body itself is, per heading 1, essentially non-porous to weakly porous and is not degraded by clean-water exposure and does not require replacement on contamination grounds alone; it can generally be cleaned and disinfected in place for Category 1 or, with appropriate decontamination, Category 2 exposures. Grout, being cementitious and more porous, is harder to fully decontaminate once contaminated water has penetrated it, and the same IICRC water-category framework referenced under Profiles 1 and 2 (Category 1/2/3; ANSI/IICRC S500, 5th ed., 2021, paywalled and not independently reviewed by MCA) generally governs whether grout can be cleaned in place or should be raked out and replaced, in the same way it governs porous-material decisions generally. The adhesive bed is the least accessible and least assessable component of the assembly for contamination purposes, since it is entirely hidden beneath the tile; where significant Category 2 or 3 contamination is suspected to have reached the adhesive bed, tile removal for direct assessment and replacement of the bed is the only reliable salvage path, since neither drying nor surface cleaning can decontaminate a hidden, saturated cementitious layer.

Salvageability of the tile itself is most often threatened not by the water event but by the drying process: aggressive or uneven drying that cracks the grout or debonds the adhesive (heading 11) can force tile removal and replacement even where the tile body itself was never at risk from the water alone.

4. Drying objectives and completion criteria

As with concrete (Profiles 1 and 2), the completion objective for the visible, accessible parts of this assembly (surface, exposed grout) can reasonably use the app's existing comparative dry-standard model — a return of comparative moisture readings toward an unaffected reference reading for the same tile/grout system. However, the genuinely load-bearing moisture reservoir in this assembly — the adhesive bed and, where present, the concrete substrate beneath it — is hidden beneath an impervious-to-vitreous tile layer that a standard restoration moisture meter cannot read through non-invasively with any reliability, and that a technician generally cannot access without removing at least one representative tile. This is a materially different completion-criteria problem from Profiles 1 and 2, where the material of concern is at least directly exposed to a meter or probe: for tile and grout, the app's comparative-reading workflow, applied only to the surface grout or tile, risks reporting "ready to verify" while a saturated adhesive bed or wet concrete substrate beneath remains undetected.

Where the substrate is concrete, the same ASTM F2170/AS 1884 in-situ RH testing discussed at length under Profile 1, heading 4, remains the technically correct way to establish the substrate's actual condition, and should be specified by a technician before any adhesive-bed or substrate-related completion decision is made for this profile, exactly as for Profile 1. **MCA derivation**: the app currently has no field or workflow that distinguishes a "tile surface/grout" reading from a "substrate" reading for this profile, and no logic that flags when a tile substrate is concrete specifically. This is carried forward as an evidence gap under heading 15.

5. Temperature limitations

Fired ceramic and porcelain tile bodies are thermally inert at any temperature restoration equipment would realistically produce and are not a temperature-limiting factor in themselves. The limiting components are, again, the grout and the adhesive bed. General product-category commentary on tile adhesives and thin-set mortars indicates many standard cementitious and modified-polymer products are formulated for relatively modest service-temperature ranges, with some premixed products rated only to roughly 49°C (120°F) and reactive/epoxy systems tolerating somewhat higher service temperatures around 71°C (160°F) in general trade discussion, while specialised high-temperature-rated adhesive products exist specifically because standard products are not rated for sustained high heat (general trade/manufacturer product-page commentary on adhesive temperature ratings, accessed 22 July 2026 — secondary tier; this report did not identify or verify a specific manufacturer's technical data sheet for a specific product used on a specific job, and this figure should not be treated as a verified control limit without that verification). Uneven or excessive heat applied directly to a small area of tiled surface is also independently associated in trade literature with rapid grout shrinkage and "ladder cracking" across grout joints, distinct from any adhesive-softening concern (general grout-troubleshooting trade commentary, accessed 22 July 2026 — secondary tier).

The current app profile's 40°C material ceiling for Tiles/Grout (unchanged by the 0006 migration from the original seed value in `scripts/migrate-005-and-seed.mjs`) sits comfortably below the lower end of the adhesive service-temperature range reported above and is a reasonable conservative figure, though — as with Profiles 1 and 2 — the controller's actual operative ceiling for this profile is not 40°C but the lower value produced by `lib/material-automation.ts::temperatureCutoffs`: the material ceiling minus 1.5°C (38.5°C) versus the global 38°C cascade ceiling, meaning the global 38°C figure again governs in practice, only 0.5°C below the material-specific figure this time — the closest margin of any of the three profiles in this report.

6. Relative-humidity limitations

No source reviewed publishes a tile- or grout-specific ambient RH damage threshold. The profile's 30% RH floor, 35% target, and 45% restart point are, as with Profiles 1 and 2, MCA conservative operational choices consistent with the flooring-category pattern, not derived from any tile- or grout-specific published figure. The one qualitative, well-documented relative-humidity-adjacent concern specific to this profile is that rapid ambient drying promotes faster grout-surface moisture loss than the grout's interior, and shrinkage differences between a fast-drying surface and a slower-drying interior are the mechanism most commonly cited for grout "ladder cracking" (general grout-troubleshooting trade commentary, accessed 22 July 2026 — secondary tier, mechanism description only, no numeric RH-rate threshold given or available).

7. GPP, dew point, vapour pressure, and condensation considerations

Where this profile's substrate is concrete, the sweating-slab-syndrome mechanism discussed under Profile 1, heading 7, is directly relevant: condensation forming beneath or at a tiled concrete floor for the same dew-point reasons discussed there would re-wet the adhesive bed and grout from below, in a location the app's ambient sensors cannot detect and a surface-only moisture meter cannot reliably read. This is a materially higher-consequence version of the same monitoring gap identified for Profile 1, because the condensation would be hidden beneath the tile rather than merely on an exposed slab surface. No source reviewed specifically extends the sweating-slab mechanism to a tiled-over slab, so this is an **MCA engineering derivation** by analogy from the documented concrete mechanism (Wagner Meters, "The Dangers of Concrete That Sweats," Jason Spangler, updated 8 July 2026) rather than a directly published finding for tile assemblies specifically, and is flagged accordingly under heading 15.

8. Airflow and equipment selection

Standard restoration air movers and dehumidification equipment (refrigerant, heat-based, or desiccant, per the discussion under Profile 1, heading 8) are appropriate for the exposed tile surface and accessible grout. However, because the adhesive bed and any concrete substrate beneath the tile are not directly exposed to room airflow at all, ambient-air-focused equipment has limited or no direct effect on drying that hidden layer; airflow and dehumidification primarily act on the room and the exposed tile/grout surface, while the substrate dries (if at all, absent tile removal) largely by the same slow, diffusion-limited pathway discussed for bare and covered concrete under Profiles 1 and 2 — through whatever exposed edges or the grout-joint network itself allow. Where a wet adhesive bed or substrate is confirmed or strongly suspected, selective tile removal to expose the substrate directly, followed by conventional concrete-drying equipment selection (Profile 1/2, heading 8), is the only way to meaningfully accelerate drying of that hidden layer, rather than relying on ambient room conditioning alone (**MCA engineering derivation** from the layered-assembly physics described under heading 2, not a directly published recommendation for this specific scenario).

9. Staged drying strategy

The generic five-stage model applies to the accessible surface and grout in the same manner as Profiles 1 and 2, with an important addition specific to this profile: the assessment stage should explicitly include a determination of whether the substrate beneath the tile is suspected to be wet (informed by the water event's severity, duration, and any visible grout discoloration or efflorescence, per heading 2) and, if so, whether representative tile removal is warranted to directly assess and dry the substrate, rather than relying solely on ambient-driven drying of the visible surface. Where tile removal is not undertaken and the substrate is concrete, the bulk-stage timeframe for this profile should realistically be expected to track the much longer, diffusion-limited timeframe discussed for Profile 1/2 rather than the faster timeframe a surface-only assessment might suggest, precisely because the app's comparative reading, taken at the surface, cannot see the substrate's true condition (heading 4).

10. Monitoring, sensor placement, and material readings

Comparative surface readings on exposed grout, using a consistent meter and method against an unaffected reference joint or area, are an appropriate application of the app's existing dry-standard workflow for the *accessible* part of this assembly, with the same IICRC-instructor caution about general-purpose electrical moisture meters not being calibrated for materials like concrete extending by analogy to the cementitious adhesive bed and grout in this assembly (Restoration & Remediation Magazine/Accuserve, Ed Jones, 17 November 2025). For the substrate and adhesive bed specifically, no non-invasive reading taken at the tile surface reliably characterises the hidden layer's actual moisture condition; where substrate moisture is a genuine concern, either representative tile removal for direct substrate access and testing (using the same methods described for Profile 1/2, heading 10, if the substrate is concrete), or a documented, explicit assumption that the substrate is being monitored and dried indirectly via the room's ambient conditions only, should be recorded by the technician, since the app itself cannot distinguish these two very different monitoring postures from a single "Tiles / Grout" material selection and a single linked reading.

11. Damage indicators and mandatory stop conditions

Grout "ladder cracking" across joints, attributed to shrinkage from uneven or rapid moisture loss, is the most specific and commonly documented physical damage mode for this profile (general grout-troubleshooting trade commentary, accessed 22 July 2026 — secondary tier). Efflorescence on grout, mechanistically identical to the concrete efflorescence discussed under Profiles 1 and 2, is a documented indicator of active moisture and soluble-salt transport and should prompt investigation of the substrate condition rather than being dismissed as cosmetic (Wagner Meters, "Grout Problems? Can Concrete Moisture Taint Your Grout?," Jason Spangler, updated 26 June 2026, explicitly cross-referencing the same mechanism on bare concrete). Additional mandatory stop/re-assessment indicators specific to this profile include: audible or visible tile drumminess or hollow-sounding tiles under light tapping, which indicates adhesive-bond loss (debonding) rather than a normal drying stage and generally requires tile removal and re-bedding rather than continued drying; visible tile lippage, movement, or lifting; grout crumbling or friability beyond normal surface soiling; and, where the substrate is concrete, any of the concrete-specific stop conditions described under Profile 1, heading 11 (curling, cracking, unexplained plateau in trend, condensation), applied to whatever portion of the substrate can be assessed.

12. Mixed-material implications

Tile substrates are very frequently concrete (Profiles 1/2), meaning a room selecting Tiles/Grout alongside Concrete Slab or Concrete - Bare for the same floor area is, in substance, describing two layers of the same physical assembly rather than two independent materials, and the room-level "lowest current cap governs" logic (`lib/material-automation.ts::computeGoverningLimits`) will select whichever profile's figures are more restrictive without any awareness that the two selections may be physically inseparable at that location. Where tile is installed over timber-based substrates (a cement-fibre sheet over timber flooring or framing) rather than concrete, the much more moisture-sensitive and slower-drying timber substrate (see the register's existing Timber Frame, Solid Hardwood, and Engineered Timber entries) becomes the governing consideration, and drying decisions for this profile should be made with direct reference to whichever substrate-material entry actually applies on site, since this profile's own figures say nothing about the substrate's tolerance.

13. Assessment of the current MCA profile

The current profile (40°C max; 30% floor; 35% target; 45% restart; 8.0 pp/h and 30.0 pp/24h base caps at bulk, halved at assessment/stabilising/equalising) is internally consistent with the register's flooring-category pattern and, per heading 5, sits at a reasonable and only narrowly redundant margin relative to the global 38°C cascade ceiling (38.5°C material-derived ceiling versus 38°C global ceiling — closer than either concrete profile). This report's most significant assessment finding for this profile is the one raised under heading 4 and repeated under headings 9 and 10: the app's single "Tiles / Grout" material selection and single comparative-reading workflow cannot distinguish between (a) a scenario where only the exposed tile surface and grout are being monitored and dried, and (b) a scenario where the hidden adhesive bed and substrate are wet and require either representative tile removal or an explicit, documented decision to dry them indirectly via ambient conditioning only. Because the two scenarios have very different realistic drying timeframes and very different completion criteria, this report recommends that any technician-facing guidance for this profile explicitly prompt for that determination during the assessment stage, rather than allowing a single surface-level "ready to verify" signal to be read as covering the whole assembly.

A secondary finding: the existing app note citing "IICRC S500 Section 13 — Non-porous materials" for this profile (`lib/guide-references.ts`) already carries its own internal "Verify section against your copy of S500" caveat. This report was unable to independently verify that section reference against a licensed copy of the standard and repeats rather than resolves that existing caveat.

14. Recommended app parameters

Parameter	Current MCA value	Proposed value	Confidence	Source / derivation
Control disposition	Controlled	Controlled (unchanged)	Medium	Tile body is non-porous to weakly porous per ASTM C373; MCA derivation
Maximum temperature (material profile)	40°C	Retain 40°C; note it sits only 0.5°C above the operative 38°C global cascade ceiling once the 1.5°C warning margin is applied	Low–Medium (as an operative limit) / Low (as a verified adhesive-specific figure)	No verified manufacturer-specific adhesive data sheet reviewed; general trade commentary only
Emergency RH floor	30%	Retain 30%	Unsupported as a tile/grout-specific figure; MCA conservative operational choice	No source found
Normal control target RH	35%	Retain 35%	Unsupported figure; MCA conservative choice	No source found
Restart RH	45%	Retain 45%	Unsupported figure; MCA conservative choice	No source found

Parameter	Current MCA value	Proposed value	Confidence	Source / derivation
Max RH drop, pp/h	8.0 (bulk) / 4.0 (assessment, stabilising, equalising)	Retain, with explicit "provisional, not a damage threshold" labelling	Unsupported as a material-damage threshold	No published universal ambient-RH-drop rate for tile/grout found; MCA provisional controller setting
Max RH drop, pp/24h	30.0 (bulk) / 15.0 (assessment, stabilising, equalising)	Retain, same labelling	Unsupported as a material-damage threshold	Same as above
Assessment/ stabilising factor	0.5× base cap	Retain; add an explicit assessment-stage prompt for "is the substrate/adhesive bed suspected wet?" (see heading 13)	Medium	`lib/material-drying-stage.ts`; MCA workflow recommendation
Bulk factor	1.0× base cap	Retain	Medium	Same as above
Equalising/verify factor	0.5× base cap	Retain; do not treat a surface-only "ready to verify" as covering a suspected-wet substrate without either tile removal or an explicit documented ambient-only decision	High (that surface and substrate readings are not interchangeable)	Layered-assembly physics; ASTM C373 tile-imperviousness classification

Parameter	Current MCA value	Proposed value	Confidence	Source / derivation
Minimum environmental history / sampling cadence	5 valid readings over >=30 minutes (shared constant)	Retain for ambient control; recommend representative-tile-removal-based substrate testing where substrate moisture is suspected, rather than relying on sampling cadence alone	Medium	MCA engineering derivation
Material reading method / dry-standard requirement	Comparative meter reading vs entered unaffected dry standard, no default numeric value	Retain for surface/grout; add distinct guidance that no non-invasive reading characterises the hidden adhesive bed or substrate	High	Layered-assembly physics; Ed Jones/Accuserve meter-calibration caution
Warning / shutdown / restart utilisation thresholds	75% / 90% / 60% of rate budget (shared constants)	Retain	Medium	MCA engineering setting

Parameter	Current MCA value	Proposed value	Confidence	Source / derivation
Confidence (overall)	—	Medium for RH/temperature band placement; Low for the specific pp/h and pp/24h numeric values and for the specific adhesive service-temperature figures cited in heading 5; High for the surface-versus-substrate completion-criteria distinction	—	—

15. Evidence gaps, assumptions, and required specialist overrides

No source reviewed publishes a universal ambient RH drop-rate limit for tile or grout; the app's rate figures remain MCA provisional controller settings pending specialist review. No source reviewed gives a verified, manufacturer-specific adhesive or grout service-temperature limit for a specific product; the temperature figures discussed under heading 5 are general trade commentary only and should be replaced with the actual product technical data sheet for any given job wherever one is available. This report's extension of the sweating-slab-syndrome mechanism to a tiled-over concrete substrate (heading 7) is an engineering derivation by analogy, not a directly published finding for tile assemblies, and should be treated as a hypothesis for specialist consideration rather than an established fact. The existing app citation to "IICRC S500 Section 13" for this profile could not be independently verified against a licensed copy of the standard and remains an open verification item, as the app's own existing note already acknowledges. This report assumes that a technician will make and document an explicit determination of whether the adhesive bed/substrate is suspected wet during the assessment stage (heading 13), since the app's current data model does not prompt for or record this distinction, and that representative tile removal will be used to directly test a suspected-wet substrate wherever practical rather than relying on indirect ambient-only inference.

16. References

Claim / parameter	Source (issuer, title, date)	URL	Source tier
ASTM C373 water-absorption tile classification (impervious/vitreous/semi-vitreous/non-vitreous)	ASTM International, *C373 Standard Test Method for Water Absorption, Bulk Density, Apparent Porosity, and Apparent Specific Gravity of Fired Whiteware Products, Ceramic Tiles, and Glass Tiles*, 2014/2017 editions	https://store.astm.org/c0373-14.html	1 (Standards body)
Grout discoloration as first sign of moisture; grout more porous than tile; efflorescence mechanism; ASTM F2170/E1745 relevance to tile installations	Wagner Meters, "Grout Problems? Can Concrete Moisture Taint Your Grout?," Jason Spangler, updated 26 June 2026	https://www.wagnermeters.com/concrete-moisture-test/concrete-info/grout-problems-moisture/	3 (Manufacturer/instrument-vendor technical literature)
Concrete moisture-testing standards (ASTM F2170, F1869) and slab-curling mechanism referenced by analogy for concrete tile substrates	ASTM International, F2170-19a and F1869-22 (as cited in Profile 1/2 references above); ACI 302.1R-04 (as cited above)	See Profile 1 references	1 (Standards bodies / industry guide)
Sweating slab syndrome / dew-point mechanism, extended here by analogy to tiled-over concrete substrates	Wagner Meters, "The Dangers of Concrete That Sweats," Jason Spangler, updated 8 July 2026	https://www.wagnermeters.com/concrete-moisture-test/concrete-info/concrete-chemistry/the-dangers-of-concrete-that-sweats/	3 (Manufacturer technical literature; extension to tile assemblies is an MCA derivation, not a direct claim of this source)

Claim / parameter	Source (issuer, title, date)	URL	Source tier
General moisture-meter calibration caution for cementitious materials	Restoration & Remediation Magazine / Accuserve, "Setting Drying Targets Utilizing the New S500," Ed Jones, 17 November 2025	https://www.accuserve.com/blog/setting-drying-targets-utilizing-the-new-s500	2 (Trade press)
IICRC water-category framework (Category 1/2/3) referenced for grout/adhesive salvageability	ANSI/IICRC S500 *Standard for Professional Water Damage Restoration*, 5th ed., 2021 (public scope only; full text paywalled and not independently reviewed by MCA)	https://iicrc.org/s500/	1 (Standards body — flagged paywalled, unverified clause-level detail)
Existing in-app claim: tile body non-porous, drying focus on adhesive bed and grout, citing "IICRC S500 Section 13"	MCA Drying Monitor, `lib/guide-references.ts` (existing app source, not new external research; the app's own note flags this section reference as unverified)	Internal repository file: `lib/guide-references.ts`	Internal (app-derived claim, carried forward and re-flagged, not independently verified against a licensed S500 copy)

All sources accessed 22 July 2026. Full ANSI/IICRC S500 and AS 3958.1 texts are proprietary, paywalled publications; MCA must retain a licensed copy of each before relying on any specific clause number.

Brick / Masonry

Research packet: claude-c4-masonry.md | 3,538 words | 6 URL references | The packet is commentary for review, not a certified limit.

Scope: this chapter separates source-supported observations, operational assumptions, unresolved uncertainty, and field verification requirements for this material.

1. Scope and material identification

This profile is the umbrella "brick or masonry, subtype not yet identified" placeholder in the MCA Drying Monitor. **[CODE FINDING]** In the live schema it was seeded with `max_temp_c = 50.0`, `rh_min_pct = NULL`, `rh_max_pct = NULL`, `damage_risk = "Negligible"` (`scripts/migrate-005-and-seed.mjs`, row `Brick / Masonry`), and it was later converted by migration `0006_history_aware_drying.sql` to `automation_mode = 'specialist_required'`, `limit_status = 'not_applicable'`, with all control-target, restart, and rate-drop columns set to `NULL`. Its `policy_source` note reads: "Modern fired masonry and heritage soft masonry have materially different safe rates; generic unattended control is blocked."

Masonry, in the general engineering sense, covers fired clay brick, concrete block, natural stone, and mortar assemblies bonded together as a composite wall or paving system. The generic profile in this app is scoped narrowly to **brick and mortar wall assemblies** — MCA's existing subtype split (Modern Fired vs Heritage Soft) is brick-specific, and stone or concrete-block masonry is out of scope for this generic entry; a technician selecting "Brick / Masonry" should be understood to mean "this is definitely brick-and-mortar, but I have not yet determined whether it is dense modern fired brick or older soft-fired/lime-mortar heritage brick."

[SOURCE] Young (2008), the primary Australian technical guide reviewed for this report, frames the underlying material category as follows: "All masonry materials, whether stone, brick, mortar, earth or concrete block, are to some degree porous... Porosity is a rough guide to durability: the higher the porosity, the less durable will be the material" (Young 2008, p.9, Section 4 "Porosity and permeability"). Reported porosity ranges are 10–30% for common brick and mortar, versus 1–5% for dense granite, bluestone, and slate (Young 2008, p.9). This single fact — that "brick" is not one material but a wide porosity band — is the scientific justification for MCA's decision to force a subtype choice before allowing unattended automation.

2. Material construction and moisture behaviour

[SOURCE] Masonry walls move moisture in three distinguishable ways, each with different drying implications: rising damp (capillary suction of ground moisture through the wall base), falling damp (moisture entering from above, e.g. a failed roof or gutter), and penetrating damp (lateral moisture ingress through a wall face) (Young 2008, Sections 7–8, pp.14, 20–21). Water-restoration events most commonly present as combinations of falling damp (burst pipe, roof leak) and, in flood scenarios, temporary saturation that behaves like an accelerated rising-damp condition.

[SOURCE] Young (2008, Section 5 "Walls breathe", p.10) describes masonry as constantly exchanging air and water vapour with the atmosphere through its pore network in response to daily temperature cycling — walls do not literally respire, but the porous structure allows continuous vapour exchange, and "apparently dry walls commonly contain water, the amount varying with changes in the season and climate." If the masonry contains salts or other hygroscopic materials, "the amount of water drawn into (and retained in) the wall can be sufficient to make the wall visibly damp, even in dry weather" (Young 2008, p.10).

[MCA DERIVATION] Because brick moisture behaviour is dominated by pore structure and salt content rather than a single "brick" material constant, MCA does not assign the generic profile a moisture-content baseline. **Hazard controlled:** misapplying one moisture-content dry standard to two structurally different brick types (dense low-porosity fired brick vs porous heritage brick) would produce a false "dry" reading in one case and a false "wet/failed" reading in the other. **Uncertainty:** high, until subtype is selected. **Monitoring/stop condition:** the app blocks unattended automation until a subtype is chosen (Section 13 below documents how this block operates in the current code).

3. Water exposure, contamination, and salvageability

[SOURCE] Historic England's flood-recovery guidance states that masonry flooded by sea water should be rinsed with clean, salt-free water as soon as possible after the flood subsides, then allowed to dry slowly to minimise chloride-salt damage to soft masonry (Historic England, "Masonry Buildings", *Flooding and Historic Buildings* technical advice series, accessed via search synthesis — see Section 15 access-limitation note). This guidance applies with more force to porous heritage brick than to dense modern fired brick, but the underlying salvage logic — remove contaminated water, do not seal the wall while wet, and do not rush the dry-out — applies to the generic profile pending subtype confirmation.

[SOURCE] Salt content itself is a salvageability criterion, not just a cosmetic one. Young (2008, Section 6.1 "Which salts?", p.12) states: "A general rule of thumb is that more than about 0.5% by weight of salt is considered cause for concern and reason for considering salt removal (desalination)." This is a direct, source-published numeric threshold — but it is a *salt-content* threshold assessed by chemical testing, not an ambient RH-drop rate, and it cannot be read across into a room-air control setting.

[MCA DERIVATION] Because the generic profile cannot distinguish salt-loaded heritage brick from largely inert modern fired brick, and because Category 2/3 water (per the cross-cutting psychrometrics standard already used elsewhere in this register) can carry biological contamination into mortar joints and any adjacent plaster keys, MCA treats "Brick / Masonry" as **not automatically salvageable by ambient drying alone** until subtype and water category are both recorded. This mirrors the plasterboard generic profile's existing rationale in the register.

4. Drying objectives and completion criteria

Because the generic profile has no assigned automation policy, it also has no completion criterion of its own. **[CODE FINDING]** `lib/material-standards.ts` maps material names to a `MaterialType` used for default dry-standard percentages, via `materialTypeForProfileName()`. Its string-matching logic checks for `"plasterboard"`, `"timber"/"hardwood"/"engineered"`, `"concrete"/"tile"`, and `"carpet"` substrings, in that order, falling through to `"other"` for anything unmatched. **None of "Brick / Masonry", "Brick - Modern Fired", or "Brick - Heritage Soft" match any of these substrings, so all three brick profiles resolve to `"other"`, and `DEFAULT_DRY_STANDARDS_PCT.other` is `null`.** In practice this means the app never proposes an automatic moisture-content dry standard for any brick profile — a technician must always enter a comparative unaffected-brick reading manually. This is a genuine, verifiable gap (Section 15 returns to it), but it is also arguably the *correct* conservative default, because no single default brick MC% would be valid across fired brick types and moisture-meter methods (see Profile 2, Section 10).

[SOURCE] The general restoration completion concept the brick profiles should eventually use is the IICRC S500 "dry standard" method: establishing pre-loss moisture content from unaffected reference material in the same structure, and drying affected material to within a small band of that reference (as already cited in the existing register's plasterboard section, and consistent with the S500 5th edition scope confirmed by the IICRC's own 2025 press release announcing Australian adoption as AS-IICRC S500). **This report was not able to review a licensed copy of the full S500 masonry/concrete chapter text and does not cite any specific clause, section, or page number from it.** MCA must retain a licensed copy before using S500 clause numbers in client-facing documentation.

5. Temperature limitations

[CODE FINDING] The generic profile's `max_temp_c` value of 50°C is a seed-script default with no accompanying source citation anywhere in the codebase or migrations; it was not revised by the `0006` migration that otherwise fully "blocked" this profile's automation fields. **This is a legacy, unreviewed value.**

[CODE FINDING] Practically, this legacy value has limited real-world effect. `temperatureCutoffs()` in `lib/material-automation.ts` computes the equipment OFF temperature as `minDefined([materialOffAt, CASCADE_HARD_MAX_C, ...])`, where `CASCADE_HARD_MAX_C = 38` is a fixed global safeguard and `materialOffAt = maxTempC - 1.5`. For the generic profile, `materialOffAt = 50 - 1.5 = 48.5°C`, which is well above the 38°C cascade ceiling, so **the cascade safeguard — not the material's own stated limit — is what actually turns equipment off** whenever this profile is selected (in the rare case it is selected without being immediately blocked by `automationAllowed === false`). The 50°C figure is therefore cosmetic in the current controller: it still gets reported as the "governing material" temperature limit if it is the lowest among selected materials' unnulled `maxTempC` values, which is misleading documentation even though it is not a safety gap (because the hard-coded 38°C cascade ceiling still binds).

[MCA DERIVATION] Recommend that the generic profile's `max_temp_c` either be set to `NULL` (consistent with all its other automation columns) or reduced to a value that is transparently sourced. Because Young (2008) and the Brick Industry Association's technical literature (reviewed in Profile 2) both describe fired brick and mortar as thermally robust at restoration temperatures — the risk pathway is evaporation-driven salt migration, not heat damage to the masonry itself — there is no source-based reason to retain a masonry-specific heat ceiling above the existing global cascade ceiling. **Hazard controlled:** none specific to brick; the global 38°C cascade ceiling already protects equipment and any co-located combustible or moisture-sensitive trim. **Uncertainty:** low (this is a documentation-accuracy fix, not a safety change, because the cascade ceiling already binds first). **Monitoring/stop condition:** unchanged — the cascade ceiling continues to apply regardless of this field's value.

6. Relative-humidity limitations

The generic profile has no RH floor or ceiling (`rh_min_pct` / `rh_max_pct` are both `NULL`). **[SOURCE]** This is appropriate: Young (2008, Section 2 "The basics", p.4) and the salt-attack mechanism described in Section 6 of the same guide ("Salt attack", pp.11–12) both show that the *safe* RH band for a masonry wall depends entirely on how much soluble salt is present and how porous the specific brick/mortar system is — modern dense fired brick with clean sand and low-alkali cement can tolerate a wider RH swing than a lime-mortared heritage wall carrying decades of rising-damp salt loading. A single generic RH band would either be too permissive for the heritage case or unnecessarily punitive for the modern case.

[MCA DERIVATION] No RH band is proposed for the generic profile. It should remain blocked until a subtype is selected, at which point Profile 2 or Profile 3's reviewed band applies.

7. GPP, dew point, vapour pressure, and condensation considerations

[SOURCE] Young (2008, Section 5, p.10) provides the clearest single explanation located for how condensation forms *inside* a masonry wall, independent of any RH sensor reading in the room: "If the air drawn into a wall is humid and if the wall material cools below the dew point then some of the water vapour in the humid air will condense as water droplets within the pores of the masonry, though the wall will still be 'dry'" to visual inspection. This matters directly for drying control, because a dehumidifier can report a falling room-air dew point while a cold masonry wall — especially an exterior wall face, a chimney breast, or a wall behind cladding — continues to gain moisture internally if its surface temperature sits below that dew point.

[SOURCE] The same guide separately warns that mechanical dehumidification of old masonry buildings needs care for a related but distinct reason: "Air-conditioning systems can draw moisture through solid masonry walls and their introduction into older buildings can be problematic" (Young 2008, Section 7.1

area discussion, p.15) — i.e. aggressively conditioning room air changes the vapour-pressure gradient across the wall and can pull additional ground or cavity moisture into the assembly, not just extract surface moisture from it.

[MCA DERIVATION] For the generic profile, no GPP or dew-point control value is proposed, because the correct response (checking whether any masonry surface temperature is below the room dew point, and pausing aggressive dehumidification if so) is a monitoring practice, not a numeric automation input the current schema captures. This is logged as an evidence/tooling gap in Section 15.

8. Airflow and equipment selection

[SOURCE] Because brick and mortar are low-evaporation-rate, high-thermal-mass materials, drying practice generally favours sustained, moderate airflow and dehumidification over intense localised heat or high-velocity air movers, which primarily dry the visible surface skin rather than the body of the wall. Young's "walls breathe" mechanism (Section 5, p.10) implies that most of the useful moisture exchange happens slowly, through the whole pore network, not through a thin surface film that a fast air mover can strip away in hours.

[MCA DERIVATION] No brick-specific equipment-role recommendation beyond the existing app-wide LGR/desiccant/dehumidifier role taxonomy in `lib/material-automation.ts` is proposed for the generic profile. Subtype-specific airflow guidance is given in Profiles 2 and 3.

9. Staged drying strategy

[CODE FINDING] `computeMaterialDryingStage()` in `lib/material-drying-stage.ts` short-circuits to the `"blocked"` stage with `rateFactor = 0` for any material whose `automationMode !== "controlled"`. Because the generic profile's `automationMode` is `"specialist_required"`, it is placed in the `"blocked"` stage regardless of any reading history — no linked comparative reading, however favourable, can move it out of that stage. This is a correct implementation of the intended design: time and readings alone must never substitute for a technician selecting the correct subtype.

10. Monitoring, sensor placement, and material readings

[MCA DERIVATION] Pending subtype selection, monitoring should still occur (ambient temperature/RH logging continues regardless of material blocking status), but no brick moisture-content reading should be treated as meaningful, because — as established in Section 4 — no default dry standard exists for any brick profile and the correct comparative-meter method differs by subtype (see Profile 2, Section 10, and Profile 3, Section 10).

11. Damage indicators and mandatory stop conditions

[SOURCE] Visible efflorescence (a white, powdery salt deposit on the wall face) is explicitly *not* by itself a stop condition — the Brick Industry Association states plainly that "efflorescence is usually not harmful to brick masonry" (Brick Industry Association 2019, Technical Notes 23A, p.1) and that "new building bloom" from construction-stage moisture typically weathers away naturally. The mandatory stop condition is the different and more serious phenomenon of **subflorescence** — salt crystallising *within* the pore structure rather than on the surface — which both Young (2008, Section 6, p.11) and the peer-reviewed crystallisation literature (Rodriguez-Navarro & Doehne 1999) identify as the mechanism that fractures, delaminates, or spalls masonry.

[SOURCE] The general condition-observation stop trigger already implemented in the app (a technician-recorded "distress observed" reading immediately blocks the material, per `lib/material-drying-stage.ts`) is directly supported: Young (2008, p.11) describes surface effects of subflorescence as "grain-by-grain loosening... or fretting and crumbling of the surface... or delamination of a complete skin," all of which are exactly the kind of visible distress a technician inspection should catch before automated drying is allowed to continue at the full base rate.

12. Mixed-material implications

[MCA DERIVATION] Because "Brick / Masonry" is blocked, in a mixed room it never contributes a numeric temperature or rate cap of its own to the room's governing limits — but per Section 5's code finding, if it is selected alongside other materials, its unreviewed `maxTempC = 50` can still be compared against other materials' limits by `computeGoverningLimits()` (the aggregation function does not skip blocked materials when computing the numeric `maxTempC`/`rhMin`/`rhMax` fields — it only adds to `blockingReasons`). In the overwhelming majority of real jobs this is harmless because 50°C will never be the *lowest* value among selected materials (nearly every other profile in the register has a lower ceiling), but it is a latent documentation inconsistency worth fixing per Section 5's recommendation.

13. Assessment of the current MCA profile

The generic profile's design intent — block unattended automation until a specific brick subtype is chosen — is well supported by the porosity-range evidence in Section 1 and is consistent with how the app already treats the generic Plasterboard and Plaster/Render profiles. Two issues found during this review, both administrative rather than safety-critical:

1. The legacy, unsourced `max_temp_c = 50` value should be cleared or replaced with a sourced figure, even though the global 38°C cascade ceiling means it is not currently load-bearing for equipment safety (Section 5).
2. All three brick profiles (this generic one and both subtypes) resolve to the `"other"` material-type bucket in `lib/material-standards.ts`, which has no default dry-standard percentage. This is

arguably correct conservatism, but it means the app gives a technician zero automatic guidance on what dry-standard method or percentage is appropriate for brick — that guidance currently exists only in a technician's own training, not in the app.

14. Recommended app parameters

Parameter	Current value	Proposed value	Confidence	Source / derivation
Control disposition	Specialist required	Specialist required (unchanged)	High	**[CODE FINDING]** — `automation_mode='specialist_required'`, migration 0006
Maximum temperature (°C)	50 (legacy seed value)	NULL, or documented as non-binding due to 38°C cascade ceiling	Low (current value) / Medium (proposed)	**[MCA DERIVATION]** — Section 5; no source supports 50°C specifically for brick
Emergency RH floor	NULL	NULL (unchanged)	N/A	Blocked profile — no numeric review parameter proposed
Normal control target RH	NULL	NULL (unchanged)	N/A	Blocked profile
Restart RH	NULL	NULL (unchanged)	N/A	Blocked profile
Max RH drop pp/h	NULL	NULL (unchanged)	Unsupported	No source publishes a universal ambient rate for undifferentiated "brick"
Max RH drop pp/24h	NULL	NULL (unchanged)	Unsupported	As above

Parameter	Current value	Proposed value	Confidence	Source / derivation
Assessment/ stabilising factor	0 (blocked stage)	0 (unchanged)	High	**[CODE FINDING]** — `computeMaterialDryingStage()` forces `"blocked"` for non-controlled automation modes
Bulk factor	0 (blocked stage)	0 (unchanged)	High	As above
Equalising/ verification factor	0 (blocked stage)	0 (unchanged)	High	As above
Min environmental history / cadence	N/A (blocked)	N/A (unchanged)	N/A	Applies only once a subtype is selected
Reading method / dry standard	None (`"other"` bucket, `DEFAULT_DRY_STANDARDS_PCT.other = null`)	None; require technician-entered comparative reading and subtype selection before any automated control	Medium	**[CODE FINDING]** + **[MCA DERIVATION]** — Section 4
Warning / shutdown / restart thresholds	N/A (blocked)	N/A (unchanged)	N/A	Applies only once a subtype is selected
Overall confidence	Unsupported	Unsupported (correctly, by design)	—	This profile intentionally carries no automation confidence

Claim-to-source table

Numeric claim	Value	Source or derivation
Brick/mortar porosity range	10–30% (vs 1–5% for dense stone)	**[SOURCE]** Young 2008, p.9
Salt-content concern threshold	>0.5% salt by weight	**[SOURCE]** Young 2008, p.12 — a salt-mass criterion, not an RH-rate criterion
Cascade hard temperature ceiling	38°C	**[CODE FINDING]** `CASCADE_HARD_MAX_C` constant, `lib/material-automation.ts`
Legacy generic max temp	50°C	**[MCA DERIVATION]** — unsourced legacy seed value, flagged for removal

15. Evidence gaps, assumptions, and required specialist overrides

- No cited source publishes a universal ambient RH-drop-rate for masonry of any kind; this generic profile deliberately carries none.
- Historic England's "Drying" and "Masonry Buildings" pages (`historicengland.org.uk/advice/technical-advice/flooding-and-historic-buildings/...`) returned HTTP 403 to this research agent's direct page fetch. The statements attributed to Historic England above were obtained through a search-engine synthesis of the same URLs, not a direct read of the rendered page. **MCA should independently verify these pages before relying on them in a legal-defensibility context.**
- `lib/material-standards.ts`'s `materialTypeForProfileName()` has no `"brick"` or `"masonry"` branch; all three brick profiles fall through to `"other"`. This is functionally conservative but should be an explicit, documented design decision rather than an accidental fallthrough.
- The generic profile's legacy `max_temp_c = 50` should be corrected per Section 5/13.
- Required specialist override: any technician-supplied brick/mortar salt-content test (per Young 2008's 0.5%-by-weight rule of thumb) or manufacturer/heritage-consultant advice always overrides this provisional guidance.

16. References

1. Young, D. (2008). *Salt Attack and Rising Damp: A Guide to Salt Damp in Historic and Older Buildings*. Prepared for the Heritage Council of NSW, Heritage Victoria, South Australian Department for Environment and Heritage, and Adelaide City Council. ISBN 978-0-9805126-4-9 (print) / 978-0-9805126-5-6 (online). November 2008. URL: https://www.environment.nsw.gov.au/sites/default/files/salt-attack-and-rising-damp-guide.pdf

(mirror: https://www.heritage.vic.gov.au/__data/assets/pdf_file/0026/505268/Salt-attack-and-rising-damp.pdf). Accessed 22 July 2026. **Tier 1** — joint Australian heritage-authority technical guide, reviewed directly (pages 1–29 read in full).

2. Brick Industry Association (2019). *Technical Notes on Brick Construction 23A: Efflorescence – Causes and Prevention*. Reston, Virginia. June 2019. URL: https://www.gobrick.com/media/file/23a-tn23a.pdf. Accessed 22 July 2026. **Tier 1** — recognised industry technical body; US-focused but internationally used as an engineering reference for fired-clay masonry. Reviewed directly (pages 1–6 read in full).
3. Rodriguez-Navarro, C. & Doehne, E. (1999). "Salt Weathering: Influence of Evaporation Rate, Supersaturation and Crystallization Pattern." *Earth Surface Processes and Landforms*, 24(3), 191–209. DOI: 10.1002/(SICI)1096-9837(199903)24:3<191::AID-ESP942>3.0.CO;2-G. Accessed 22 July 2026. **Tier 1, peer-reviewed** — full text is paywalled on Wiley Online Library; reviewed via publisher abstract and multiple independent secondary summaries of its findings, not the complete original text. **MCA should obtain the full paper before citing specific figures or page numbers from it.**
4. Historic England. "Drying" and "Masonry Buildings", in *Flooding and Historic Buildings* technical advice series. URLs: https://historicengland.org.uk/advice/technical-advice/flooding-and-historic-buildings/repair-and-emergency-works/drying/ ; https://historicengland.org.uk/advice/technical-advice/flooding-and-historic-buildings/building-construction/masonry-buildings/. Accessed 22 July 2026. **Tier 1** — national heritage authority, but direct page fetch returned HTTP 403; content relayed via search-engine synthesis only. **Access-limited — verify directly before formal reliance.**
5. IICRC. *AS-IICRC S500 Published — Press Release*. March 2025. URL: https://iicrc.org/wp-content/uploads/2025/04/AS-IICRC-S500-Published-Press-Release_March-2025.pdf. Accessed 22 July 2026. **Tier 1**, confirms the Australian-adopted standard's scope includes masonry/concrete drying science, but is a press release, not the standard itself; **proprietary — MCA must hold a licensed copy** before citing any specific clause.

Internal code sources reviewed directly for this report (not restoration-science citations): `lib/material-automation.ts`, `lib/material-drying-stage.ts`, `lib/material-standards.ts`, `drizzle/0005_materials_automation.sql`, `drizzle/0006_history_aware_drying.sql`, `scripts/migrate-005-and-seed.mjs`, `docs/material-drying-parameter-register-2026-07-22.md`, `app/guide/page.tsx`, `lib/guide-references.ts`.

Brick - Modern Fired

Research packet: claude-c4-masonry.md | 3,670 words | 4 URL references | The packet is commentary for review, not a certified limit.

Scope: this chapter separates source-supported observations, operational assumptions, unresolved uncertainty, and field verification requirements for this material.

1. Scope and material identification

[CODE FINDING] `Brick - Modern Fired` was inserted by migration `0006_history_aware_drying.sql` with `max_temp_c=40`, `rh_min_pct=35`, `rh_max_pct=65`, `control_target_rh_pct=40`, `control_restart_rh_pct=48`, `max_rh_drop_per_hour=5`, `max_rh_drop_per_24_hours=18`, `automation_mode='controlled'`, `damage_risk='Efflorescence / mortar shrinkage'`, and a policy note restricting its use: "Modern dense fired brick only. Do not use for heritage soft brick, lime mortar or salt-loaded assemblies."

This profile is intended for post-war and contemporary Australian brick veneer and solid-brick construction: dense, hard-fired clay units (commonly extruded and fired to vitrification or near-vitrification), laid in Portland-cement-based mortar, typically with a cavity or veneer air gap behind the outer skin in modern construction. It explicitly excludes soft-fired heritage brick, which is covered separately in Profile 3.

2. Material construction and moisture behaviour

[SOURCE] Modern fired clay brick is manufactured to a controlled firing schedule that produces a denser, less porous, and mechanically stronger unit than the softer, lower-temperature-fired bricks common before the twentieth century. Standards Australia/Standards New Zealand publish a dedicated test-method series for masonry units — AS/NZS 4456.14 defines the water-absorption test and AS/NZS 4456.17 defines the initial rate of absorption (IRA) test, IRA being "the amount of water absorbed in 1 minute through the bed face of the unit," used primarily to design mortar bond strength, not drying behaviour (AS/NZS 4456 series, summarised via Standards New Zealand and Building CodeHub abstract listings). **This report reviewed only the publicly available abstracts/scope descriptions of AS/NZS 4456.14 and .17, not the full paywalled standard, and does not cite any specific numeric IRA or absorption acceptance value from it.**

[SOURCE] Young (2008, Section 4, p.9) places "bricks and mortar" in the 10–30% porosity band generally, but modern dense fired units sit toward the lower end of that band; the guide separately notes (Section 2, p.4, Figure 2 caption) that "paler (underfired) bricks are more susceptible to salt attack than the darker, more well-fired ones" — i.e. firing temperature and density directly affect salt-attack susceptibility even within the "modern fired brick" category, which is a useful caution against treating this profile as uniformly risk-free.

[SOURCE] Even dense, well-fired brick is not immune to salt-related moisture problems, because the salts responsible for efflorescence and subflorescence most often originate in the mortar, not the brick itself: "The primary and most obvious source of contamination of otherwise efflorescence-free brick is the mortar used in wall construction," quoting research by W.E. Brownell reproduced in the Brick Industry Association's technical note (Brick Industry Association 2019, p.3). The same note explains that Portland cement's alkali content is the principal contributor, and that ASTM C150 allows specifying "low-alkali cement" with a compositional cap of 0.60% equivalent alkalis (Brick Industry Association 2019, p.3, citing ASTM C150 and C114). This is a genuine numeric standard value, but it is a *cement-composition* specification, not a drying-rate control.

3. Water exposure, contamination, and salvageability

[SOURCE] Modern fired brick and cement mortar are both largely inert to water in the sense that matters for salvageability — they do not decompose, support mould growth as a food source, or lose structural strength from wetting the way plasterboard, timber, or carpet backing do. The Brick Industry Association's note treats even repeated efflorescence events as a maintenance nuisance rather than a structural failure: "efflorescence is usually not harmful to brick masonry" (Brick Industry Association 2019, p.1). This supports a general presumption of salvageability for modern fired brick assemblies affected by clean or moderately contaminated water, subject to two qualifiers below.

[SOURCE] The qualifiers are: (a) if efflorescence "occurs more than a year after construction is complete, it can generally be attributed to excessive water penetration or poor drainage" (Brick Industry Association 2019, p.1) — i.e. recurring efflorescence on an established wall is itself evidence of an ongoing moisture-ingress defect that ambient drying will not fix; and (b) "under certain specific circumstances and conditions, it is possible for the crystals of efflorescence to form within the bodies of brick units. When this occurs, the growth of crystals and the resulting pressure may cause cracking and distress to masonry" (Brick Industry Association 2019, p.2) — this is the subflorescence mechanism, and it is the mandatory stop-condition trigger referenced in Section 11.

[SOURCE] Category-3 (grossly contaminated, e.g. sewage or floodwater) exposure to brick veneer cavity walls raises a separate, non-moisture salvageability question: whether wall-cavity insulation, weep holes, or wall ties have trapped contaminated debris that ambient drying cannot remove. Restoration trade guidance on cavity-wall drying (reviewed via industry publication search synthesis, not a single authoritative document with a stable citation) generally recommends thermal-imaging assessment and, where necessary, selective removal or injection-port access to dry and inspect the cavity directly, rather than relying on ambient room drying to dry a sealed cavity.

4. Drying objectives and completion criteria

[CODE FINDING] As established in Profile 1 Section 4, `materialTypeForProfileName("Brick - Modern Fired")` resolves to `"other"`, so `defaultDryStandardFor()` returns `null` — the app proposes no automatic dry-standard percentage for this profile. A technician must enter a linked comparative "unaffected" brick reading (`dryStandardPct`) for the drying-stage engine (`computeMaterialDryingStage()`) to progress this material out of the `"assessment"` stage (see Section 9).

[MCA DERIVATION] In the absence of a source-published brick moisture-content dry standard, MCA's recommended completion method is the same comparative approach IICRC S500 uses generally: take a moisture-meter reading (see Section 10 for method) on an unaffected area of the same brick/mortar type in the same building, and treat that reading as the dry standard for the affected area. **Hazard controlled:** false "complete" calls from applying a generic brick MC% that does not match the specific unit/mortar combination on site. **Uncertainty:** medium — the comparative method is standard restoration practice but the specific meter scale used must be brick-appropriate (Section 10). **Monitoring/stop condition:** the reading must be linked to the correct `job_material_id` and taken with a consistent method across the baseline and follow-up readings, per the existing `applyMaterialDryingStages()` logic.

5. Temperature limitations

[CODE FINDING] The stated `max_temp_c = 40` is, per the analysis in Profile 1 Section 5, **not the value that actually governs equipment shutdown** in the current controller. `temperatureCutoffs()` computes `materialOffAt = 40 - 1.5 = 38.5°C`, and takes the minimum against `CASCADE_HARD_MAX_C = 38`. Because `38 < 38.5`, the hard-coded 38°C global cascade ceiling wins, and equipment is switched off at 38°C regardless of this material's own 40°C figure. The 40°C value is therefore currently non-binding for equipment control, though it still participates in the "governing material" display/attribution logic in `computeGoverningLimits()`.

[SOURCE] No source reviewed for this report identifies an intrinsic heat-damage threshold for fired clay brick or Portland-cement mortar anywhere near 38–40°C; brick is fired in the 900–1200°C range during manufacture and cement mortar cures and later tolerates far higher service temperatures without damage. The risk pathway at issue is not heat damage to the masonry itself, but the indirect effect of temperature on evaporation rate (and hence on salt migration and crystallisation location — see Section 6/11), and on any co-located combustible, timber, or moisture-sensitive finish that may share the room.

[MCA DERIVATION] Recommend retaining 40°C as documented policy but recognising explicitly that the binding limit in practice is the global 38°C cascade ceiling, not a brick-specific one. **Hazard controlled:** equipment/room over-temperature and, secondarily, excessive evaporation-rate acceleration in salt-bearing mortar. **Uncertainty:** low for equipment safety (cascade ceiling is a hard, tested global rule); medium for the salt-migration rationale (no brick-specific study locates the exact temperature at which evaporation-driven subflorescence risk becomes unacceptable). **Monitoring/stop condition:** unchanged from current implementation.

6. Relative-humidity limitations

[CODE FINDING] Current values: `rh_min_pct = 35` (emergency floor), `rh_max_pct = 65` (ceiling), `control_target_rh_pct = 40`, `control_restart_rh_pct = 48`.

[MCA DERIVATION] No source reviewed publishes an ambient RH floor or ceiling specific to modern fired brick. These figures were evidently set by MCA to sit in the same general band as Render-Cement and other moderately salt-sensitive wall profiles already in the register (Render-Cement: floor 40%, target 43%, restart 50%; Brick-Modern-Fired: floor 35%, target 40%, restart 48% — slightly wider/lower than render, consistent with dense fired brick being less porous and less salt-reactive than cement render, which is applied thinner and more exposed). **Hazard controlled:** over-drying the room below the point where mortar/salt-bearing joints could dehydrate too abruptly (see Section 11), while still leaving enough of a deadband (35%–48% restart) that equipment does not short-cycle. **Uncertainty:** medium — the band is an internally-consistent MCA judgement relative to comparable wall materials already in the register, not a brick-specific study finding. **Monitoring/stop condition:** the existing overdry-protection rule (`evaluateAutomation()`, rule `"overdry_protection"`) already forces equipment off at or below the 35% floor regardless of any other rule.

7. GPP, dew point, vapour pressure, and condensation considerations

[SOURCE] As established generally in Profile 1 Section 7, condensation within a masonry wall occurs whenever the wall's internal pore-air temperature is below the dew point of the humid air drawn into it (Young 2008, p.10). For a brick-veneer cavity wall specifically, the cavity air space and any weep holes mean the outer skin can be at a substantially different temperature from the inner skin — a cold outer brick leaf on a winter night, combined with warm humid air being pushed into the cavity by an interior dehumidifier's exhaust or by poor sealing, is a plausible re-wetting pathway that ambient room-air RH sensors alone will not detect.

[MCA DERIVATION] No brick-specific GPP or dew-point setpoint is proposed beyond the app's existing general dew-point display (already covered in the app's Guide page, Section 5, "Grains per Pound & Dew Point"). **Hazard controlled:** cavity re-condensation in brick veneer. **Uncertainty:** high — this is a physically real risk with no brick-specific quantification located in the literature reviewed. **Monitoring/stop condition:** recommend a technician cavity-temperature spot check (infrared or probe) whenever a brick veneer wall is part of an active job, since the room controller cannot see cavity conditions.

8. Airflow and equipment selection

[SOURCE] Dense fired brick's low permeability means airflow directed at the wall face mainly accelerates surface-level evaporation rather than drawing moisture from deep within the assembly — consistent with Young's general observation (2008, p.10) that most masonry moisture exchange occurs slowly through the whole pore network. Cavity-wall drying practice reviewed via industry-publication search synthesis recommends ducted airflow into the cavity itself (injection ports or selective access) with a negative-pressure exhaust path, rather than relying solely on room-air movers, whenever the cavity itself (not just the visible face) is wet.

[MCA DERIVATION] For room-level automation (the scope of this app's controller), no brick-specific equipment-role change is proposed beyond the existing dehumidifier/LGR/desiccant roles already implemented. **Hazard controlled/uncertainty/monitoring:** not applicable — this section is descriptive rather than proposing a new automation input.

9. Staged drying strategy

[CODE FINDING] The generic staged-drying engine in `lib/material-drying-stage.ts` applies without modification to this profile once `automation_mode = 'controlled'` (confirmed in migration 0006): assessment/stabilising at 50% of base rate (2.5 pp/h / 9.0 pp/24h), bulk at 100% (5.0 pp/h / 18.0 pp/24h), and equalising/ready-to-verify at 50% again — identical mechanics to the register's existing controlled materials. Advancement to bulk requires two linked readings at least six hours apart, falling moisture, and a no-distress inspection (`STABILISATION_MIN_HOURS = 6`), exactly as documented in the existing register for other controlled materials.

[SOURCE] This time/reading-gated mechanism is directly consistent with the caution in the peer-reviewed crystallisation literature that damage from salt crystallisation is driven by supersaturation kinetics, not simply by elapsed drying time — Rodriguez-Navarro & Doehne (1999) found that "low relative humidity promoted rapid evaporation of saline solutions and higher supersaturation levels, resulting in the greatest damage," meaning a material that appears to be drying "fine" on a simple timer could still be accumulating damaging supersaturation inside the wall if the ambient RH fall is too fast for too long. The requirement for a falling comparative moisture reading, not just elapsed time, before advancing to the full bulk rate directly mitigates this.

10. Monitoring, sensor placement, and material readings

[SOURCE] Moisture-meter selection matters for brick specifically because pin-type (resistance) meters calibrated for wood or gypsum scales will not read brick or mortar moisture correctly; masonry moisture assessment generally requires either a masonry-calibrated non-invasive meter, a calcium-carbide (Speedy) test, or gravimetric oven-drying of an extracted sample, consistent with the IICRC S500's own instruction (cited in the existing register) that "the only way to assess concrete moisture accurately is with instruments calibrated for masonry materials" — the same principle extends to brick.

[MCA DERIVATION] Because `lib/material-standards.ts` currently has no `"masonry"`/`"brick"` branch, the app gives no in-product warning if a technician takes a brick reading with a wood- or gypsum-scale meter setting. **Hazard controlled:** false dry-standard comparisons from mismatched meter scales. **Uncertainty:** medium. **Monitoring/stop condition:** recommend the app record which meter scale/method was used alongside each material reading for brick profiles (a data-capture gap, not just a policy gap — see Section 15).

[MCA DERIVATION] Sensor placement recommendation: place the ambient RH/temperature sensor pair away from direct line-of-sight to the brick face (to avoid a false-low RH reading from localised surface evaporation skewing the room average), and take comparative moisture readings at multiple heights if rising damp is suspected, mirroring Young's (2008, p.14) observation that the evaporative zone for Australian exterior walls typically sits between 0.5 m and 1.2 m above ground level, with the damp zone itself extending up to about 1.0–1.5 m.

11. Damage indicators and mandatory stop conditions

[SOURCE] As in Profile 1, ordinary surface efflorescence is not a stop condition. The mandatory stop condition is any sign of subflorescence-driven distress: cracking, spalling, or crumbling of the brick face, or "growth of crystals and the resulting pressure... cracking and distress to masonry" from within the unit (Brick Industry Association 2019, p.2). The current controller's `distress_observed` condition status, which forces `computeMaterialDryingStage()` to return `"blocked"` regardless of reading history, is the correct implementation mechanism for this stop condition.

[SOURCE — contrary evidence check] A genuine search for contrary evidence (i.e. evidence that faster ambient drying is *safe* or *beneficial* for salt-bearing masonry) returned the opposite finding at peer-reviewed level: Rodriguez-Navarro & Doehne (1999) documented that the crystallisation pattern of sodium sulphate is strongly affected by relative humidity, with the more damaging anhydrous form (thenardite) tending to crystallise as subflorescence at RH below roughly 50%, while the less damaging hydrated form (mirabilite) tends to form nearer the surface at higher RH. Lower RH and faster evaporation therefore should not be assumed to be simply "faster and better" for modern fired brick if its mortar carries meaningful soluble-salt content — this is the load-bearing evidentiary support for retaining a rate cap on this profile rather than allowing unlimited-rate drying once the room is above the emergency floor.

12. Mixed-material implications

[CODE FINDING] In a mixed room, this profile's hourly (5.0 base) and daily (18.0 base) rate caps, each scaled by its own stage factor, are compared against every other selected material's caps by `computeGoverningLimits()`, and the lowest current hourly and lowest current daily cap govern the whole room (existing register mechanism, unchanged for this profile). A room combining Brick - Modern Fired with, for example, Carpet & Underlay (5.0 pp/h / 20.0 pp/24h base) would be governed by whichever material's *current stage* produces the lower effective cap — not necessarily the brick, since a carpet still in `"stabilising"` (50% of its own larger base) could still be more or less restrictive than brick depending on both materials' current stage.

13. Assessment of the current MCA profile

The current provisional values are internally consistent with the rest of the register (numerically identical hourly/daily rate to Render-Cement, a plausible RH band positioned between Concrete-Bare and the more conservative heritage/lime profiles) and are supported in direction, if not in exact magnitude, by the peer-reviewed finding that low-RH, fast evaporation increases salt-crystallisation damage risk in porous, salt-bearing masonry systems. Two findings from this review:

1. The documented 40°C temperature ceiling is not currently the binding equipment-shutdown temperature; the global 38°C cascade ceiling is. This should be corrected in documentation (Section 5) even though it does not represent a safety gap.
2. No source located publishes a modern-fired-brick-specific ambient RH-drop rate; the 5 pp/h / 18 pp/24h figures remain, and should remain documented as, an MCA provisional setting.

14. Recommended app parameters

Parameter	Current value	Proposed value	Confidence	Source / derivation
Control disposition	Controlled	Controlled (unchanged)	High	**[CODE FINDING]** migration 0006
Maximum temperature (°C)	40	40 (retain; document as non-binding vs. 38°C cascade ceiling)	Low-Medium	**[MCA DERIVATION]** — Section 5; no brick-specific heat-damage study located
Emergency RH floor	35%	35% (unchanged)	Medium	**[MCA DERIVATION]** — Section 6, positioned relative to comparable wall profiles
Normal control target RH	40%	40% (unchanged)	Medium	As above
Restart RH	48%	48% (unchanged)	Medium	As above

Parameter	Current value	Proposed value	Confidence	Source / derivation
Max RH drop pp/h (base)	5.0	5.0 (unchanged)	Low	**[MCA DERIVATION]** — no source publishes a universal rate; supported in direction by Rodriguez-Navarro & Doehne 1999
Max RH drop pp/24h (base)	18.0	18.0 (unchanged)	Low	As above
Assessment/ stabilising factor	50% (2.5 / 9.0)	50% (unchanged)	High	**[CODE FINDING]** `STABILISATION_RATE_FACTOR`
Bulk factor	100% (5.0 / 18.0)	100% (unchanged)	High	**[CODE FINDING]** `BULK_RATE_FACTOR`
Equalising/ verification factor	50% (2.5 / 9.0)	50% (unchanged)	High	**[CODE FINDING]** `EQUALISATION_RATE_FACTOR`
Min environmental history / cadence	>=5 valid readings spanning >=30 min	Unchanged	High	**[CODE FINDING]** `RATE_MIN_SAMPLES`, `RATE_MIN_HISTORY_MS`
Reading method / dry standard	None (`"other"` bucket)	Add explicit masonry-calibrated meter or calcium-carbide/gravimetric method requirement, with technician-entered comparative baseline	Medium	**[CODE FINDING]** + **[MCA DERIVATION]** — Section 10

Parameter	Current value	Proposed value	Confidence	Source / derivation
Warning/ shutdown/restart thresholds	75% / 90% / 60% of current cap (app-wide)	Unchanged	High	**[CODE FINDING]** `RATE_WARNING_FRACTION`, `RATE_STOP_FRACTION`, `RATE_RESTART_FRACTION`
Overall confidence	Low/provisional	Low/provisional (unchanged)	—	No source-published brick-specific rate exists

Claim-to-source table

Numeric claim	Value	Source or derivation
Efflorescence generally non-harmful; subflorescence is the damage mechanism	—	**[SOURCE]** Brick Industry Association 2019, pp.1–2
Low-alkali cement alkali cap	0.60% equivalent alkalis	**[SOURCE]** ASTM C150/C114, cited in Brick Industry Association 2019, p.3 (specification value, not a drying-rate value)
Subflorescence favoured by RH below ~50% (thenardite)	—	**[SOURCE]** Rodriguez-Navarro & Doehne 1999, abstract-level finding
Cascade hard temperature ceiling	38°C	**[CODE FINDING]** `CASCADE_HARD_MAX_C`
Stage rate factors (50/100/50%)	—	**[CODE FINDING]** `lib/material-drying-stage.ts` constants
RH band (35/40/48%) and rate caps (5/18)	—	**[MCA DERIVATION]** — positioned relative to comparable register entries; no brick-specific source
Evaporative/damp zone height, Australian exterior walls	0.5–1.2 m (evaporative), up to ~1.0–1.5 m rise	**[SOURCE]** Young 2008, p.14

15. Evidence gaps, assumptions, and required specialist overrides

- No source-published ambient RH-drop rate exists for fired brick; the rate caps remain MCA provisional settings.
- AS/NZS 4456.14 and .17 (water absorption, initial rate of absorption) were reviewed only at abstract/scope level; MCA should obtain the licensed standard before citing specific IRA or absorption pass/fail values in client-facing material.
- Think Brick Australia publishes an "Efflorescence Fact Sheet" (2024) and a suite of technical manuals, but these require a free account/login to access in full; this research agent could not verify their content beyond publicly indexed page metadata. **Flagged as a login-gated source MCA should independently retrieve.**
- `lib/material-standards.ts` has no masonry-specific dry-standard default or meter-method field; this is a real product gap, not just a documentation gap (Section 10).
- Required specialist override: manufacturer brick/mortar technical data, a structural engineer's assessment of any cracking observed during drying, or a heritage consultant's advice (if the specific building has any heritage listing despite using modern brick) always override this provisional guidance.

16. References

1. Brick Industry Association (2019). *Technical Notes on Brick Construction 23A: Efflorescence – Causes and Prevention*. Reston, Virginia. June 2019. URL: https://www.gobrick.com/media/file/23a-tn23a.pdf. Accessed 22 July 2026. **Tier 1** — reviewed directly (pages 1–6 read in full).
2. Young, D. (2008). *Salt Attack and Rising Damp: A Guide to Salt Damp in Historic and Older Buildings*. Heritage Council of NSW et al. November 2008. URL: https://www.environment.nsw.gov.au/sites/default/files/salt-attack-and-rising-damp-guide.pdf. Accessed 22 July 2026. **Tier 1** — reviewed directly.
3. Rodriguez-Navarro, C. & Doehne, E. (1999). "Salt Weathering: Influence of Evaporation Rate, Supersaturation and Crystallization Pattern." *Earth Surface Processes and Landforms*, 24(3), 191–209. DOI: 10.1002/(SICI)1096-9837(199903)24:3<191::AID-ESP942>3.0.CO;2-G. Accessed 22 July 2026. **Tier 1, peer-reviewed** — reviewed via abstract and secondary summaries only; full text paywalled.
4. Standards Australia / Standards New Zealand. *AS/NZS 4456.14:2003 — Masonry units, segmental pavers and flags, Methods of test, Part 14: Determining water absorption properties*, and *AS/NZS 4456.17:2003 — Part 17: Determining initial rate of absorption (suction)*. Accessed 22 July 2026 via publicly indexed scope/abstract listings (Standards New Zealand shop, Building CodeHub, SAI Global). **Tier 1 standard — proprietary; full clause text not reviewed. MCA must obtain a licensed copy before citing specific IRA or absorption values.**

5. ASTM International. *ASTM C67 — Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile* and *ASTM C150 — Standard Specification for Portland Cement*, both cited secondhand within Brick Industry Association (2019). Accessed 22 July 2026 via the BIA technical note only; the ASTM standards themselves were not independently retrieved. **Tier 1 standards, cited at second hand — MCA should obtain licensed copies before quoting specific clauses.**
6. IICRC. *AS-IICRC S500 Published — Press Release*. March 2025. URL: https://iicrc.org/wp-content/uploads/2025/04/AS-IICRC-S500-Published-Press-Release_March-2025.pdf. Accessed 22 July 2026. **Tier 1**, proprietary — no specific clause cited.
7. Think Brick Australia. *Technical Manuals* (index page) and *Efflorescence Fact Sheet* (2024). URLs: https://www.thinkbrick.com.au/technical/manuals/technical-manuals/ ; efflorescence fact sheet requires account login. Accessed 22 July 2026. **Tier 2** — publicly visible page metadata only; full document content not verified. **Login-gated; MCA should retrieve a full copy independently.**

Internal code sources reviewed directly: `lib/material-automation.ts`, `lib/material-drying-stage.ts`, `lib/material-standards.ts`, `drizzle/0006_history_aware_drying.sql`, `docs/material-drying-parameter-register-2026-07-22.md`.

Brick - Heritage Soft

Research packet: claude-c4-masonry.md | 3,463 words | 6 URL references | The packet is commentary for review, not a certified limit.

Scope: this chapter separates source-supported observations, operational assumptions, unresolved uncertainty, and field verification requirements for this material.

1. Scope and material identification

[CODE FINDING] `Brick - Heritage Soft` was inserted by migration `0006_history_aware_drying.sql` with `max_temp_c=28`, `rh_min_pct=45`, `rh_max_pct=65`, `control_target_rh_pct=48`, `control_restart_rh_pct=53`, `max_rh_drop_per_hour=1.5`, `max_rh_drop_per_24_hours=5`, `automation_mode='specialist_required'`, `limit_status='provisional'`, `damage_risk='Soft-face spalling / lime erosion / salt crystallisation'`. The register (`docs/material-drying-parameter-register-2026-07-22.md`) explicitly states these numbers are "1.5 pp/h and 5 pp/24h for review only" and that "the app remains blocked" until an approved heritage drying plan is obtained.

This profile targets pre-twentieth-century soft, low-fired clay brick, typically laid with lime mortar (rather than Portland cement), commonly found in Australian heritage buildings and frequently affected by rising damp, salt loading from decades of ground-salt migration, or a missing/failed damp-proof course.

2. Material construction and moisture behaviour

[SOURCE] Young (2008, p.4, Figure 2 caption) directly ties firing quality to salt-attack vulnerability: "Paler (underfired) bricks are more susceptible to salt attack than the darker, more well-fired ones." Heritage soft brick, by definition, is at the underfired end of this spectrum — its firing temperature was typically lower and less controlled than modern industrial kilns achieve, producing a softer, more porous, more absorbent unit.

[SOURCE] Many nineteenth-century Australian buildings were constructed with no damp-proof course at all, or with early DPC materials — "roofing slates laid in mortar with an overlapping second layer, sheets of glass, lead, hardwoods, bitumen-impregnated fibre, felt or paper, and various asphalt and tar-based compositions" (Young 2008, p.16) — that have since failed, been bridged by rising ground levels, or were never fully effective. This is the central reason heritage soft brick walls are disproportionately affected by rising damp compared to modern construction, which uses a continuous polyethylene DPC by default.

[SOURCE] The rate at which rising damp reaches equilibrium height, and the height itself, is climate- and construction-dependent: "In Australia the normal exterior height limit for rising damp ranges from 1.0 to 1.5 metres above ground level, whereas in cooler, more humid climates damp may rise several metres before evaporating. The evaporative zone is commonly from 0.5 to 1.2 metres above ground level"

(Young 2008, p.14). Internally, the damp zone height depends heavily on ventilation and heating/air-conditioning use: "the more ventilation the lower will be the damp zone... The addition of heating or air-conditioning will increase the rate of drying and so increase the associated decay" (Young 2008, p.15).

[SOURCE] Heritage soft brick's lime mortar is itself part of the moisture-management system, not an incidental jointing material. The SPAB's technical advice note explains that traditional lime mortars and renders are deliberately more permeable ("breathable") than modern cement products, allowing a wall to take in and release moisture cyclically without trapping it; a hard cement repointing or render applied over a damp lime-mortared wall "prevented walls from drying out and led to structural problems" (SPAB, *Control of Dampness*, summarised via search synthesis of the SPAB technical advice note by Douglas Kent).

3. Water exposure, contamination, and salvageability

[SOURCE] Historic England's flood guidance, reviewed via search synthesis (see Section 15 access note), states that masonry flooded by sea water should be rinsed with clean, salt-free water as soon as possible, then allowed to dry slowly "so as to minimise the effects of chloride-salt damage to soft masonry" — a direct, named application of this exact material category. The same guidance states that "impermeable heavily cement-based mortar will exacerbate deterioration during a flood because it holds the moisture in the masonry for longer and causes salts to crystallise within the historic materials," and recommends removing hard cement mortar and repointing with weaker, more porous lime-based mortar to help the wall dry.

[SOURCE] Historic England's overarching completion criterion for old buildings differs deliberately from a modern moisture-content target: "old buildings are damper than new buildings so the criteria should be 'dry for the purpose' — i.e. equilibrium in moisture content has been achieved, and the remaining moisture will not support the active growth of fungal spores, mould, mildew or insect infestation" — and separately, "overdrying can be just as harmful as the flood itself." This is a direct, named contrary-evidence caution against treating "as dry as possible, as fast as possible" as a valid objective for this material.

[SOURCE] Young (2008, p.24, Section 9.4 "Managing salt attack with maintenance" area) frames heritage masonry salt damage as a long-term, cyclical, maintainable condition rather than a one-time repair: after roughly 100 years, decay reaches a maximum rate, and periodic mortar renewal plus salt removal (desalination) can reset the decay clock, "in this hypothetical case, every twenty years" — explicitly describing this as "an approach which requires ongoing maintenance," not a cure. This matters for salvageability judgements after a water-restoration event: heritage soft brick affected by a flood or leak is being added to a pre-existing, decades-long salt-decay trajectory, not starting from a clean baseline.

4. Drying objectives and completion criteria

[SOURCE] As above, Historic England's "dry for the purpose" standard — equilibrium moisture content that will not support mould, decay, or insect activity, understood as normal for the specific old building rather than compared to a modern moisture-content target — is the most directly relevant completion criterion located for heritage masonry. **[CODE FINDING]** The app's own comparative dry-standard mechanism (linking a reading to an unaffected baseline) is compatible with this concept in principle, but as with Profiles 1 and 2, `materialTypeForProfileName()` provides no default percentage for brick, so a technician must supply their own baseline reading.

[MCA DERIVATION] Because this profile is `specialist_required`, no automated completion criterion is proposed; completion should be determined by the heritage/conservation specialist's own assessment, informed by comparative readings the app can still log for record-keeping even while automation is blocked.

5. Temperature limitations

[CODE FINDING] `max_temp_c = 28`. Unlike Profiles 1 and 2, this value **is** the binding equipment-shutdown driver: `materialOffAt = 28 - 1.5 = 26.5°C`, which is below the global `CASCADE_HARD_MAX_C = 38°C`, so this material's own limit governs (`minDefined([26.5, 38, ...]) = 26.5`).

[SOURCE] No source reviewed for this report publishes a specific heat-damage threshold for lime mortar or soft-fired brick at 28°C. The figure is materially lower than Profile 2's 40°C, which is directionally consistent with the evidence that heat accelerates evaporation and hence salt-migration/crystallisation risk (Section 11), and with SPAB/Historic England's general caution against heating old, salt-affected fabric aggressively. **[MCA DERIVATION]** — **Hazard controlled:** accelerated evaporation-driven subflorescence in salt-loaded, lime-mortared masonry. **Uncertainty:** high — the specific number 28°C is a conservative MCA choice, not a study finding. **Monitoring/stop condition:** because this profile is already `specialist_required` and blocked from unattended automation, this value functions as a review parameter for the eventual specialist-approved plan, not a currently enforced automated ceiling.

6. Relative-humidity limitations

[CODE FINDING] `rh_min_pct = 45` (floor), `rh_max_pct = 65` (ceiling), `control_target_rh_pct = 48`, `control_restart_rh_pct = 53` — all notably higher than Profile 2's equivalent figures (35/65/40/48).

[SOURCE] This higher floor is consistent with, though not derived from a single specific number in, Historic England's "dry for the purpose" principle: old, permeable, salt-affected masonry is expected to sit at a higher equilibrium moisture/humidity than modern construction, and driving it down toward a modern-building target is exactly the "overdrying can be just as harmful as the flood itself" scenario the same guidance warns against.

[MCA DERIVATION] Hazard controlled: driving ambient RH low enough to pull the wall well below its long-term historical equilibrium, which both increases subflorescence risk (Section 11) and risks desiccation cracking of lime mortar and any lime plaster keys. **Uncertainty:** high — no source publishes a specific safe RH floor for lime-mortared heritage brick; 45% is MCA's conservative extrapolation from the general "keep it damper than a modern building" principle. **Monitoring/stop condition:** because automation is blocked, this is a review parameter for specialist sign-off, not a live control setting.

7. GPP, dew point, vapour pressure, and condensation considerations

[SOURCE] The same wall-breathing/internal-condensation mechanism described in Profile 1 Section 7 (Young 2008, p.10) applies with greater force to heritage soft brick, because its higher porosity and hygroscopic salt content mean it draws in and retains more atmospheric moisture through vapour exchange than dense modern brick does — "if there are salts or other hygroscopic (moisture-attracting) materials in the masonry then the amount of water drawn into (and retained in) the wall can be sufficient to make the wall visibly damp, even in dry weather" (Young 2008, p.10).

[MCA DERIVATION] No numeric GPP or dew-point setpoint is proposed. Given the profile is already specialist-required, dew-point and vapour-pressure management for heritage masonry should be an explicit part of the required specialist drying plan, not an automated app setting.

8. Airflow and equipment selection

[SOURCE] SPAB and Historic England guidance both emphasise gentle, gradual conditions over forced rapid drying for old permeable fabric — SPAB frames this as preserving the wall's ability to "breathe" (moisture in, then evaporate out again) rather than sealing or forcing it, and warns specifically against hard cement renders that trap moisture rather than against fast airflow per se; the broader caution against "overdrying" from Historic England applies to any equipment strategy, mechanical or passive, that removes moisture faster than the specific building's fabric and salt loading can tolerate.

[MCA DERIVATION] No specific equipment-role recommendation is proposed for this profile beyond flagging that any active mechanical drying of heritage soft brick should occur only under the required specialist plan (Section 15), consistent with the register's existing treatment of Plaster - Lime/Heritage.

9. Staged drying strategy

[CODE FINDING] Because `automation_mode = 'specialist_required'`, `computeMaterialDryingStage()` returns `"blocked"` with `rateFactor = 0` unconditionally, exactly as for the generic Brick/Masonry profile in Profile 1 Section 9. No reading history, however favourable, can move this material out of the blocked stage; only removing the block by recording an approved specialist plan (an operational/process step outside the current stage engine) would allow controlled automation.

10. Monitoring, sensor placement, and material readings

[SOURCE] Young (2008, Section 11 "Diagnosis", pp.30–34, referenced in the table of contents reviewed) covers moisture-meter use and salt chemical analysis as the two core diagnostic tools for heritage masonry — moisture meters to map the extent and height of dampness, and chemical salt testing to determine whether the >0.5%-by-weight concern threshold (Section 3) has been crossed. Both should be part of any heritage brick job's monitoring record, independent of whether automation is active.

[MCA DERIVATION] As with Profile 2, no default dry-standard or meter-method field exists for brick in `lib/material-standards.ts`. For heritage soft brick this gap matters more, because a comparative reading taken with the wrong method or against the wrong "unaffected" reference (e.g. a different brick batch, or a section of wall with different historical salt exposure) is more likely to be misleading than for a uniform modern brick run.

11. Damage indicators and mandatory stop conditions

[SOURCE] The core mandatory stop condition — any sign of spalling, delamination, fretting, or crumbling from subflorescence — applies with the same or greater force here as in Profiles 1 and 2 (Young 2008, p.11; Brick Industry Association 2019, p.2), compounded by lime mortar's own vulnerability: SPAB and Historic England guidance both treat visible mortar erosion, "sacrificial" joint loss, or any new cracking as signals to pause and reassess, not to push through with faster drying.

[SOURCE — contrary evidence check] The Rodriguez-Navarro & Doehne (1999) finding on evaporation-rate-driven crystallisation damage (Profile 2, Section 11) applies with greater force here, because heritage soft brick and its associated rising-damp history are exactly the salt-loading scenario that peer-reviewed crystallisation research addresses. A 2025 *Journal of Materials in Civil Engineering* study on masonry under combined mechanical load and chloride-salt crystallisation (DOI: 10.1061/JMCEE7.MTENG-18668) similarly examined how salt-crystallisation cycles degrade masonry's mechanical properties — reviewed here at abstract level only, but consistent in direction with Young's and Rodriguez-Navarro's findings that cyclic wetting/drying and crystallisation, not simple elapsed time, drives structural degradation.

[SOURCE — contrary evidence check, opposite direction] A genuine search was also made for evidence that *slower* drying could itself be harmful (e.g. prolonged dampness enabling mould, insect, or fungal decay in any adjacent timber). Young (2008, Box 1, p.15) directly addresses this: "moulds have the potential to cause health problems... indoor mould growth can and should be controlled by controlling moisture levels. Keeping walls relatively dry is a sensible precaution. In building science terms, surface relative humidities... should be kept below 80% for periods of a month at a time." This is the one source-published numeric humidity threshold located in this research that is stated as a general building-science control value (80% surface RH sustained for up to a month) rather than a masonry-decay-rate figure — it is a mould-risk threshold, not a masonry salt-damage threshold, and the two pull in different directions: mould risk argues for not leaving the wall too damp for too long, while salt-crystallisation risk argues for not drying it too fast. **This tension is exactly why the profile is specialist-required rather than either "dry it as fast as possible" or "leave it alone."**

12. Mixed-material implications

[CODE FINDING] Because this profile is blocked (`automation_mode='specialist_required'`), `computeGoverningLimits()` adds a blocking reason ("Brick - Heritage Soft requires a reviewed subtype or specialist drying plan") to the room's `blockingReasons` array whenever it is selected, and `automationAllowed` becomes `false` for the entire room regardless of how favourable every other selected material's conditions are — matching the register's existing statement that "any blocked selected material blocks unattended automation for the room." A technician cannot work around this by selecting Brick - Heritage Soft alongside only well-behaved controlled materials; the room stays blocked until the heritage material itself is resolved (subtype confirmed as actually modern, or a specialist plan recorded).

13. Assessment of the current MCA profile

The decision to keep this profile specialist-required, with numeric values labelled explicitly as "review only" in the existing register, is strongly supported by the evidence gathered: Historic England's "overdrying can be just as harmful as the flood itself," SPAB's breathing-wall principle, Young's century-scale salt-decay-maintenance framing, and the peer-reviewed crystallisation-kinetics literature all point toward heritage masonry needing case-by-case specialist judgement rather than a single automated rate. No finding from this research suggests the current 28°C / 45–65% RH / 1.5 pp/h / 5 pp/24h review parameters are unreasonable as a *starting point* for a specialist's own plan, but none of them are source-published either — they are, correctly, MCA's own conservative extrapolation, clearly labelled as such in the register.

14. Recommended app parameters

Parameter	Current value	Proposed value	Confidence	Source / derivation
Control disposition	Specialist required	Specialist required (unchanged)	High	**[CODE FINDING]** migration 0006

Parameter	Current value	Proposed value	Confidence	Source / derivation
Maximum temperature (°C)	28 (review only)	28 (retain as specialist-plan starting point)	Low	**[MCA DERIVATION]** — no source-published figure; directionally consistent with heat/evaporation-rate caution
Emergency RH floor	45% (review only)	45% (unchanged)	Low	**[MCA DERIVATION]** — Section 6; extrapolated from "dry for the purpose" principle
Normal control target RH	48% (review only)	48% (unchanged)	Low	As above
Restart RH	53% (review only)	53% (unchanged)	Low	As above
Max RH drop pp/h (review only)	1.5	1.5 (unchanged)	Unsupported	No source publishes a universal rate; strongly conservative relative to Profile 2 given greater salt/porosity risk
Max RH drop pp/24h (review only)	5.0	5.0 (unchanged)	Unsupported	As above
Assessment/ stabilising/bulk/ equalising factor	0 (blocked stage, unconditional)	0 (unchanged)	High	**[CODE FINDING]** `computeMaterialDryingStage()`

Parameter	Current value	Proposed value	Confidence	Source / derivation
Min environmental history / cadence	N/A (blocked)	N/A until a specialist plan is recorded; then apply the same >=5-reading/30-minute rule as other controlled materials	Medium	**[CODE FINDING]** + **[MCA DERIVATION]**
Reading method / dry standard	None (`"other"` bucket)	Require heritage-specialist-approved comparative reading method before any automated control is ever enabled for this profile	Medium	**[MCA DERIVATION]** — Section 10
Warning/ shutdown/restart thresholds	N/A (blocked)	N/A until specialist plan recorded	N/A	Applies only if/when unblocked
Overall confidence	Unsupported (by design)	Unsupported (unchanged)	—	Correctly conservative; specialist plan required before any of these numbers control equipment

Claim-to-source table

Numeric claim	Value	Source or derivation
Underfired/paler brick more salt-attack-susceptible	—	**[SOURCE]** Young 2008, p.4
Salt-content concern threshold	>0.5% by weight	**[SOURCE]** Young 2008, p.12
Australian rising-damp evaporative zone	0.5–1.2 m; rise to 1.0–1.5 m	**[SOURCE]** Young 2008, p.14

Numeric claim	Value	Source or derivation
Mould-risk surface RH threshold	<80% sustained for up to a month	**[SOURCE]** Young 2008, Box 1, p.15
"Dry for the purpose" / overdrying-is-harmful principle	—	**[SOURCE]** Historic England, "Drying" (accessed via search synthesis)
Subflorescence favoured by low RH / fast evaporation	—	**[SOURCE]** Rodriguez-Navarro & Doehne 1999
28°C / 45–65% RH / 1.5 pp/h / 5 pp/24h review parameters	—	**[MCA DERIVATION]** — no source-published brick-specific figure exists; explicitly labelled provisional/review-only in the live register
Cascade hard temperature ceiling (not binding here)	38°C	**[CODE FINDING]** `CASCADE_HARD_MAX_C` — this profile's own 28°C governs instead

15. Evidence gaps, assumptions, and required specialist overrides

- No source publishes a universal ambient RH-drop rate, temperature ceiling, or RH band for heritage soft brick or lime mortar; every numeric value in Section 14 is an MCA provisional review parameter, exactly as already labelled in the live register.
- Historic England's and Historic Environment Scotland's guidance pages were accessed through search-engine synthesis, not a direct successful page fetch (both returned access barriers to this research agent's automated tools). **MCA must independently verify these two sources' exact wording before quoting them in a legal-defensibility document.**
- SPAB's *Control of Dampness* technical advice note (Douglas Kent) was likewise reviewed via search synthesis of its published PDF, not a line-by-line direct read; MCA should retrieve and archive the PDF directly.
- The 2025 *Journal of Materials in Civil Engineering* salt-crystallisation paper (DOI: 10.1061/JMCEE7.MTENG-18668) was reviewed at abstract/metadata level only; full author list, methodology, and specific numeric findings were not independently verified and are not quoted here beyond the general direction of its conclusions.
- Required specialist override: this entire profile exists to be overridden. No automation should run against these figures without a named heritage/conservation specialist's approved plan, salt-content testing (Young 2008's diagnostic chapter), and, where the building is heritage-listed, the

relevant planning/heritage authority approval referenced in Young (2008, Section 10, "Approach": "when dealing with listed heritage buildings always check for any planning or heritage approvals that may be required before undertaking any works").

16. References

1. Young, D. (2008). *Salt Attack and Rising Damp: A Guide to Salt Damp in Historic and Older Buildings*. Heritage Council of NSW, Heritage Victoria, South Australian Department for Environment and Heritage, and Adelaide City Council. ISBN 978-0-9805126-4-9. November 2008. URL: https://www.environment.nsw.gov.au/sites/default/files/salt-attack-and-rising-damp-guide.pdf. Accessed 22 July 2026. **Tier 1** — reviewed directly (pages 1–29 read in full, including Sections 1–10 and Figures 17–19).
2. Historic England. "Drying" and "Masonry Buildings," in *Flooding and Historic Buildings* technical advice series. URLs: https://historicengland.org.uk/advice/technical-advice/flooding-and-historic-buildings/repair-and-emergency-works/drying/ ; https://historicengland.org.uk/advice/technical-advice/flooding-and-historic-buildings/building-construction/masonry-buildings/. Accessed 22 July 2026. **Tier 1** — national heritage authority; direct page fetch returned HTTP 403, content relayed via search-engine synthesis only. **Access-limited — verify directly.**
3. Society for the Protection of Ancient Buildings (SPAB). Kent, D. *Control of Dampness*, Technical Advice Note. URL: https://www.spab.org.uk/sites/default/files/SPAB%20Control_of_Dampness_Edn_01_Rev_01_0.pdf. Accessed 22 July 2026. **Tier 1** — recognised UK heritage conservation body; reviewed via search-engine synthesis of the published PDF, not a full direct read. **MCA should retrieve and archive the PDF directly.**
4. Historic Environment Scotland. *Damp: Causes and Solutions*, INFORM Guide. URL: https://www.historicenvironment.scot/publications/all/publication/?publicationId=bd396452-624b-4b87-9ae4-a59500b4dff4. Accessed 22 July 2026. **Tier 1** — national heritage authority; reviewed via search-engine synthesis only.
5. Rodriguez-Navarro, C. & Doehne, E. (1999). "Salt Weathering: Influence of Evaporation Rate, Supersaturation and Crystallization Pattern." *Earth Surface Processes and Landforms*, 24(3), 191–209. DOI: 10.1002/(SICI)1096-9837(199903)24:3<191::AID-ESP942>3.0.CO;2-G. Accessed 22 July 2026. **Tier 1, peer-reviewed** — abstract/secondary-summary level only; full text paywalled.
6. [Authors not independently confirmed] (2025). "Impact of Salt Crystallization on the Mechanical Properties of Masonry." *Journal of Materials in Civil Engineering*, 37(5). DOI: 10.1061/JMCEE7.MTENG-18668. Accessed 22 July 2026. **Tier 1, peer-reviewed** — reviewed at abstract/metadata level only via the publisher's DOI record and third-party citation aggregators; full author list and complete text not independently verified. **MCA should retrieve the full paper and confirm authorship before formal citation.**

7. Brick Industry Association (2019). *Technical Notes on Brick Construction 23A: Efflorescence – Causes and Prevention*. Reston, Virginia. June 2019. URL: https://www.gobrick.com/media/file/23a-tn23a.pdf. Accessed 22 July 2026. **Tier 1** — reviewed directly; cited here for the general efflorescence/subflorescence mechanism, which applies to soft-fired brick with even greater force than to the dense modern brick it primarily addresses.

Internal code sources reviewed directly: `lib/material-automation.ts`, `lib/material-drying-stage.ts`, `lib/material-standards.ts`, `drizzle/0006_history_aware_drying.sql`, `docs/material-drying-parameter-register-2026-07-22.md`.

Plaster / Render

Research packet: claude-c5-plaster-render.md | 2,762 words | 5 URL references | The packet is commentary for review, not a certified limit.

Scope: this chapter separates source-supported observations, operational assumptions, unresolved uncertainty, and field verification requirements for this material.

1. Scope and material identification

"Plaster / Render" is the umbrella selection an MCA operator picks before a technician has identified the specific composition of a wet wall or ceiling finish. In Australian residential and commercial construction, three chemically and mechanically distinct families are commonly grouped under this single word:

- **Cement-based render** — a Portland-cement, sand, and (usually) polymer or lime-modified coating applied externally or internally over masonry, blockwork, or fibre-cement sheet.
- **Gypsum-based decorative or fibrous plaster** — calcined gypsum (plaster of Paris) cast or hand-run into cornices, ceiling roses, mouldings, and smooth internal wall/ceiling finishes, often reinforced with hessian and cast onto a timber support frame.
- **Lime-based plaster and render** — non-hydraulic or hydraulic lime putty or lime mortar, used historically as the base and finish coat on solid masonry walls and increasingly specified today for heritage conservation and breathable-wall retrofits.

These three families respond to water, heat, and humidity in materially different ways (Sections 2–8 of Profiles 2–4 below set out the differences in detail). A single ambient-air control recipe cannot safely serve all three: the temperature ceiling that is conservative for cement render is potentially damaging if applied without qualification to a decorative gypsum ceiling rose on an old timber armature, and the RH floor that suits both of those is markedly more aggressive than heritage-conservation guidance recommends for lime plaster on solid masonry (see Profile 4, Section 6). The MCA app's existing generic "Plaster / Render" profile therefore functions as an intentional placeholder, matching the treatment already applied to the generic "Plasterboard" and "Brick / Masonry" profiles in the current parameter register.

In practice, an MCA field technician arriving at a loss will frequently be unable to distinguish these three families at a glance, particularly where a painted finish obscures the substrate. Visual cues that support identification include: a hard, slightly hollow-sounding, machine- or float-textured external wall coating is more likely to be cement render; a smooth, crisp-edged internal cornice, ceiling rose, or run moulding — especially in a pre-1960s building — is more likely to be cast gypsum (decorative/fibrous) plaster; and a soft, chalky, uneven hand-finished internal wall in a nineteenth- or early-twentieth-century masonry building, particularly one with any heritage listing or conservation overlay, is more likely to be lime-based. None of these visual heuristics is a substitute for a technician's positive identification, but they explain why the generic profile is a genuinely distinct operational state rather than an oversight: the correct next action is always "identify," not "guess conservatively and proceed."

2. Material construction and moisture behaviour

Cement render is a rigid, comparatively low-porosity cementitious skin bonded to a masonry or sheet substrate; it wets and dries mainly through capillary movement in its own pore structure and through vapour exchange at the surface (Profile 2, Section 2). Gypsum-based decorative plaster is a cast, largely inorganic calcium-sulfate matrix, frequently reinforced with organic hessian fibre and fixed to timber, both of which are hygroscopic and mechanically weakened by sustained wetting (Profile 3, Section 2). Lime plaster and render are the most vapour-open of the three: lime putty or lime mortar carbonates slowly and remains permeable to liquid and vapour moisture throughout its service life, which is the basis of its use as a "breathable" heritage material (Profile 4, Section 2).

Because the three systems differ in porosity, mechanical reinforcement, and chemical stability when wet, a generic reading of "plaster" or "render" moisture content on a single moisture-meter material scale is unreliable until the substrate is identified; using the wrong scale (for example, a gypsum scale on a lime or cement substrate) produces numbers that do not correspond to any published dry-standard reference. The three families also differ in how far moisture migrates from the point of ingress: cement render's comparatively fine, tortuous pore network wicks moisture more slowly and over a smaller area than a soft, more open-pored lime system on solid masonry, while gypsum decorative plaster's behaviour depends heavily on whether the specific casting is solid or hollow-backed and on the permeability of any paint or size coating applied over it. A generic assessment therefore cannot reliably predict the extent of hidden wetting behind a visibly damp patch, which is a further reason unattended automation is inappropriate before identification.

3. Water exposure, contamination, and salvageability

All three plaster/render families can be affected by any IICRC water category (Category 1 clean water through Category 3 grossly contaminated water); category drives contamination-related salvage decisions in the same way as for other porous building materials, but it does not by itself determine which drying temperature or humidity regime is safe. Independent of category, the restoration industry consensus classifies solid plaster among the low-permeance "Class 4" (specialty drying) situations under the IICRC S500 water-damage-restoration framework — materials with low porosity that hold moisture deep in the matrix and require longer, more carefully managed drying than higher-permeance materials such as carpet [Source 3]. The specific numeric procedures within S500 itself are in a paywalled standard that MCA has not independently licensed for this review; this report relies on secondary descriptions of the classification concept, not a verified quotation of standard text.

Salvageability judgements for this generic category are further complicated by the fact that the three families carry very different default salvage postures once identified: cement render is chemically inert and, contamination aside, is rarely condemned by wetting alone (Profile 2, Section 3); lime plaster is described in conservation literature as capable of softening, swelling, and re-hardening without collapse, and is often the preferred material to retain and re-dry rather than replace (Profile 4, Sections 2–3); while gypsum decorative plaster sits closer to plasterboard's more precautionary "replace unless proven otherwise" posture once contamination or structural signs are present (Profile 3, Section 3). A generic assessment cannot safely default to any one of these three postures, and doing so risks either unnecessary demolition of salvageable heritage fabric or, conversely, prolonged unattended drying of a material that should have been replaced.

4. Drying objectives and completion criteria

For every plaster/render subtype, the industry-standard drying objective is the same in principle even though the numeric dry-standard differs by material: return the affected material to a moisture condition equivalent to a comparative, unaffected sample of the same construction in the same building (the "dry standard"), confirmed with a moisture meter on the correct material scale. A generic "Plaster / Render" selection cannot supply that scale or that standard, because the underlying chemistry is unknown until a technician identifies cement, gypsum, or lime composition. Recording a numeric "dry standard" reading against the generic profile in the MCA job record should therefore be treated as provisional and superseded once the specific subtype is selected, so that historical job data is not misread later as a validated baseline for a material that was never actually identified.

5. Temperature limitations

No single temperature ceiling is defensible across all three families. Cement render tolerates surface temperatures into the high 30s°C before manufacturer-recommended limits are approached (Profile 2, Section 5); gypsum decorative plaster shares some of the same calcination-risk chemistry as plasterboard's gypsum core but is often fixed to older, more heat-sensitive timber armatures (Profile 3, Section 5); lime plaster and render, particularly in heritage fabric, are managed to markedly lower and gentler temperatures in published post-flood guidance (Profile 4, Section 5). Applying the least conservative of these to an unidentified plaster would risk damaging the other two.

6. Relative-humidity limitations

The same logic applies to RH. Post-flood conservation guidance for historic buildings recommends a comparatively narrow 40–50% RH band during gentle drying [Source 5], which is tighter and less aggressive than the RH floors applied to cement render or modern gypsum systems elsewhere in the MCA register. A generic profile cannot safely default to either extreme.

7. GPP, dew point, vapour pressure, and condensation considerations

Drying, in psychrometric terms, is driven by maintaining a vapour-pressure differential between a wet material's surface and the surrounding air, usually created by lowering the air's absolute moisture content (grains per pound, GPP) below that of the material [Source 6]. This mechanism is common to all plaster and render types, but the safe rate at which that differential should be created, and the surfaces that must be kept above dew point to avoid re-wetting condensation, depend on the specific substrate and its cavity/insulation context, which is unknown for a generic selection. A dehumidifier producing very dry, low-GPP air is equally capable of drying cement render, gypsum decorative plaster, or lime plaster too quickly; the point at which "too quickly" becomes damaging is the variable that differs by subtype (Profile 2, Section 6; Profile 3, Section 6; Profile 4, Sections 5–7), not the underlying psychrometric mechanism.

8. Airflow and equipment selection

Generic guidance can state only that direct, concentrated heat or airflow onto an unidentified decorative or heritage plaster surface should be avoided until the technician confirms the material is not friable, reinforced, or heritage-listed (Profile 3, Section 8; Profile 4, Section 8). No specific equipment recommendation is safe to automate before that identification occurs. Where a technician has deployed initial extraction and ventilation equipment purely to arrest active water ingress (rather than to actively dry the plaster/render itself), that equipment should be logged in the MCA job record as emergency mitigation, not as evidence that a drying regime has been selected, so that the automation controller does not infer a controlled-drying state from equipment presence alone.

9. Staged drying strategy

Because the material identity is unresolved, no staged drying strategy can be automated. The correct "stage" for a generic Plaster / Render selection is, in every case, "assessment" — obtain positive identification of the substrate and select the matching specific profile. This mirrors the MCA staged-drying model's own "assessment" stage definition, under which no linked comparative material reading exists and the stage does not advance from time alone; for the generic profile, the blocking condition is not the absence of a reading but the absence of a validated identification, and the two should not be conflated in job documentation.

10. Monitoring, sensor placement, and material readings

Scanning (non-invasive) moisture meters can map suspected wet extent on any plaster or render surface without committing to a material scale, and are the appropriate first tool. Quantitative pin-type or non-invasive readings on a specific material scale (gypsum, cement/masonry, or a lime-specific approach) should not be logged as a controlling "dry standard" reading until the subtype is confirmed, because a reading on the wrong scale does not correspond to a valid comparative baseline. Where a technician is uncertain between two subtypes on initial inspection, this review recommends recording the scanning-meter map and photographic evidence against the generic profile, then re-attributing that evidence to the specific profile once identification is confirmed, rather than discarding it — the wet-area map itself is subtype-independent and remains useful.

11. Damage indicators and mandatory stop conditions

Any of the following observed on an unidentified plaster/render surface should halt unattended drying pending assessment: visible efflorescence or salt bloom, cracking, bulging, hollow-sounding areas when tapped, delamination from the substrate, or friability. These are common warning signs across all three subtypes (see Profiles 2–4, Section 11) and are conservative to apply generically.

12. Mixed-material implications

Plaster and render are almost never dried in isolation. Cement render sits on masonry or sheet substrates that dry far more slowly than the render skin itself (Profile 2, Section 12); gypsum decorative plaster is frequently fixed to timber framing or battens (Profile 3, Section 12); lime plaster and render are applied over solid masonry that may itself be salt-laden (Profile 4, Section 12). In a mixed room, the generic Plaster / Render selection should be treated as a hard block on unattended automation rather than averaged against faster-drying materials, consistent with the existing MCA rule that any blocked selected material blocks room-level automation.

13. Assessment of the current MCA profile

The current MCA treatment — `automation_mode = specialist_required`, no numeric control values — is supported by the evidence above. The three underlying material families have genuinely different, non-interchangeable safe operating envelopes; a generic profile that supplied a single numeric compromise would necessarily be unsafe for at least one of the three. This assessment concurs with the equivalent treatment already applied to the generic Plasterboard and Brick / Masonry profiles in the current register, and recommends no substantive change to the generic Plaster / Render disposition beyond the guidance in Sections 3–12 above.

This review also considered, and rejects, an alternative design in which the generic profile would default to the most conservative numeric envelope among the three specific profiles (the lowest temperature ceiling and the narrowest RH band of Render - Cement, Plaster - Decorative, and Plaster - Lime / Heritage) rather than blocking automation entirely. That approach would appear superficially safer, but it would also mask the underlying identification problem: a technician could leave a job running indefinitely on the generic profile's conservative defaults without ever confirming the true substrate, delaying the point at which salt-attack risk (Profile 4), structural-fixing risk (Profile 3), or sulfate-attack risk (Profile 2) is actually assessed. Retaining a hard block, as the current register does, creates an operational incentive to complete identification promptly, which this review regards as the safer design overall even though it is less permissive in the short term.

14. Recommended app parameters

Parameter	Current MCA value	Recommended value	Confidence	Source / derivation
Control disposition	Specialist required	Specialist required (unchanged)	High	Section 1–3 above; matches existing generic-profile pattern
Max temperature	Not applicable	Not applicable	High	No universal ceiling can serve all three subtypes
Emergency RH floor	Not applicable	Not applicable	High	See Section 6
RH target / restart	Not applicable	Not applicable	High	See Section 6
Max RH drop pp/h, pp/24h	Not applicable	Not applicable	High	See Rate rule statement above
Required action	Not specified in register text	"Identify cement render, decorative/fibrous plaster, or lime/heritage construction before any control automation"	High	Consistent with current register's stated required action for this profile

15. Evidence gaps, assumptions, and required specialist overrides

- **Evidence gap:** no source located gives a numeric threshold for how long an unidentified plaster/render surface can safely sit wet before a mandatory specialist assessment must occur; this review assumes the general 24–48 hour water-damage response window cited elsewhere in restoration literature applies, but that figure is not plaster-specific.
- **Evidence gap:** no source located quantifies the reliability of the visual-identification heuristics offered in Section 1 (texture, finish, and building age as indicators of cement, gypsum, or lime

composition); they are offered as field orientation only, not as a validated identification method, and must not be encoded into the app as an automated classification rule.

- **Assumption:** this profile assumes an MCA technician with basic material-identification competence (visual and tactile assessment of substrate, supported by a scanning moisture meter) is available before automation is requested.
- **Assumption:** this review assumes that where a technician cannot confidently distinguish the three subtypes on site, the safe default is to remain on the generic, specialist-required profile rather than to guess in favour of the least restrictive of the three specific profiles.
- **Required specialist override:** a technician must always identify the specific subtype and select the corresponding specific profile; there is no scenario in which unattended automation should be enabled against the generic selection. Where identification remains genuinely ambiguous after initial inspection (for example, a painted-over finish of uncertain composition, or a render that may conceal an earlier lime coat), a materials specialist or conservator should confirm composition, if necessary by a small, discreet test exposure, before a specific profile is selected.

16. References

1. Ruth Nicholls, "Flooding: Risk and Remediation," *The Building Conservation Directory*, 2012. https://www.buildingconservation.com/articles/flooding/flooding.htm — Tier 2 (recognised conservation trade publication).
2. Richard Ireland, "Conserving Decorative Plaster," *The Building Conservation Directory*, 2005. https://www.buildingconservation.com/articles/decorplast/decorative_plaster.htm — Tier 2.
3. Upper Restoration, "The 4 Classes and Categories of Water Damage," accessed 22 July 2026. https://upperrestoration.com/the-4-classes-and-categories-of-water-damage/ — Tier 3 (secondary trade summary of IICRC S500 classification concepts; used only to describe the Class/Category concept, not to establish a numeric limit).
4. IICRC, "S500," standard overview page, accessed 22 July 2026. https://iicrc.org/s500/ — Tier 1 (standards body), full standard text paywalled and not independently reviewed for this report; flagged for MCA to obtain a licensed copy.
5. Ruth Nicholls (as Source 1) — RH/temperature guidance reused for Section 6.
6. Advanced DRI, "Dehumidification Science," accessed 22 July 2026. https://advanceddri.com/dehumidification-science — Tier 3 (secondary trade explainer of GPP concept, used only to explain the psychrometric mechanism, not a numeric control limit).

All sources accessed 22 July 2026.

Render - Cement

Research packet: claude-c5-plaster-render.md | 2,803 words | 5 URL references | The packet is commentary for review, not a certified limit.

Scope: this chapter separates source-supported observations, operational assumptions, unresolved uncertainty, and field verification requirements for this material.

1. Scope and material identification

This profile covers cement-based render: a factory-blended or site-mixed Portland-cement, sand, and lime and/or polymer-modified coating trowel-applied over masonry, concrete blockwork, or fibre-cement sheet substrates, typically 6–20 mm thick in one or more coats. It excludes acrylic/polymer "paint-on" texture coatings applied purely as a decorative topcoat over an already-cured render base (those are thin-film finishes, not the structural render body), and it excludes lime-only or gypsum-only systems, which are covered in Profiles 3 and 4. The profile applies to render that has been wetted by a plumbing failure, roof leak, or similar water-damage event affecting an already-cured, in-service render system — new, still-curing render exposed to rain before it has hydrated is a distinct construction-defect scenario addressed separately in Section 5.

2. Material construction and moisture behaviour

Cement render hardens through the hydration of Portland cement: calcium silicates react with water to form calcium silicate hydrate gel, which binds the sand aggregate into a rigid, moderately low-porosity matrix. Manufacturer guidance for a polymer-modified cement-based render states that, at 25°C and 50% RH, the material dries touch-dry in roughly 6–10 hours depending on substrate dampness, but the render should be kept damp for the first 12 hours after application so that cement hydration completes; if it dries too rapidly during this initial period, hydration is incomplete and the render becomes weak and friable, with a minimum 7-day cure recommended before the render is considered structurally mature [Source 1]. This is directly relevant to two MCA operating scenarios: (a) render damaged by water while still within its original cure window, where rapid forced drying can arrest hydration and permanently weaken the coating, and (b) fully cured, in-service render subsequently wetted by an unrelated water event, where the hydration-completeness concern no longer applies and the objective is simply moisture removal from an already-hardened, rigid matrix.

Once fully cured, cement render is markedly less porous and less permeable to vapour than gypsum or lime systems, so it wicks and releases moisture more slowly than those materials, and ambient-air drying acts mainly on the render surface and any cracks or joints rather than deep within the matrix.

Australian cement render is frequently a multi-coat system — a bonding/scratch coat, a body/levelling coat, and a thin polymer-modified or acrylic finish coat or texture coating — rather than a single homogeneous layer, and modern site practice increasingly uses pre-blended, polymer-fortified bagged products rather than a site-mixed sand-and-cement mix. Each coat can have a different porosity and cure profile, and a water event can leave the outer finish coat visibly dry to the touch while the base coat behind it, or the masonry substrate behind that, remains substantially wetter. This layered construction is the practical reason a single ambient-air moisture reading of the render face is a poor proxy for whether the wall system as a whole has reached its dry standard (Section 4), and it is also why coastal and humid-subtropical Australian conditions — where render systems are frequently exposed to wind-driven rain and prolonged high ambient humidity even without an internal plumbing failure — can leave a render system carrying more background moisture at the time of an unrelated water-damage event than an equivalent system in a drier inland climate.

3. Water exposure, contamination, and salvageability

Cement render itself is less absorbent than paper-faced gypsum board, but salvageability is governed by the wall assembly and observed condition rather than water category alone: (1) the substrate behind the render may require different treatment; (2) a water event can mobilise soluble salts, with crystallisation and repeated wetting/drying contributing to efflorescence, blistering, cracking or surface loss [Source 6]; and (3) render that has already debonded, is hollow-sounding, or shows active efflorescence should be assessed for repair or removal rather than subjected to continued unattended drying.

Render applied to masonry in coastal areas, or on buildings affected by historical rising damp, can be exposed to salts carried in groundwater, sea spray or contaminated flood water. Modern dense cement render can also restrict the drying path of more permeable masonry. A water event that introduces or mobilises salts should therefore be flagged for a materials assessment even where immediate moisture readings are falling, because the salt source, coating permeability and substrate condition are not established by the room sensor [Source 6].

4. Drying objectives and completion criteria

The drying objective is to return the render, and the substrate behind it, to their pre-loss moisture condition, verified against a comparative dry-standard reading taken from an unaffected area of the same render/substrate system on a cement/masonry moisture-meter scale. Ambient surface dryness of the render is not proof that the substrate behind it is dry; render is a barrier coating, and a dry-to-the-touch render face can mask a substrate that is still releasing moisture into the cavity or wall behind it, which is why the completion criterion must reference both the render and its substrate.

5. Temperature limitations

Manufacturer technical data for a cement-render admixture states application should not proceed if the surface temperature is greater than 40°C or below 10°C, or is likely to fall below 10°C during application or drying [Source 2]. A separate acrylic-fortified render manufacturer's ready-mix product specifies a minimum application temperature (do not apply below 5°C) but does not publish an explicit maximum in the sections reviewed [Source 3]. These figures describe safe **application** conditions for new render, not a post-water-event drying ceiling for cured render, but they are the closest available manufacturer-published temperature bounds and are used here as the best available anchor: the current MCA ceiling of 35°C sits comfortably below the 40°C application ceiling published for the fortified render product, which supports the existing 35°C value as conservative rather than as an independently derived drying-specific limit. No source located in this review publishes a temperature ceiling specific to force-drying fully cured, water-damaged cement render.

6. Relative-humidity limitations

No manufacturer or standards source located in this review publishes an RH floor specific to drying water-damaged cement render. The current MCA floor of 40% is markedly higher than the 25–30% floors applied to gypsum-based systems elsewhere in the register; this is a conservative MCA choice reflecting cement render's lower permeability and slower internal moisture transport — driving ambient RH very low against a material that releases moisture slowly risks a large, unproductive vapour-pressure differential at the surface with little corresponding benefit, and it increases the risk of surface crazing on any residual lime or polymer content in the render if drying is uneven. This reasoning is an MCA engineering judgement, not a cited numeric derivation.

7. GPP, dew point, vapour pressure, and condensation considerations

Effective drying of render depends on maintaining a vapour-pressure gradient that moves moisture from the wetter assembly toward the conditioned air [Source 7]. Because cement render is frequently the external skin of a wall, particular attention is required to the temperature of the substrate behind it: if that substrate falls below the dew point of the conditioned air, condensation can form at the interface and re-wet the assembly. This risk is elevated in external walls adjoining an unconditioned or cold cavity.

8. Airflow and equipment selection

Air movers directed across the render surface disrupt the saturated boundary layer and are appropriate; low-grain-refrigerant (LGR) dehumidifiers are generally suitable for the ambient temperature ranges involved. Because cement render is a barrier coating over a slower-drying substrate, injection or cavity drying of the substrate behind the render (where physically accessible, e.g., via existing weep holes or vents) may be needed in addition to ambient-air drying of the render face; this is a site-specific decision for a technician, not something the automated controller can determine from ambient sensors alone.

9. Staged drying strategy

A conservative staged approach mirrors the general MCA staged-drying model: (1) confirm the render is fully cured (not a recent, still-curing application) and assess for sulfate-attack indicators, debonding, or hollow areas; (2) establish ambient drying conditions within the temperature and RH limits in Sections 5–6; (3) monitor comparative moisture readings on the render and, where feasible, the substrate behind it; (4) once the render reading approaches the dry standard, hold a stabilisation/equalisation period before considering the material dry, to allow any slower-drying substrate moisture to equalise without re-wetting the render face; (5) verify with a technician before returning the wall to service or applying further finishes.

10. Monitoring, sensor placement, and material readings

A pin- or non-invasive moisture meter set to a cement/masonry-appropriate scale should be used, not a wood or gypsum scale, which will produce erroneous readings on a cementitious matrix. Readings should be taken at multiple heights and locations across the affected render, with an unaffected comparative area established as the dry standard. Where the render conceals a masonry or sheet substrate of interest, a secondary reading of that substrate (via probe holes drilled by a technician, where permitted) provides the more decision-relevant "is the wall actually dry" answer, since surface render dryness alone is not sufficient (Section 4).

11. Damage indicators and mandatory stop conditions

Unattended drying should stop and trigger a technician review if any of the following are observed: new or worsening cracking; bulging or debonding; active efflorescence or salt bloom; or a render surface that dries visibly while the substrate behind it is not correspondingly falling. Continued room drying does not diagnose or remove the source of salt or bond failure [Source 6].

12. Mixed-material implications

Cement render is a coating, not a self-supporting wall — the substrate behind it (masonry, block, or sheet) governs the true drying timeline. In a mixed room where cement render shares space with faster-drying finishes (paint, vinyl, tile), the render/substrate system is very likely to be the slowest-drying selected material and should be expected to govern the room's rate cap under the MCA "lowest current cap governs" rule, consistent with the existing register's treatment of other low-permeance, Class 4 materials.

13. Assessment of the current MCA profile

The current 35°C temperature ceiling is reasonably supported as conservative relative to the 40°C application ceiling published for at least one Australian render product [Source 2]. The 40% RH floor, 43% target, and 50% restart values are plausible, conservative MCA engineering choices given cement render's low permeability, but they are not derived from a published numeric source, and this should be stated to any specialist reviewing the profile. The bulk-cap RH-drop rate (5.0 pp/h / 18.0 pp/24h) and the associated stabilising/equalising factor (50%) are, consistent with the rate-rule statement at the top of this report, MCA-internal provisional settings with no published material-specific numeric precedent; they should be understood by reviewers as conservative operational guardrails rather than validated damage thresholds.

14. Recommended app parameters

Parameter	Current MCA value	Proposed value	Confidence	Source / derivation
Control disposition	Controlled	Controlled (unchanged)	Medium	Cement render is chemically stable and not mould-food; automation is plausible with the stop conditions in Section 11
Max temperature (°C)	35	35 (unchanged)	Medium	Below the 40°C application ceiling in Source 2; no drying-specific ceiling published
Emergency RH floor (%)	40	40 (unchanged)	Low	MCA engineering judgement; no published numeric source
Control target RH (%)	43	43 (unchanged)	Low	MCA engineering judgement
Restart RH (%)	50	50 (unchanged)	Low	MCA engineering judgement
Bulk max RH drop (pp/h / pp/24h)	5.0 / 18.0	5.0 / 18.0 (unchanged); label explicitly as MCA provisional, not a damage threshold	Low	No universal published rate exists (rate-rule statement)

Parameter	Current MCA value	Proposed value	Confidence	Source / derivation
Assessment/ stabilising factor	50%	50% (unchanged)	Low	Consistent with MCA's general staged-drying model; no material-specific source
Mandatory stop condition	Not itemised in register text	Add explicit stop-on-observation for cracking/crazing, hollow sound, debonding, active efflorescence	High	Section 11; corroborated by Source 6
Cure-window check	Not present	Add a technician-entered flag: "render age < 7 days" forces specialist-required disposition	Medium	Source 1 (still-curing render is a distinct hydration-arrest risk)

15. Evidence gaps, assumptions, and required specialist overrides

- **Evidence gap:** no manufacturer or standards source located in this review publishes a drying-specific (as opposed to application-specific) maximum temperature or RH floor for force-drying water-damaged, fully cured cement render.
- **Evidence gap:** the bulk RH-drop-rate cap (5.0 pp/h / 18.0 pp/24h) has no published material-specific source; it is an MCA-derived conservative operational limit intended to reduce the risk of uneven surface drying and crazing, and it should be treated as provisional pending specialist review.
- **Assumption:** this profile assumes the render is fully cured (age at time of water event greater than the 7-day minimum cure period cited in Source 1). Render still within its original cure window when wetted should be treated under a stricter, specialist-reviewed regime, not this profile's standard controlled parameters.
- **Required specialist override:** any observation consistent with sulfate attack, structural cracking, or substrate debonding requires a building/materials specialist assessment before drying continues; manufacturer technical data for the specific render product installed always overrides the generic values in this report.

For field governance, the 5.0 pp/h and 18.0 pp/24h values must therefore be described as controller throttles, not as the material's scientifically established maximum drying rate. Their function is to slow an abrupt change in room conditions while technicians verify bond, cracking, salts, substrate moisture, and progress. Retaining those values does not prove that a particular render system is undamaged, dry through its full depth, or ready for recoating. Those conclusions require the inspections and product-specific acceptance evidence described above.

Before this controlled profile is used, the job record should identify the installed render product where practicable, the substrate, coating or paint system, approximate age, water source and duration, and any history or signs of salts or rising damp. If those facts cannot be established, the conservative stabilising stage should remain active and the uncertainty should be visible in the drying log. Ambient temperature, RH and GPP describe the air driving the process; they cannot establish the moisture distribution or bond condition through the wall. Comparative readings should therefore be taken at consistent marked locations, including the wettest known area, perimeter transitions and an unaffected control, with the same instrument and method recorded each time.

The 35 C ceiling is also a conservative MCA operational choice, not a post-loss limit validated by the cited application datasheets. New-product application and cure limits do not prove how an aged, painted, salt-affected or partly debonded wall will respond after water damage. Any field trial intended to relax the rate or temperature controls should begin in shadow mode, retain technician approval, and document the material reading trend and distress inspections before and after the change. A rate increase should be reversible immediately if cracking, hollow areas, salt bloom, stalled substrate readings, rising dew point or other deterioration is observed.

16. References

1. Sika Australia, "Davco Render," product page (search-indexed content, direct page access unavailable at time of review). Content corroborated via search-engine cache, accessed 22 July 2026. Tier 1 (manufacturer) — **flagged**: the manufacturer's own page could not be directly re-fetched during this review; MCA should independently verify this datasheet's current content and revision date before relying on the 6–10 hour dry time, 12-hour damp-cure, and 7-day cure figures.
2. Dulux AcraTex, "RenderWall AcraBuild Plus," technical data sheet AUAC00134, distributor-hosted copy. https://www.inspirationspaint.com.au/Documents/technical-data-sheets/Dulux%20Acratex%20RenderWall%20Acrabuild%20Plus.pdf — Tier 1 (manufacturer); application temperature limit (do not apply above 40°C or below 10°C) directly stated in datasheet text.
3. Rockcote, "Quick Render Fine," technical data sheet, effective 5 June 2023. https://rockcote.com.au/wp-content/uploads/2020/09/QuickRender_Fine_TDS_June2023.pdf — Tier 1 (manufacturer); minimum application temperature stated, maximum not confirmed in the reviewed excerpt.

4. Standards Australia, AS 3700 Masonry Structures (current edition 2018, amendments to 2023). Standard text is commercially licensed and was not independently reviewed in full for this report. Tier 1 (standards body) — **flagged as paywalled**; MCA must retain a licensed copy before relying on specific AS 3700 render-detailing clauses.
5. descomconsultant.com.au, "AS 3700 Guide: Masonry Structure Standards in Australia," accessed 22 July 2026. https://descomconsultant.com.au/australian-building-standards-guide/as-3700-guide-masonry-structures-in-australia/ — Tier 3 (secondary summary, used only for high-level context on AS 3700's scope, not for numeric clause content).
6. NSW Department of Planning, Housing and Infrastructure (Office of Environment and Heritage / Heritage Council of NSW), "Salt Attack and Rising Damp: A Guide to Salt Damp in Historic and Older Buildings." https://www.environment.nsw.gov.au/sites/default/files/salt-attack-and-rising-damp-guide.pdf — Tier 1 (government heritage body); content reviewed via search-index summary due to PDF text-extraction limits in this session — recommend MCA independently re-verify page-level detail before formal reliance.
7. Advanced DRI, "Psychrometric Principles: Water Damage Restoration," accessed 22 July 2026. https://advanceddri.com/psychrometric-principles-water-damage-restoration — Tier 3 (trade explainer, used only to describe the vapour-pressure/GPP mechanism, not a numeric limit).

All sources accessed 22 July 2026.

Plaster - Decorative

Research packet: claude-c5-plaster-render.md | 2,962 words | 5 URL references | The packet is commentary for review, not a certified limit.

Scope: this chapter separates source-supported observations, operational assumptions, unresolved uncertainty, and field verification requirements for this material.

1. Scope and material identification

This profile covers decorative and fibrous plaster: cast or hand-modelled gypsum (calcium sulfate) plasterwork used for cornices, ceiling roses, mouldings, and smooth solid-plaster wall or ceiling finishes. It includes traditional Australian fibrous plaster — a thin gypsum-plaster shell reinforced with layers of hessian scrim and typically fixed to, or cast integrally with, a timber support frame or battens — which became widely used in Australian public and domestic buildings from the late nineteenth century onward and remains in production for heritage reproduction and new decorative work today. It excludes plasterboard/gypsum lining board (a separate MCA profile family) and excludes lime-based decorative plasterwork, which is covered in Profile 4.

The profile also covers contemporary gypsum-based decorative wall finishes that are not fibrous-reinforced in the traditional sense — solid run cornices and cast ceiling centres produced by present-day fibrous-plaster workshops for both heritage reproduction and new residential and commercial fit-outs. It does not extend to acrylic or lime-based "Venetian"/polished-plaster decorative wall finishes, which are typically thin, trowel-burnished coatings over a different substrate and are outside the scope of this review; where such a finish is present over a gypsum or lime base coat, the base coat's material identity (Profile 3 or Profile 4) should govern the drying profile, with the polished finish treated as a surface coating whose own manufacturer guidance on moisture exposure and resealing should be obtained separately by the technician.

2. Material construction and moisture behaviour

Decorative gypsum plaster is chemically the same calcium sulfate hemihydrate (plaster of Paris, $CaSO_4 \cdot 0.5H_2O$) that rehydrates to the dihydrate form when mixed with water and set, as used in plasterboard cores — but it is cast solid, without the paper facing that gives plasterboard its tensile strength, and traditional fibrous plasterwork substitutes a hessian (jute) scrim for that reinforcement [Source 4; Source 1]. Both the gypsum matrix and the hessian scrim are affected by sustained wetting: the gypsum core softens and loses compressive strength when saturated, in the same manner described for plasterboard's gypsum core, and the organic hessian reinforcement is hygroscopic, loses strength when wet, and is a potential mould-growth substrate in the same way as plasterboard's paper facing. Fibrous plaster elements are typically fixed to timber support frames or battens with plaster "nibs" or metal ties; if the timber swells and later shrinks, or if the nibs deteriorate, the plasterwork can de-bond from its support independently of the gypsum's own strength loss [Source 2].

Traditional fibrous plaster casting is also, by construction, a hollow-backed assembly rather than a solid mass: a cornice or ceiling rose is typically a thin (often under 20 mm) gypsum-and-hessian shell over an air void, supported at intervals by the timber frame, rather than a solid block of plaster. This has two consequences for moisture behaviour that distinguish it from solid decorative plaster or from plasterboard: first, the thin shell can dry relatively quickly at the exposed face while trapped moisture and humid air persist in the enclosed void behind it, particularly where the void is also part of an unventilated ceiling space; and second, the hollow construction gives the assembly comparatively little thermal or moisture buffering mass, so its surface can respond quickly to ambient temperature and RH swings, which is part of the reason conservative, gradual environmental control is preferred over aggressive forcing.

3. Water exposure, contamination, and salvageability

As with plasterboard, category classification under the IICRC framework distinguishes clean, grey, and blackwater exposures, and Category 2/3 exposure or visible mould growth is a strong indicator that gypsum-based decorative plaster requires replacement rather than in-place drying, for the same decontamination-difficulty reasons documented for standard plasterboard. Decorative and fibrous elements carry an additional salvage consideration not present in flat plasterboard: **heritage or artistic value**. A damaged nineteenth-century ceiling rose or cornice may warrant conservation-led repair (recasting from a mould taken of an undamaged matching section, or in-situ consolidation) even where a plain plasterboard panel of equivalent water damage would simply be replaced [Source 2]. This is a salvage-strategy decision for a heritage or conservation specialist, not something the drying controller can determine.

A further, specifically documented salvage complication is that visible inspection of fibrous plaster after a water event can be misleading in both directions. UK guidance on large fibrous-plaster ceilings — a similar hessian-and-gypsum construction to Australian fibrous plasterwork, published in the specific context of assessing ageing hessian ties and hangers — notes that a tie or hanger can "appear sound even though the hessian inside has weakened or completely deteriorated," leaving what the source describes as an "empty egg shell" of plaster with no effective reinforcement left inside it [Source 5]. That guidance also documents that hessian ties in that context have an estimated service life of around 80 years independent of any water event, meaning an older ceiling rose or cornice that has also been recently wetted may be assessed against a support system that was already close to the end of its working life before the water damage occurred. This reinforces the Section 9 requirement for a positive, hands-on structural check (including, where appropriate, inspection from above the ceiling void) rather than relying on visual assessment of the exposed decorative face alone.

4. Drying objectives and completion criteria

The drying objective is the same dry-standard principle applied elsewhere: a comparative moisture reading from an unaffected area of the same decorative plasterwork, taken with a moisture meter on a gypsum-appropriate scale. As with plasterboard, gypsum's equilibrium moisture content in a normal indoor environment is low (of the order of the sub-1% figures documented for gypsum wallboard cores), but decorative plasterwork's greater thickness, its hessian reinforcement, and its typically indirect fixing to a timber frame mean that visual/tactile assessment for continued structural integrity (no ongoing sagging, no active nib failure) must accompany the numeric moisture reading before drying is considered complete.

5. Temperature limitations

No manufacturer or conservation-literature source located in this review publishes a temperature ceiling specific to decorative or fibrous gypsum plaster water-damage drying. The material shares its gypsum chemistry with plasterboard, where manufacturer literature places a sustained-temperature limit in the low-40s°C range to avoid calcination of the gypsum core (documented independently in the existing MCA plasterboard register entry). However, decorative and fibrous plasterwork is frequently older, is fixed to timber armatures that are themselves heat- and moisture-sensitive, and — where reinforced with hessian rather than paper — has a different, less-studied thermal tolerance for its reinforcement layer. Conservation guidance for post-flood drying of historic buildings generally (not gypsum-specific) recommends keeping ambient drying temperatures moderate, citing risks of accelerated mould growth above roughly 18°C in an already-damp building and cracking from heat applied too aggressively to sensitive finishes [Source 3]. In the absence of a gypsum-decorative-plaster-specific figure, this review treats the current MCA ceiling of 30°C as a conservative engineering choice, set below the plasterboard calcination-risk range and consistent with the general caution against rapid or aggressive heating of older, reinforced ornamental plasterwork, rather than as a value directly traceable to a single published number for this specific material.

A further reason for caution at higher temperatures is specific to the hollow-backed construction described in Section 2: heat applied to the exposed decorative face of a cornice or rose does not heat the enclosed void behind it evenly, and an uneven thermal gradient across a thin, brittle gypsum-and-hessian shell is a plausible (though not separately quantified in any source located here) contributor to the cracking risk that is well documented qualitatively for gypsum plaster generally.

6. Relative-humidity limitations

No source located in this review publishes an RH floor specific to gypsum-based decorative or fibrous plaster. The current MCA floor (40%) is notably higher and more conservative than the 25–30% floors used for standard plasterboard in the existing register. This is a defensible conservative choice given that decorative plasterwork is frequently thicker, older, and mechanically dependent on a hessian/timber support system whose behaviour under aggressive drying is less studied than that of modern paper-faced plasterboard, but it is an MCA engineering judgement, not a cited figure. It is also consistent with the broader pattern in this report that heritage-adjacent, structurally reinforced, or otherwise irreplaceable materials are given a narrower, gentler RH band than mass-produced, easily replaced equivalents (compare the plasterboard floor of 25% in the existing register with the 40% floor proposed here and the still-narrower 45% floor recommended for lime/heritage plaster in Profile 4, Section 6).

7. GPP, dew point, vapour pressure, and condensation considerations

The same vapour-pressure-differential mechanism applies as for other gypsum-based materials (Profile 1, Section 7). A specific risk for decorative plasterwork is that ceiling roses and cornices are frequently located near cold, poorly insulated ceiling voids or external wall junctions; if the ambient conditioning creates air with a dew point close to the temperature of a cold void surface behind the plasterwork, condensation there can re-wet the plaster from behind, undermining a visually dry front face. Because the void behind a cornice or rose is rarely instrumented by an MCA sensor directly, this risk is difficult for the automated controller to detect from ambient room readings alone, and is a further reason a technician's periodic physical inspection (Section 10) is a necessary complement to, not a replacement for, ambient sensor monitoring.

8. Airflow and equipment selection

Direct, concentrated airflow onto friable or already-cracked ornamental plasterwork should be avoided; broader, indirect air movement that reduces the ambient boundary layer without mechanically stressing fragile relief detail is preferred, consistent with the general conservation guidance to protect vulnerable decorative surfaces during emergency response [Source 6]. LGR dehumidification to establish the target RH band, combined with gentle air circulation rather than a fan aimed directly at ornamental relief, is the appropriate equipment approach. Where the enclosed void behind a cornice or ceiling rose is accessible from a roof space or the floor above, and is suspected of retaining humid air, a technician may choose to ventilate that void directly (for example, via existing access hatches) as a separate action from the room-level ambient drying that the MCA controller manages; this void-side ventilation decision is outside what ambient room sensors can inform and should remain a technician judgement call.

9. Staged drying strategy

A conservative staged strategy for decorative plasterwork should include an explicit structural-safety check ahead of any moisture-content staging: because these elements are cast and hung (ceiling roses, cornices) or applied to a support frame, a technician must confirm the fixing/support system has not failed before extended unattended drying is permitted, given that ongoing water exposure can progressively weaken plaster nibs and timber fixings independent of the moisture-content trend line [Source 2]. Given the documented difficulty of assessing hessian-tie condition from below (Section 3;

Source 5), this structural-safety check should, wherever access allows, include a check from above the ceiling void as well as visual assessment of the finished face, rather than relying on the finished face alone.

10. Monitoring, sensor placement, and material readings

A gypsum-scale moisture meter should be used, matching the approach documented for plasterboard. For three-dimensional relief work (cornices, roses), readings should be taken at multiple points across the profile, not just a single flat-surface point, because moisture retention can vary significantly between the thin decorative relief and the thicker structural backing plaster. Where hessian reinforcement is suspected to be wet, a visual/tactile check for continued adhesion (tapping for hollow sound, checking for sagging) should accompany numeric readings, and — consistent with Source 5's finding that a tie can look sound while its hessian core has failed — a purely tactile or acoustic check from below should not be treated as conclusive on its own where access to inspect from above the ceiling void is available.

11. Damage indicators and mandatory stop conditions

Unattended drying must stop and trigger technician review on any of: new sagging or deflection of ceiling-mounted decorative elements (a safety-critical indicator, given the risk of a ceiling rose or cornice section detaching); new cracking through relief detail; hollow sound indicating de-bonding from the support frame; or visible mould on hessian reinforcement. Given the potential for a failed fixing to result in a falling hazard, any sagging observation should be treated as more urgent than the equivalent observation on a flat plasterboard surface, and — given the documented risk that a tie can appear sound from below while failed internally [Source 5] — the absence of visible sagging should not, on its own, be treated as confirmation that the support system is intact for an older or long-wetted installation.

12. Mixed-material implications

Decorative plasterwork is fixed to, or backed by, timber framing in the overwhelming majority of installations. As with plasterboard on timber framing, the framing typically holds more water and dries more slowly than the plaster itself; timber should be verified dry (consistent with the timber moisture standards applied elsewhere in the MCA register) before finishing repairs are undertaken, and the framing's slower drying should be expected to govern the room-level rate cap under the MCA "lowest cap governs" rule when decorative plaster shares a room with faster-drying materials. Where a decorative ceiling shares a roof or floor void with services (wiring, older gas fittings, or plumbing runs), water pooling in that void can also re-wet the plaster from above well after the room-level ambient RH has been brought under control, which is a further reason the void itself, not just the room, should be part of a technician's ongoing inspection routine for this material.

13. Assessment of the current MCA profile

The current parameters (30°C max; 40% floor; 43% target; 50% restart; 2.0/8.0 bulk pp/h/pp24h) are, in the absence of a decorative-plaster-specific published source, reasonably characterised as conservative extensions of the logic already applied to standard plasterboard in the existing register, adjusted downward (lower temperature ceiling, higher RH floor, slower bulk rate cap) to account for the additional structural-fixing and heritage-value risks unique to cast/reinforced ornamental plasterwork. This is a sound engineering rationale but should be explicitly labelled as such for specialist review, since no manufacturer or conservation-literature source independently confirms these specific numbers for decorative/fibrous plaster.

14. Recommended app parameters

Parameter	Current MCA value	Proposed value	Confidence	Source / derivation
Control disposition	Controlled	Controlled, conditional on a technician-confirmed "fixing/support intact" flag before bulk-stage advancement	Medium	Section 9; Source 5
Max temperature (°C)	30	30 (unchanged)	Low–Medium	Conservative extension of plasterboard gypsum-calcination logic; no decorative-plaster-specific source
Emergency RH floor (%)	40	40 (unchanged)	Low	MCA engineering judgement
Control target RH (%)	43	43 (unchanged)	Low	MCA engineering judgement
Restart RH (%)	50	50 (unchanged)	Low	MCA engineering judgement

Parameter	Current MCA value	Proposed value	Confidence	Source / derivation
Bulk max RH drop (pp/h / pp/24h)	2.0 / 8.0	2.0 / 8.0 (unchanged); explicitly labelled MCA provisional	Low	No universal published rate exists (rate-rule statement)
Mandatory stop condition	Not itemised in register text	Add explicit stop-on-observation for sagging/deflection (treat as safety-critical), hollow sound, hessian mould	High	Section 11
Structural fixing check	Not present	Add technician-entered "support/fixing verified intact" gate before advancing past assessment/stabilising stage	High	Section 9; Source 5

15. Evidence gaps, assumptions, and required specialist overrides

- **Evidence gap:** no manufacturer or conservation source located in this review states a temperature or RH figure specific to decorative/fibrous gypsum plasterwork drying; all numeric values in this profile are MCA-derived by conservative analogy to plasterboard and to general post-flood conservation caution.
- **Evidence gap:** the specific mechanical tolerance of aged hessian reinforcement and historic plaster-nib fixings under forced drying is not addressed in any source located in this review.
- **Assumption:** this profile assumes the decorative element is gypsum-based, not lime-based; lime-based ornamental plasterwork should be assessed under Profile 4.
- **Required specialist override:** any building with heritage-listed or historically significant decorative plasterwork should have a heritage conservator or structural specialist assess salvageability and set drying parameters before relying on this profile's automated values; any observed sagging or fixing failure requires immediate cessation of unattended drying and a structural safety assessment.

16. References

1. Trevor Proudfoot, "Decorative Lime Plaster," *The Building Conservation Directory*, 2001. https://www.buildingconservation.com/articles/limeplast/limeplast.htm — Tier 2 (recognised conservation trade publication); used here for general decorative-plasterwork casting/curing context, cross-referenced fully under Profile 4.
2. Richard Ireland, "Conserving Decorative Plaster," *The Building Conservation Directory*, 2005. https://www.buildingconservation.com/articles/decorplast/decorative_plaster.htm — Tier 2; principal source for structural-fixing, support-frame, and heritage-salvage guidance in this profile.
3. Ruth Nicholls, "Flooding: Risk and Remediation," *The Building Conservation Directory*, 2012. https://www.buildingconservation.com/articles/flooding/flooding.htm — Tier 2; source for general post-flood temperature/mould-risk guidance applied by analogy.
4. General materials chemistry on calcium sulfate dihydrate/hemihydrate phase transitions, corroborated across multiple secondary educational and engineering references located via search, accessed 22 July 2026 — Tier 3 (secondary/educational sources; no single peer-reviewed primary source was successfully accessed during this review for a decorative-plaster-specific calcination figure). **Flagged**: MCA should treat any specific calcination onset temperature as unverified for this profile until a primary materials-science or manufacturer source is obtained.
5. Ronnie Clifford, "Maintaining Large Fibrous Plaster Ceilings," *The Building Conservation Directory*, 2016. https://www.buildingconservation.com/articles/fibrous-plaster-ceilings/fibrous-plaster-ceilings.htm — Tier 2; source for hessian-tie service life (~80 years), the "empty egg shell" hidden-deterioration finding, and the recommendation for two-sided (above and below) structural inspection.
6. Australian Institute for the Conservation of Cultural Material (AICCM), "Flood Recovery Guidelines." https://aiccm.org.au/wp-content/uploads/2022/10/Flood-recovery-guildelines.pdf — Tier 1 (recognised national conservation body); PDF text could not be extracted in this session — content cited here reflects the document's known general scope (item-specific, gentle handling of moisture-sensitive heritage material) as also referenced in the existing MCA register's Upholstery/Fabric and Paper/Documents entries; MCA should independently re-verify page-level detail before formal reliance on this document for decorative-plaster-specific guidance.

All sources accessed 22 July 2026.

Plaster - Lime / Heritage

Research packet: claude-c5-plaster-render.md | 2,860 words | 9 URL references | The packet is commentary for review, not a certified limit.

Scope: this chapter separates source-supported observations, operational assumptions, unresolved uncertainty, and field verification requirements for this material.

1. Scope and material identification

This profile covers lime-based plaster and render: non-hydraulic lime putty or natural hydraulic lime (NHL) mortar systems applied as base and finish coats on solid masonry, earth, or timber-lath construction, predominantly found in pre-twentieth-century heritage buildings and in contemporary heritage-conservation or breathable-wall work. It is distinct from cement render (Profile 2) and gypsum decorative plaster (Profile 3) both chemically and in its conservation significance, and it is the most likely of the four profiles in this report to be attached to a heritage-listed structure where unattended, aggressive drying carries a genuine risk of irreversible fabric loss.

This profile also covers contemporary "breathable wall" retrofit work, where lime plaster or render is deliberately specified over solid masonry — including in buildings with no formal heritage listing — specifically to manage rising or penetrating damp by permitting vapour movement, rather than for a decorative or heritage-matching purpose. The moisture-management and salt-crystallisation considerations in Sections 2–3 below apply equally to this contemporary use case, even though the fabric-preservation urgency described for listed heritage buildings does not.

2. Material construction and moisture behaviour

Lime plaster and render are made by slaking quicklime (produced by firing limestone at very high temperature) into lime putty, then combining it with sand and, in the case of hydraulic and fibrous coats, hair reinforcement [Source 5]. The material hardens primarily through slow carbonation — a reaction with atmospheric carbon dioxide that reforms calcium carbonate — rather than through the hydraulic-cement hydration reaction that hardens Portland-cement render; standard sets are documented as occurring over roughly five to ten days, during which the material must be protected from drying out too quickly or it will crack [Source 5]. Once cured, lime plaster and render remain markedly more vapour-permeable ("breathable") than cement or gypsum systems, which is the basis of their continued specification for heritage and damp-affected solid-masonry walls: the material is understood in conservation literature to absorb, buffer, and release moisture vapour, helping to manage — rather than trap — dampness in a solid wall [Source 3; Source 4]. Independent flood-recovery guidance for historic buildings notes that older lime-based plasters "may soften and swell when wet, but usually without collapsing, and they harden again once dry," in clear contrast to modern gypsum plaster, whose calcium sulfate is partially soluble in cold water and which is more likely to require replacement after equivalent exposure [Source 6].

3. Water exposure, contamination, and salvageability

Lime plaster's resilience to wetting (Section 2) means that, in the absence of contamination, structural failure, or a salt-loading problem, in-place drying and retention of the original historic fabric is frequently the appropriate outcome — a materially different default to the "replace unless proven otherwise" posture appropriate for gypsum systems. The dominant salvage risk for lime plaster on solid masonry is not the plaster itself but **soluble salts**, which are drawn into the wall by rising or penetrating damp and which crystallise destructively as the wall dries: hidden subsurface crystallisation (cryptoflorescence) is understood in conservation literature to be more damaging than visible surface efflorescence, because fine pores cannot accommodate the expansive growth of the salt crystals and are broken apart from within [Source 1]. Visible efflorescence, while unsightly, is described in the same literature as comparatively harmless and can extend some 10–20 mm from the surface without indicating serious underlying damage — the practical implication for MCA operation is that the *absence* of visible efflorescence is not evidence that a salt-laden wall is drying safely, since the more damaging crystallisation is, by definition, the kind that is not visible from the room [Source 1].

Lime plaster and render are explicitly recommended in Australian and UK heritage guidance as a **sacrificial** coating in salt-affected walls: the plaster is expected to fail and be renewed periodically, preferentially to the masonry it protects, and cement render is specifically flagged as unsuitable because it can trap salts and accelerate decay of the masonry behind it [Source 2; Source 8]. This sacrificial framing has a direct operational consequence for MCA: unlike Profile 2's cement render, where new cracking or efflorescence is treated as an unambiguous stop condition warranting a defect investigation, a degree of eventual plaster deterioration in a salt-affected lime system is an accepted, expected part of the material's normal service life, and the specialist's judgement about what deterioration is "expected sacrificial wear" versus "damage requiring an urgent change of approach" cannot be reduced to a sensor threshold.

4. Drying objectives and completion criteria

Unlike the flat numeric "dry standard" approach used for plasterboard or cement render, the drying objective for lime plaster on heritage masonry is better framed as *slow, even moisture release without inducing salt crystallisation damage or thermal/mechanical shock to historic fabric*, verified by both moisture-meter trend and ongoing visual inspection for new efflorescence, blistering, or powdering. Conservation guidance is explicit that a numeric completion point is secondary to the *manner* of drying: forced drying that produces a dry-feeling surface while the wall's mass remains wet is described as storing up secondary damage that appears later, after finishing work has already been carried out [Source 6].

5. Temperature limitations

Independent post-flood conservation guidance for historic buildings recommends keeping ambient air temperature preferably below 20°C during drying, cautioning that temperatures above roughly 18°C encourage mould growth in an already-damp building, while temperatures below 4°C risk ice-crystal formation in the wet fabric [Source 6]. This is materially **more conservative** than the current MCA ceiling of 25°C for this profile. This is a genuine, sourced contrary-evidence finding: the current MCA temperature ceiling for Plaster - Lime / Heritage should be reviewed against this guidance, and this report recommends flagging the discrepancy for specialist review rather than silently adopting either figure. Separately, a commercial lime-render manufacturer's application guidance specifies an ambient/wall temperature window of +5°C to +30°C for **new** plaster application [Source 7] — a different scenario (new material curing) from post-flood drying of existing historic fabric, and not a substitute for the flood-drying-specific figure in Source 6.

6. Relative-humidity limitations

The same post-flood conservation guidance recommends monitoring and maintaining relative humidity at 40–50% during gentle drying of historic buildings [Source 6]. The current MCA settings for this profile (45% floor, 48% target, 53% restart) sit close to, but at and slightly above, the upper end of this published band, particularly the 53% restart point. This is a second contrary-evidence finding worth flagging: MCA's current band is broadly consistent with, but not identical to, the one directly-relevant published figure located in this review, and a specialist reviewer should confirm whether the restart point should be tightened toward 50%.

7. GPP, dew point, vapour pressure, and condensation considerations

The same GPP/vapour-pressure mechanism applies as elsewhere (Profile 1, Section 7), but conservation guidance places much greater weight on the *rate* of the vapour-pressure differential than on its magnitude: gentle, natural ventilation is the recommended first approach, with mechanical dehumidification introduced cautiously rather than as the default aggressive first response, precisely because a steep vapour-pressure gradient is what drives the salt migration and crystallisation damage described in Section 3 [Source 6]. Surface condensation risk is a secondary but real concern in solid, thermally massive masonry walls, where interior surface temperatures can lag air temperature changes; ambient conditioning should avoid creating a dew point close to the likely surface temperature of the (often cold) masonry.

8. Airflow and equipment selection

Conservation guidance for lime plaster explicitly favours natural ventilation over forced mechanical drying as the default, reserving dehumidifiers and extraction fans for situations that require them, rather than as an automatic first response [Source 6; Source 7]. Where mechanical dehumidification is used, gentle, indirect airflow is preferred over air movers aimed directly at the wall surface, consistent with the broader caution against rapid, uneven drying (Sections 4–6). This is a further point of contrast with cement render and decorative gypsum plaster (Profile 2, Section 8; Profile 3, Section 8), where LGR dehumidification is treated as a standard first-line tool rather than a reserved, secondary option — a difference that follows directly from lime plaster's much greater sensitivity to an aggressive vapour-pressure gradient (Section 7 above).

9. Staged drying strategy

A staged approach for lime/heritage plaster should default to the most conservative stage (equivalent to MCA's "stabilising" rate factor) for longer than for non-heritage materials, and should require a positive, technician-recorded assessment of salt loading (visual efflorescence check, and where available a quantitative salt survey) before any escalation toward a faster drying rate, given that salt-laden walls are the primary damage pathway identified in the evidence above (Section 3). This is consistent with, and reinforces, the current MCA disposition of `specialist_required` for this profile.

10. Monitoring, sensor placement, and material readings

Because lime plaster's drying and cracking risk is closely tied to salt content rather than moisture content alone, monitoring should combine a moisture-meter trend (using a scale and method agreed with the specialist, since lime and masonry moisture-meter scales are less standardised than the gypsum scale used for plasterboard) with periodic visual inspection for new or worsening surface salt bloom, blistering, or powdering, which are damage indicators in their own right (Section 11) independent of the numeric moisture reading.

11. Damage indicators and mandatory stop conditions

Consistent with the existing MCA register's treatment of this profile, unattended automation must remain blocked, and any of the following observed during specialist-directed drying should trigger an immediate reassessment: new or increasing salt efflorescence or subflorescence; blistering, powdering, or exfoliation of the plaster surface; de-bonding from the substrate (commonly from lath swelling and subsequent shrinkage) [Source 6]; or any softening/collapse beyond the "soften and swell without collapsing" behaviour described as normal for sound lime plaster [Source 6].

12. Mixed-material implications

Lime plaster is applied to solid masonry, earth, or timber-lath substrates that are themselves frequently salt-affected and slow-drying; in a mixed room, this profile should be expected to impose the slowest rate cap of any selected material, and — because it remains `specialist_required` — should continue to block room-level unattended automation entirely under the existing MCA "any blocked material blocks the room" rule, which this review endorses without change.

Timber-lath backing is a further mixed-material consideration specific to this profile: many pre-twentieth-century solid-plaster ceilings and internal partitions are lime plaster keyed onto timber laths rather than applied directly to masonry, and de-bonding from lath swelling and subsequent shrinkage is itself a documented failure mode independent of salt attack [Source 6]. Where this construction is present, the timber lath should be assessed and treated under the same drying caution applied to other exposed timber framing in the MCA register, and its condition (soundness of the key, absence of active swelling/shrinkage cycling) should be checked alongside the plaster face rather than assumed from the plaster's own moisture trend.

13. Assessment of the current MCA profile

The `specialist_required` disposition, and the treatment of the profile's 1.0 pp/h / 4.0 pp/24h figures as review-only parameters rather than an unattended control cap, are well supported by the evidence in this report: lime/heritage plaster carries a genuine, sourced risk (salt-crystallisation damage from drying that is too fast, and irreversible fabric loss on heritage-listed structures) that justifies mandatory specialist involvement. The two numeric discrepancies identified in Sections 5 and 6 (temperature ceiling higher than, and RH restart slightly above, the one directly comparable published figure) should be corrected or explicitly justified in specialist review before this profile's review parameters are used as a starting point for any specialist-authored drying plan.

This assessment also notes that this profile is the only one of the four covered in this report where the balance of evidence points toward tightening the existing MCA figures rather than either retaining them or leaving a genuine gap unfilled. That is a materially different outcome from Profiles 2 and 3, where the existing values were found to be plausible, conservative engineering choices in the absence of a directly contrary source. MCA's specialist reviewer should treat the Section 5–6 findings as the single highest-priority correction arising from this entire report, given the combination of a heritage-listed-fabric context, a genuine irreversibility risk, and an identified, sourced gap between the current setting and the best available published guidance.

14. Recommended app parameters

Parameter	Current MCA value	Proposed value	Confidence	Source / derivation
Control disposition	Specialist required	Specialist required (unchanged)	High	Section 3, 9, 13; Sources 1, 2, 6, 8

Parameter	Current MCA value	Proposed value	Confidence	Source / derivation
Max temperature (°C)	25	Flag for specialist review; published post-flood conservation guidance suggests a lower figure (preferably below 20°C)	Medium	Source 6 — direct contrary evidence
Emergency RH floor (%)	45	45 (unchanged); within published 40–50% band	Medium	Source 6
Control target RH (%)	48	48 (unchanged); within published 40–50% band	Medium	Source 6
Restart RH (%)	53	Flag for specialist review; slightly above the published 40–50% band upper bound	Medium	Source 6 — direct contrary evidence
Review-only max RH drop (pp/h / pp/24h)	1.0 / 4.0	1.0 / 4.0 (unchanged); explicitly labelled MCA provisional review parameter, not a control cap	Low	No universal published rate exists (rate-rule statement)
Salt-loading gate	Not present	Add technician-entered "salt survey / visual efflorescence check completed" field before any specialist-authored drying plan is entered	High	Section 3, 9; Sources 1, 2, 8

15. Evidence gaps, assumptions, and required specialist overrides

- **Evidence gap:** the single most directly relevant numeric source located in this review for post-flood ambient conditions in historic buildings (Source 6) is a UK conservation-trade-publication article, not an Australian government or peer-reviewed standard; Australian heritage bodies (Heritage Council of NSW, Heritage Victoria) publish extensively on salt attack and lime mortar repair generally [Sources 2, 8] but this review did not locate an Australian-specific numeric temperature/RH figure for post-flood drying of lime-plastered walls. MCA should treat the Section 5–6 figures as the best available published anchor, not an Australian-context-verified number.
- **Evidence gap:** no source located in this review gives a quantitative salt-content threshold above which drying must stop; the guidance is qualitative (any new/worsening efflorescence or subflorescence triggers reassessment).
- **Assumption:** this profile assumes the structure or element is either heritage-listed or otherwise identified as lime-plastered/rendered solid masonry construction; ambiguous cases should default to specialist assessment before any drying commences.
- **Required specialist override:** a heritage conservation specialist (architect, materials conservator, or equivalent) must approve any drying plan for this profile; the review parameters in this report are explicitly not a substitute for that approval, and the temperature/RH discrepancies noted in Sections 5–6 must be resolved by that specialist, not defaulted to either this report's or the current register's figures.

16. References

1. Catherine Woolfitt, "Soluble Salts in Masonry," *The Building Conservation Directory*, 2000. https://www.buildingconservation.com/articles/salts/salts_masonry.htm — Tier 2 (recognised conservation trade publication); source for crystallisation-mechanism and cryptoflorescence description.
2. NSW Department of Planning, Housing and Infrastructure (Heritage Council of NSW), "Salt Attack and Rising Damp: A Guide to Salt Damp in Historic and Older Buildings." https://www.environment.nsw.gov.au/sites/default/files/salt-attack-and-rising-damp-guide.pdf — Tier 1 (government heritage body); content reviewed via search-index summary — recommend MCA independently re-verify full text before formal reliance on specific numeric claims.
3. Heritage Plastering (trade practitioner), "Lime & Plaster Water Management," accessed 22 July 2026. https://www.heritage-plastering.co.uk/lime-plaster-water-management-things-to-consider/ — Tier 3 (trade practitioner site; corroborating context on breathability, not a primary numeric source).
4. Lime-Mortars.co.uk / Conserv, "The Lime Plaster Guide," accessed 22 July 2026. https://www.lime-mortars.co.uk/lime-plaster/guides/the-lime-plaster-guide — Tier 3 (manufacturer/trade guide; corroborating context only).

5. Trevor Proudfoot, "Decorative Lime Plaster," *The Building Conservation Directory*, 2001. https://www.buildingconservation.com/articles/limeplast/limeplast.htm — Tier 2; source for lime putty production, carbonation curing timeline (5–10 days), and crack-risk-from-rapid-drying during initial cure.
6. Ruth Nicholls, "Flooding: Risk and Remediation," *The Building Conservation Directory*, 2012. https://www.buildingconservation.com/articles/flooding/flooding.htm — Tier 2; principal source for the post-flood temperature (below ~20°C, avoid >18°C, avoid <4°C) and RH (40–50%) guidance used in Sections 5–7, and for lime-vs-gypsum flood-response contrast in Section 2.
7. Core Conservation, "Replastering Flooded Walls" (Rinzaffo MGN product guidance), accessed 22 July 2026. https://www.coreconservation.co.uk/solution/replastering-flooded-walls/ — Tier 3 (conservation supplier/practitioner site with a commercial product interest; used only for the +5°C to +30°C new-application temperature window and general salt-filter-coat concept, flagged as commercially linked and not used to set any control parameter in this report).
8. Heritage Council of Victoria (Heritage Victoria), "Lime Mortars for the Repair of Masonry." https://www.heritage.vic.gov.au/__data/assets/pdf_file/0020/505262/Lime-mortars-for-the-repair-of-masonry.pdf — Tier 1 (state heritage body); content reviewed via search-index summary (repointing-and-sacrificial-mortar guidance, cement-exacerbates-salt-damage finding) — PDF full text could not be extracted in this session; MCA should independently re-verify before formal reliance.
9. Historic England, "Mortars, Renders & Plasters," *Practical Building Conservation* series. https://historicengland.org.uk/images-books/publications/mortars-renders-plasters-conservation/ — Tier 1 (UK national heritage body); page-level content beyond the publication's stated scope and general findings (porous lime render encourages evaporation and helps minimise penetrating/rising damp effects) was not independently extracted in this session; the full published volume should be obtained by MCA for detailed reliance.

All sources accessed 22 July 2026.

Plasterboard

Research packet: gemini-g1-plasterboard-standard.md | 3,112 words | 6 URL references | The packet is commentary for review, not a certified limit.

Scope: this chapter separates source-supported observations, operational assumptions, unresolved uncertainty, and field verification requirements for this material.

1. Scope and Material Identification

This profile pertains to generic plasterboard, a ubiquitous interior building material. Plasterboard is a composite panel consisting of a gypsum (calcium sulfate dihydrate) core pressed between two layers of heavy paper liner. It is also commonly known as drywall, gypsum board, wallboard, or gib board.

This "generic" classification serves as a placeholder within the MCA drying control system, intended to be used for initial assessment only. It acknowledges the existence of a plasterboard material without specifying its composition, thickness, or properties. The generic category is a crucial first step in a risk mitigation process, formally recognising that while a material has been identified as plasterboard, its specific characteristics are currently unknown. This ambiguity presents a significant risk, as different types of plasterboard have vastly different performance characteristics. These can include, but are not limited to:

- **Standard Plasterboard:** The most common type, used for general walls and ceilings.
- **Fire-Rated Plasterboard (Type X, Type C):** Contains glass fibres and other additives to improve its fire resistance. Drying this improperly can compromise its ability to slow the spread of fire, a critical life-safety feature. The core is denser and designed to hold together longer under extreme heat.
- **Moisture-Resistant Plasterboard (MR Board):** Features a specially treated paper and core containing silicone or wax to resist moisture absorption. Often used in bathrooms and kitchens. Misidentification could lead to a misunderstanding of its wicking properties and drying speed.
- **Acoustic Plasterboard:** Has a higher density core and sometimes multiple layers to dampen sound transmission between rooms. Its unique composition affects its drying characteristics.
- **Impact-Resistant Plasterboard:** Includes a denser core and often a fibreglass mesh to resist damage from impacts. This affects its porosity and drying rate.

Due to this variability, this profile is intentionally restrictive. Automated or unattended drying operations are blocked under this profile, as the specific performance limitations of the material are unknown. The primary function of this profile is to flag the need for a qualified technician to identify the specific subtype of plasterboard and select the appropriate, more detailed drying profile before proceeding. Misidentification can lead to material failure, compromised fire or acoustic ratings, and unsafe conditions. Attempting to dry a fire-rated board as if it were standard, for example, could result in it appearing visually intact but having its fire-retardant properties completely negated. This creates a hidden and dangerous liability. The generic profile thus acts as a mandatory "hard stop" in the workflow, forcing a human-in-the-loop verification to ensure safety and efficacy. This aligns with the principle that a thorough assessment is required before remediation decisions can be made. The status remains **specialist_required** until a subtype and specific salvage conditions are recorded.

2. Material Construction and Moisture Behaviour

Plasterboard's behaviour when wet is a function of its two primary components: the gypsum core and the paper facing. Understanding their individual properties is key to understanding the material as a whole.

- **Gypsum Core:** The core is composed of crystalline calcium sulfate dihydrate ($CaSO_4 \cdot 2H_2O$). It is formed by heating raw gypsum to remove about 75% of its chemically bound water, turning it into a powder known as stucco. This stucco is then mixed with water and various additives to form a slurry that is poured onto the paper liner. As it sets, it recrystallizes, re-incorporating the water molecules to form a solid, porous core. While gypsum itself is an inorganic mineral and not a food source for mould, its porous structure acts like a sponge. When it becomes wet, its compressive strength is significantly reduced. It can become soft and friable, losing its structural integrity. The core contains about 21% chemically bound water by weight, which is critical for its fire-resistant properties. This water is released as steam when heated (a process called calcination), which absorbs thermal energy and slows heat transfer. This is distinct from the free moisture absorbed during a water damage event, which weakens the board.
- **Paper Facing:** The front and back surfaces of the board are covered in heavy-duty paper, often made from recycled materials. This paper provides the board's tensile strength and a smooth surface for finishing. This paper is cellulosic (organic) and is highly hygroscopic, meaning it absorbs and retains water readily. It is the primary food source for mould growth. The bond between the paper and the gypsum core, often formed with starch-based adhesives, is frequently compromised by prolonged water exposure. This leads to delamination, where the paper peels away from the core, rendering the board unsalvageable. The paper also provides a pathway for moisture to wick upwards, often much faster and higher than the water can penetrate the denser gypsum core.

When exposed to water, plasterboard wicks moisture rapidly, often far above the visible water line. The rate and extent of wicking depend on the duration of exposure, water temperature, the specific composition of the board, and the type of paper liner. As noted by GIB, it is recommended to inspect for moisture at least 300mm above the visible damage to account for this wicking.

3. Water Exposure, Contamination, and Salvageability

The decision to dry or replace plasterboard is governed primarily by the level of contamination in the water source, as defined by the new Australian Standard AS-IICRC S500, and the duration of exposure.

- **Category 1 (Clean Water):** This category describes water originating from a sanitary source. According to manufacturers like Gyprock and Siniat, plasterboard affected by Category 1 water may be salvageable if drying procedures are initiated promptly and the board is not structurally compromised. The U.S. EPA emphasizes a critical response window of **24-48 hours** to dry wet materials and prevent mould growth. If the board remains structurally sound after drying, it can often be retained. However, a critical complicating factor is the presence of insulation. GIB notes the importance of removing wet insulation from wall cavities to allow the framing and the back of the plasterboard to dry. In most cases, this necessitates removal of the plasterboard.
- **Category 2 (Grey Water):** This water contains significant contamination. The porous nature of plasterboard's paper and core makes effective decontamination extremely difficult. Industry standards lean heavily toward removal and replacement for any plasterboard with direct contact to Category 2 water.
- **Category 3 (Black Water):** This water is grossly contaminated. Sources include sewage and floodwater. **Replacement is mandatory.** Gyprock explicitly states that plasterboard contaminated by floodwater cannot be salvaged or recycled. The health risks are too significant to warrant any attempt at salvage.

Irrespective of water category, replacement is required if the board shows signs of structural failure. This includes sagging (especially in ceilings), bulging, delamination of the paper from the core, or fastener failure (nails or screws popping or pulling through the softened paper and gypsum). Any visible mould growth also mandates removal.

4. Drying Objectives and Completion Criteria

The primary objective is to return the plasterboard to its pre-loss moisture condition without causing secondary damage. The completion criteria, or "Drying Goal," is not a single, universal number. It must be established by measuring the moisture content of an unaffected area of the same material within the structure. This is known as the **Dry Standard**.

For plasterboard, the Equilibrium Moisture Content (EMC) in a typical indoor environment (e.g., 20°C and 40-60% RH) is very low, generally **less than 1% moisture content (MC) by weight**. A moisture meter, correctly set to the gypsum scale, should read below 1% in a dry, unaffected sample. Therefore, the drying goal is to achieve readings consistent with this baseline. It is crucial to use the correct scale on the moisture meter; using the "wood" scale will produce erroneously high readings and lead to unnecessary and potentially damaging over-drying.

Verifying that the underlying structural framing has also reached its own dry standard (e.g., <16% MC for pine timber framing in Australia, or <19% in many parts of North America) is a critical prerequisite to finishing repairs. If the framing is left wet, moisture will slowly transfer back into the new or dried plasterboard, leading to future problems.

5. Temperature Limitations

Exposing generic plasterboard to excessive heat can cause irreversible damage. The primary risk is **calcination**, a process where the chemically bound water molecules in the gypsum crystal ($CaSO_4 \cdot 2H_2O$) are driven off by heat. This process begins at temperatures around 66°C (150°F) but can be accelerated by prolonged exposure to lower temperatures. Calcination permanently weakens the gypsum core, turning it back into a soft powder and destroying the board's structural integrity and fire-resistant properties.

Manufacturer specifications generally recommend that plasterboard not be exposed to sustained temperatures exceeding **42°C to 50°C (108°F to 122°F)**. Directing high-temperature heat sources at the material is highly discouraged. A conservative upper limit is essential for a generic profile where the specific board's composition and heat tolerance are unknown. The generic profile must default to the most conservative value to prevent harm. These are explicitly **MCA provisional controls**, not published damage thresholds.

6. Relative-Humidity Limitations

The drying process relies on establishing a vapour pressure differential between the wet material and the surrounding air. This is primarily achieved by lowering the relative humidity (RH) of the air using dehumidifiers. While very low RH can accelerate drying, it can also cause problems if not managed correctly.

The goal is to maintain ambient RH at a level that promotes steady, controlled evaporation. Typically, maintaining an RH between **30% and 40%** provides an effective and safe drying environment for most building materials, including plasterboard. This range creates a sufficient vapour pressure differential to encourage drying without being so aggressive that it causes secondary damage. High humidity (above 60%) will significantly slow the drying process and dramatically increase the risk of secondary damage, including mould growth on other materials within the affected area, a risk underscored by EPA guidance on response times.

7. GPP, Dew Point, Vapour Pressure, and Condensation Considerations

Drying is fundamentally a process of manipulating vapour pressure. The moisture in a wet material exerts a high vapour pressure. The surrounding air has a lower vapour pressure. Moisture moves from the area of high pressure (the material) to the area of low pressure (the air). Grains Per Pound (GPP) or grams per kilogram (g/kg) is an absolute measure of the water vapour in the air. By using dehumidifiers to lower the GPP of the air, we create a larger vapour pressure differential, thus accelerating drying.

A critical consideration in this process is the **dew point temperature**. The dew point is the temperature at which the water vapour in the air will condense into liquid water. If the surface temperature of any building material falls below the dew point of the air, condensation will occur. This re-wets materials and defeats the drying effort. This is a particular risk when using desiccant dehumidifiers, which can produce very dry (low GPP) but warm air. Therefore, the drying environment must be managed to keep all surfaces safely above the dew point of the air within the drying chamber.

8. Airflow and Equipment Selection

Air movers (typically axial or centrifugal fans) are essential for efficient drying. They work by disrupting the thin layer of saturated, high-humidity air that forms at the surface of the wet plasterboard, known as the "boundary layer." By breaking up this layer, drier ambient air can come into direct contact with the wet surface, promoting continuous and rapid evaporation.

- **Placement Strategy:** Air movers should be positioned to create a continuous, circulating vortex of air that flows across all affected surfaces. They should not be aimed directly at a single spot from close range, as this can cause overly rapid surface drying.
- **Dehumidification:** Dehumidifiers remove the moisture that the air movers have helped evaporate. The choice of dehumidifier (LGR or Desiccant) depends on the scale of the water damage and the ambient temperature and humidity conditions.

9. Staged Drying Strategy

A generic drying strategy should be conservative and methodical.

1. **Initial Assessment & Safety:** A technician must first ensure the site is safe and then perform the critical task of identifying the specific material subtype to move beyond this generic profile. This includes assessing the water category.
2. **Water Extraction:** Remove all standing water.
3. **Controlled Demolition (if required):** Baseboards are typically removed. Siniat and GIB both note that for significant water damage, removal is often the most effective path. If removal is required, GIB recommends cutting at least 300mm above the highest visible water mark.
4. **Establish Drying Environment:** Deploy air movers and dehumidifiers to establish the target temperature and humidity conditions (e.g., Temp < 42°C, RH 30-40%). Contain the affected area to create a "drying chamber."
5. **Monitoring:** Regularly monitor material moisture content and ambient conditions, logging data daily to track progress toward the established Dry Standard.
6. **Final Verification:** Once the plasterboard and all adjacent structural materials have reached their drying goals, confirm this state with a stabilisation phase before removing equipment.

10. Monitoring, Sensor Placement, and Material Readings

Effective monitoring is crucial to ensure drying is proceeding as planned.

- **Tools of the Trade:** A combination of non-penetrating moisture meters, penetrating (pin-type) moisture meters, and infrared cameras is used for a comprehensive assessment. Penetrating meters must be set to a "gypsum" scale for accurate readings.
- **Sensor Placement and Data Logging:** Establish monitoring points on affected materials, adjacent materials, and in an unaffected area to establish the Dry Standard. For plasterboard walls, readings should be taken at various heights up the wall. All readings should be recorded daily in a log.

11. Damage Indicators and Mandatory Stop Conditions

Automated drying is blocked for this profile. A technician must re-evaluate the material for replacement if the following indicators are observed:

- **Physical Deformation:** Any sagging, bulging, or warping that does not resolve as the material dries.
- **Delamination:** The paper facing peeling or bubbling away from the gypsum core. Siniat notes this as a clear indicator for replacement.
- **Fastener Failure:** Screws or nails "popping" or pulling through the paper facing.
- **Microbial Growth:** Any visible mould growth.
- **Persistent Odours:** May indicate bacterial growth or trapped moisture.

12. Mixed-Material Implications

Plasterboard is part of a complex building assembly, and its drying cannot be considered separately from other components.

- **Differential Drying:** Timber or steel framing, insulation, and adjacent materials all have different drying rates. It is critical to ensure the framing is adequately dry before replacing or finishing the plasterboard.
- **Vapour Barriers:** Impermeable or semi-impermeable layers like vinyl wallpaper or gloss paints can trap moisture, preventing drying. In such cases, the surface layer must be perforated or removed.
- **Insulation:** As highlighted by GIB, if insulation within the wall cavity is wet, the plasterboard lining must generally be removed to allow for the removal and replacement of the insulation and the drying of the structural cavity.

13. Assessment of the Current MCA Profile

The current MCA generic profile correctly identifies the primary risk associated with this material category: profound uncertainty. By blocking unattended drying, the profile enforces a mandatory "technician check." This is a critical safety and quality control measure. The rationale is unequivocally sound:

- **Performance Uncertainty:** The specific properties of specialty plasterboards can be significantly different from standard board. Attempting to dry one type as another can lead to hidden damage.
- **Safety:** Directing powerful airflow at a water-logged plasterboard ceiling could trigger a structural collapse.
- **Efficiency and Efficacy:** A generic, one-size-fits-all drying plan would be highly inefficient and likely ineffective.

Therefore, the profile's primary function as a "stop and verify" control is fully supported by established principles of professional water damage restoration. It prioritizes safety and accuracy over speed.

14. Recommended App Parameters

For a *generic* profile, the parameters should be informational only, not for operational control. When this profile is selected, the app should display the following guidance:

- **Automated Control:** Disabled. Message: "Automated drying is not available for unidentified materials."
- **Technician Action Required:** "MATERIAL IDENTIFICATION REQUIRED. On-site assessment is mandatory. Identify material subtype, contamination category, and structural integrity. Select a specific material profile to proceed with a drying plan."
- **General Guidance (Informational Only):**
- **Initial Assessment Zone:** "Assess water source per AS-IICRC S500. Is it Category 1, 2, or 3? Category 2 or 3 contact requires mandatory replacement of plasterboard."
- **Default Temperature Limit (for planning):** "Do not plan for drying environments that will expose the material to temperatures exceeding 40°C (104°F)." This is a **MCA provisional control**.
- **Default RH Target (for planning):** "Plan for a target ambient RH of 30-40% to create an effective drying environment."
- **Drying Goal:** "A project-specific Drying Goal must be established by measuring an unaffected sample of the same material on-site."

15. Evidence Gaps, Assumptions, and Required Specialist Overrides

- **Evidence Gaps:** There is a lack of publicly available, manufacturer-supplied quantitative data on the precise rate of strength loss in plasterboard relative to moisture content.
- **Assumptions:** The core assumption is that the user is a trained technician qualified to correctly identify material subtypes, assess contamination levels according to the S500 standard, and evaluate structural integrity.
- **Required Specialist Overrides:** A qualified restoration technician must perform the on-site assessment and select the correct, specific profile. There is no circumstance where it is appropriate for a user to override the "stop" control of the generic profile without this positive identification.

16. References & Claim-to-Source Matrix

This section provides references used to inform the principles outlined in this profile.

Reference List

ID	Issuer	Title	URL	Accessed
1	CSR Gyprock	Frequently Asked Questions	https://www.gyprock.com.au/contact-us/other/frequently-asked-questions	2026-07-22
2	Siniat Australia	Wet plasterboard: repair or replace?	https://www.siniat.com.au/en-au/resources-link-page/blog/2073994/	2026-07-22
3	GIB (Winstone Wallboards)	Water-Damaged Plasterboard: Your Top Questions Answered	https://www.gib.co.nz/gib-news/articles/water-damaged-plasterboard/	2026-07-22
4	GIB (Winstone Wallboards)	Assessing And Remediating Water Damage To Plasterboard Linings	https://www.gib.co.nz/gib-news/articles/assessing-and-remediating-water-damage-to-plasterboard-linings/	2026-07-22

ID	Issuer	Title	URL	Accessed
5	U.S. Environmental Protection Agency (EPA)	Water Damage: Table on Mold Prevention and Remediation	https://www.epa.gov/mold/water-damage-table-mold-prevention-mold-remediation-schools-and-commercial-buildings	2026-07-22
6	IICRC	Australia Standard Published for Professional Water Damage Restoration	https://iicrc.org/wp-content/uploads/2025/04/AS-IICRC-S500-Published-Press-Release_March-2025.pdf	2026-07-22

Claim-to-Source Table

Claim	Source(s)
Plasterboard affected by clean water may be salvageable if addressed quickly.	Gyprock [1], Siniat [2], GIB [4]
Material must be replaced if contaminated by floodwater or sewage.	Gyprock [1]
The critical window to prevent mould growth is 24-48 hours.	EPA [5]
Wet insulation in wall cavities must be removed.	GIB [3]
When removing damaged board, cut at least 300mm above the visible water mark.	GIB [3]
Signs of replacement include swelling, delamination, and fastener popping.	Siniat [2], GIB [4]
The new Australian Standard for water damage restoration is AS-IICRC S500.	IICRC [6]

Claim	Source(s)
Ceilings that have been inundated with water usually require replacement.	Siniat [2]

Plasterboard - Standard

Research packet: gemini-g1-plasterboard-standard.md | 3,118 words | 4 URL references | The packet is commentary for review, not a certified limit.

Scope: this chapter separates source-supported observations, operational assumptions, unresolved uncertainty, and field verification requirements for this material.

1. Scope and Material Identification

This profile pertains to Standard Plasterboard, typically 10mm (3/8 inch) or 13mm (1/2 inch) in thickness, used for general-purpose interior walls and ceilings. It does not possess special properties such as enhanced fire resistance, moisture resistance, acoustic dampening, or impact resistance. It is the most common type of plasterboard found in residential and light commercial construction.

This profile applies *only* under a strict set of **clean-water salvage conditions**. The material must have been affected by **Category 1 (Clean Water)** as defined by the AS-IICRC S500 standard. Furthermore, a qualified technician must have assessed the plasterboard and deemed it salvageable, meaning it is structurally sound, free from swelling, delamination, fastener failure, or other physical defects. Crucially, the decision to salvage is extremely time-sensitive. Prolonged exposure to clean water, elevated humidity, and suitable temperatures can quickly lead to microbial growth. What begins as a Category 1 water event can become a Category 3 contamination problem within 48-72 hours due to biological amplification. Therefore, this profile should only be activated when active, controlled drying can commence within the widely recognized 24-48 hour window following the initial water intrusion. Any delay beyond this period exponentially increases the risk of requiring full removal and replacement. Meticulous **documentation** of the water source, time of intrusion, and initial assessment findings is mandatory to justify the decision to attempt salvage.

2. Material Construction and Moisture Behaviour

Standard plasterboard's reaction to water is dictated by its composite nature: a porous gypsum core and absorbent paper facings. The core, primarily calcium sulfate dihydrate, provides compressive strength and fire resistance but becomes soft and weak when saturated. The **paper facer** provides all the tensile strength. When wet, this paper loses a significant portion of its strength, making it susceptible to tearing, especially around fasteners. The bond between the paper and core, often a starch-based adhesive, is also vulnerable. This adhesive can become a food source for mould and can weaken upon saturation, leading to delamination.

The moisture behaviour is complex. Water wicks rapidly along the paper facings, often travelling far higher than the visible water line. The **gypsum core** absorbs moisture more slowly but holds a larger volume. During drying, this creates a differential. Aggressive drying techniques can "flash-dry" the paper surface while the core remains saturated. This is highly problematic, as the paper will shrink as it dries against a still-swollen, wet core, causing the paper to pull away and delaminate. Controlled, gradual drying is therefore essential to allow moisture to migrate from the core through the paper without stressing the bond. This requires a carefully balanced drying environment, not just brute-force heat and airflow. The behaviour of **joints**, which are filled with a different compound, further complicates things. Joint compound is denser and dries more slowly than the plasterboard itself, requiring careful monitoring to ensure the entire assembly, not just the board surface, is dry.

3. Water Exposure, Contamination, and Salvageability

This profile is strictly limited to Category 1 clean water exposures where drying begins promptly. The decision to dry or replace is not optional if certain conditions are met. Replacement is the only viable option under the following circumstances:

- **Contamination Level:** Exposure to Category 2 (Grey Water) or Category 3 (Black Water) mandates removal. The porous paper and gypsum core cannot be reliably decontaminated, and the health risks associated with attempting to do so are unacceptable. Over time, even a Category 1 source can lead to significant biological **contamination** as dormant mould spores on building surfaces amplify in the wet environment. If microbial growth is visible, the material is treated as Category 3.
- **Insulation and Cavities:** The presence of wet insulation within a wall or ceiling cavity is a critical stop condition. Wet insulation (e.g., fibreglass, cellulose) loses its thermal properties and cannot be dried in place. It acts as a moisture reservoir, preventing the back of the plasterboard and the structural framing from drying. In these cases, the plasterboard *must* be removed to allow for the removal and replacement of the insulation and the thorough drying of the cavity.
- **Structural Integrity:** The board must be physically sound. Any signs of sagging (especially for ceilings, which carry their own weight), bulging, or delamination indicate the core or paper bond has failed. **Fasteners** pulling through the softened paper face are another clear sign of irreversible structural weakness.
- **Prolonged Exposure:** If the plasterboard has been saturated for more than approximately 48-72 hours, the risk of structural compromise and microbial growth becomes too high to justify salvage.
- **Hazardous Materials:** The presence of lead-based paint or asbestos-containing joint compound requires specialist abatement and removal, not in-place drying, which could aerosolize hazardous particles.

4. Drying Objectives and Completion Criteria

The primary objective is to return the plasterboard and all associated structural components to their pre-loss moisture condition. This condition is known as the **Dry Standard**, and it is not a fixed, universal value. It must be determined on-site by taking **unaffected comparative readings**. A qualified technician must use a calibrated moisture meter to measure an identical piece of plasterboard in an unaffected area of the same building. This reading becomes the specific drying goal for that project.

While the Equilibrium Moisture Content (EMC) for plasterboard in a stable indoor environment is typically very low, often **less than 1% moisture content (MC)**, relying on this as a universal target is not best practice. The on-site Dry Standard is the only defensible completion criterion. The **meter method** is critical: a penetrating (pin-type) moisture meter must be used, set to the "gypsum" or an appropriate non-wood scale. Using the wood scale will produce inaccurate, artificially high readings, leading to unnecessary and potentially damaging over-drying. Comprehensive **documentation** of the Dry Standard reading, its location, and all subsequent monitoring data is essential for verifying project completion. The ultimate goal is not just a dry surface, but a return to moisture equilibrium for the entire assembly.

5. Temperature Limitations

Exposing plasterboard to excessive heat can cause irreversible calcination, where the chemically-bound water in the gypsum crystals is driven off, permanently destroying the board's strength and fire rating. While calcination begins in earnest at higher temperatures, prolonged exposure to moderately high temperatures can still cause damage.

- **Manufacturer Guidance:** Key manufacturers like USG Boral and Knauf advise against exposing their products to sustained temperatures above **42°C (107.6°F)**. This should be treated as an absolute upper limit, not a target.
- **Cautious Analysis:** The risk is not just to the core but also to the paper and its bond. High heat can scorch the paper or cause it to dry and shrink too quickly, leading to delamination.

For these reasons, a conservative approach is warranted. The MCA provisional engineering control setting a maximum ambient temperature of **38°C** is a sound and cautious limit. This is not a published damage threshold but an operational control that provides a sensible safety buffer, preventing localized hotspots from air movers from accidentally exceeding the material's tolerance. Maintaining temperatures within this conservative range helps ensure a controlled, rather than destructive, drying process.

6. Relative-Humidity Limitations

The core of the drying process is managing the ambient relative humidity (RH) to create a consistent vapour pressure differential. The goal is to encourage steady evaporation from the material into the air.

- **Optimal Range:** A target RH between **30% to 40%** is widely accepted in the restoration industry as an effective and safe range for most structural materials. This creates a strong drying potential without being overly aggressive.

- **Risks of Low RH:** Pushing the RH too low (e.g., below 25%) with high-performance dehumidifiers can be counterproductive for plasterboard. It can cause the paper facer to flash-dry and shrink before the gypsum core has released its moisture, increasing the risk of delamination and face checking.

The MCA provisional engineering controls—**emergency floor at 25% RH, target at 28% RH, and restart at 35% RH**—represent a deliberately aggressive but still managed drying strategy. These values should be understood as operational parameters for an automated system, designed to maximize efficiency while attempting to stay within a safe window. They are not fixed physical laws but adjustable controls that balance speed against the risk of secondary damage.

7. GPP, Dew Point, Vapour Pressure, and Condensation Considerations

Professional drying is the practical application of psychrometry. The entire process revolves around manipulating vapour pressure. Wet plasterboard has a high vapour pressure; the goal is to make the surrounding air have a much lower vapour pressure, encouraging moisture to move from the material to the air. This is achieved by lowering the absolute humidity of the air, measured in Grains Per Pound (GPP) or grams per kilogram (g/kg). Dehumidifiers are used to reduce the GPP of the air within a contained drying chamber.

A critical limiting factor is the **dew point temperature**. If any surface within the drying chamber drops below the dew point of the air, condensation will form, re-wetting materials and stalling the project. This is a significant risk in complex environments with multiple materials and potential thermal bridges. For example, cold concrete slabs or metal components can easily fall below the dew point if the drying environment is not carefully managed. Technicians must monitor both ambient conditions and surface temperatures (using infrared thermometers) to prevent condensation, especially in the initial stages of drying when moisture loads are high.

8. Airflow and Equipment Selection

Air movers (fans) and dehumidifiers are the primary tools. Air movers are critical for breaking the "boundary layer"—a thin layer of stagnant, saturated air that forms on the surface of wet material. By disrupting this layer, drier air is brought into contact with the surface, accelerating evaporation.

- **Equipment Strategy:** The equipment must be selected and placed to dry the entire building assembly. This includes considering **coatings** on the plasterboard. Gloss paints, vinyl wallpaper, or textured finishes can act as vapour barriers, trapping moisture. If such coatings are present, they may need to be perforated or removed to allow moisture to escape.
- **Cavity Drying:** If a wall cavity is damp but the insulation is dry and the plasterboard is salvageable (a rare combination), specialized cavity drying systems may be employed. These systems introduce dry air through small holes, typically drilled behind where the baseboard sits, to promote drying within the enclosed space. This requires careful pressure management and is a specialist task.

9. Staged Drying Strategy

A successful drying project follows distinct **stage transitions**.

1. **Assessment and Preparation:** The initial stage involves confirming all salvageability criteria are met, removing baseboards, and perforating any vapour-barrier coatings. All decisions and initial moisture readings must be recorded in the project **documentation**.
2. **Active Drying:** This is the main phase where dehumidifiers and air movers run continuously to maintain the target environment (e.g., Temp < 38°C, RH 25-35%). Daily monitoring of material moisture content is mandatory. Progress should be consistent; a stall for more than 24-48 hours is a key **stop condition** requiring investigation.
3. **Stabilisation/Equalisation:** Once the material reaches its Dry Standard, the project is not yet complete. Slower-drying materials (like timber framing or joint compound) may still hold excess moisture. The equipment is typically left running for another 12-24 hours. This "stabilisation" phase allows moisture to equalize across the assembly, ensuring the plasterboard does not reabsorb moisture from adjacent wet materials after the equipment is turned off.
4. **Final Verification:** After stabilisation, equipment is shut down. A final set of moisture readings is taken after a few hours to confirm that all materials have remained at or below their respective Dry Standards.

10. Monitoring, Sensor Placement, and Material Readings

Effective monitoring and **documentation** are non-negotiable for a defensible drying project.

- **Meter Method:** Readings must be taken with a pin-type moisture meter set to a gypsum scale. Non-penetrating meters are useful for rapid scanning, but final verification requires pin readings. For a standard wall, readings should be taken at multiple heights (e.g., 50mm, 150mm, 300mm) above the floor and in the center of the affected area.
- **Comparative Readings:** The most important reading is the **unaffected comparative reading** used to establish the Dry Standard. This "control" reading gives context to all other measurements.
- **Sensor Placement:** Monitoring points should be established on the affected plasterboard, on adjacent materials (e.g., timber sill plate), and on the control material. Each point should be mapped and numbered, and readings logged daily to track progress and identify anomalies or stalls.

11. Damage Indicators and Mandatory Stop Conditions

Automated or manual drying must be stopped and re-evaluated by a technician if any of the following occur:

- **Drying Stall:** Progress towards the Dry Standard ceases for more than 24-48 consecutive hours. This often indicates a hidden moisture source or an issue with the drying environment. This is a critical **stop condition**.
- **Physical Degradation:** The appearance of any new or worsening physical damage, such as delamination, sagging, bulging, or fastener heads pulling through the paper face. This indicates the material's structural limit has been reached, and it is no longer salvageable.
- **Microbial Growth or Odours:** The development of any visible mould or persistent musty odours indicates a contamination issue that requires physical removal, not just drying.
- **Environmental Control Failure:** If the drying equipment cannot consistently maintain the specified temperature and humidity parameters, the process is not controlled and must be halted until the issue is resolved.

12. Mixed-Material Implications

Plasterboard is never dried in isolation. It is part of an assembly of **mixed materials**.

- **Framing:** The most critical adjacent material is the structural framing. Timber framing must be dried to its own Dry Standard (typically <16% MC in Australia) to prevent long-term issues like rot, decay, and fastener corrosion. Steel framing must be dried to prevent rust. The plasterboard cannot be considered "done" until the framing behind it is also verifiably dry.
- **Differential Drying Rates:** Materials dry at different speeds. Dense timber sill plates or hardwood elements will dry much slower than the plasterboard face. The drying plan must account for the slowest-drying structural material, not the fastest. This is a common failure point in improperly managed projects.
- **Floor Coverings and Subfloors:** Moisture can be trapped in or under adjacent floor coverings and subfloors, acting as a continuous source of moisture that wicks back into the base of the wall. These must be assessed and dried concurrently.

13. Assessment of the Current MCA Profile

The MCA provisional profile for Standard Plasterboard provides a reasonable, if conservative, starting point for automated drying controls.

- **Max Temperature (38°C): Supported.** This is a safe and cautious operational control, well below the ~42°C manufacturer-stated limit.
- **RH Parameters (floor 25%, target 28%, restart 35%): Derivable.** These settings create an aggressive drying environment. While effective, they operate at the lower end of the ideal RH spectrum and require careful monitoring to avoid over-drying of the paper facer. These are best viewed as **MCA provisional engineering controls pending field validation.**
- **Bulk Cap (8 pp/h and 30 pp/24h): Unsupported and Provisional.** This parameter appears to be a proprietary MCA engineering control to limit the rate of moisture removal, likely to prevent overly

aggressive drying that could cause delamination. It is not based on a published industry standard. Its effectiveness requires field validation, and it should not be considered a fixed damage limit.

- **General Assessment:** The profile's core logic is sound, but its reliance on proprietary parameters like "Bulk Cap" highlights the need for technician oversight and the ability to override these settings based on professional judgment and site-specific conditions.

14. Recommended App Parameters

The parameters for a professional drying application should prioritize industry-standard, verifiable goals over proprietary rate limits.

Parameter	Current MCA Profile	Recommended Profile	Justification
Max Temperature	38°C	40°C	Provides a slight increase in drying efficiency while maintaining a conservative safety buffer below the 42°C manufacturer-recommended maximum sustained temperature.
RH Target	28%	30%	Aligns with the lower end of the industry-standard 30-40% "sweet spot," providing aggressive drying while slightly reducing the risk of over-stressing the paper facer compared to a 28% target.
RH Floor	25%	25%	Supported as a reasonable lower limit to prevent excessively dry conditions that could damage materials.

Parameter	Current MCA Profile	Recommended Profile	Justification
RH Restart	35%	35%	Supported as a sensible trigger point for reactivating dehumidification cycles.
Bulk Cap	8pp/h, 30pp/24h	Remove. Label as "MCA Provisional Engineering Control."	This is not a verifiable industry metric. The primary stop condition should be achieving the Dry Standard, not an arbitrary drying rate.
Completion Criteria	Not explicitly defined	Material MC matches on-site Dry Standard and remains stable for 12-24 hours after equipment shutdown.	This is the only clear, verifiable, and defensible definition of a successfully completed drying project.

15. Evidence Gaps, Assumptions, and Required Specialist Overrides

- **Evidence Gaps:** There is a lack of publicly available, quantitative data linking specific rates of moisture removal (e.g., %MC loss per hour) to the onset of physical damage in plasterboard under controlled drying conditions. The "Bulk Cap" value is therefore based on internal heuristics rather than external data.
- **Assumptions:** This entire profile operates on the critical assumption that a trained and certified technician has correctly performed the initial assessment: confirming Category 1 water, verifying structural integrity, ruling out all replacement criteria (like wet insulation), and correctly establishing the Dry Standard. An error in this initial assessment invalidates the entire drying effort.
- **Required Specialist Overrides:** A specialist must have the authority to override automated controls, particularly provisional ones like the "Bulk Cap." For example, on a project with very high initial saturation, a technician might choose to allow a higher initial drying rate and then taper it off as the material approaches its Dry Standard. All such overrides must be meticulously justified and documented.

16. References

Claim / Parameter	Source (Issuer, Title, Date)	URL / Reference	Source Tier
Max Temperature < 42°C	USG Boral, Plasterboard Installation Guide	aluforminteriors.com.au	1 (Manufacturer)
Water Categories & Salvageability	IICRC, S500 Standard for Professional Water Damage Restoration (2021)	IICRC S500-2021	1 (Standards Body)
Dry Standard Goal (<1% MC)	Lignomat, "Moisture problems in building and drying"	lignomatusa.com	2 (Industry Expert)
RH Drying Range (30-40%)	IICRC, S500 Standard	IICRC S500-2021	1 (Standards Body)
Mould Growth Risk after 24-48h	Knauf/Siniat, "OnBoard: Assessing Wet Plasterboard" (2017)	siniat.com.au	1 (Manufacturer)
Mandatory Replacement (Black Water)	IICRC, S500 Standard	IICRC S500-2021	1 (Standards Body)
Framing MC before lining (<16%)	QBCC, "Acceptable standards of workmanship for plastering"	qbcc.qld.gov.au	2 (Government Body)
Mandatory removal with wet insulation	IICRC, S500 Standard	IICRC S500-2021	1 (Standards Body)

All sources accessed on 22 July 2026.

Plasterboard - Moisture Resistant

Research packet: gemini-g2-plasterboard-specialty.md | 3,272 words | 6 URL references | The packet is commentary for review, not a certified limit.

Scope: this chapter separates source-supported observations, operational assumptions, unresolved uncertainty, and field verification requirements for this material.

1.0 scope/identification

This profile applies to Moisture Resistant (MR) gypsum plasterboard, often referred to as 'wet area plasterboard'. These products are designed for use as a lining in areas subject to intermittent moisture, high humidity, and potential water splashes, such as bathrooms, laundries, kitchens, and protected external soffits. They are not designed for immersion or constant saturation.

Identification:

- **Australia:** Typically identified by a light blue or grey-green paper face. Common trade names include CSR Gyprock Aquachek™, Knauf WetStop™ (a name change from WaterStop™), and Siniat M-Bloc™.
- **New Zealand:** Typically identified by a green paper face. The predominant product is Winstone Wallboards GIB Aqualine® .

These products are distinct from standard plasterboard due to chemical additives in the gypsum core and the paper liner that repel water and inhibit moisture absorption. They are also distinct from cementitious or fibre-cement (FC) sheet products, which offer higher water resistance and are often used as a tile substrate in shower enclosures. This profile specifically excludes cement-based boards and standard plasterboard that has been treated with a post-manufacture waterproofing membrane, focusing only on the properties of the MR board itself. The primary function of MR board is to provide a stable, moisture-tolerant substrate for finishes (paint, tiles, etc.) and to prevent moisture damage to the surrounding framing and building elements in high-humidity service conditions, as outlined in manufacturer literature (CSR Gyprock, n.d.; Knauf, n.d.; Winstone Wallboards, 2021).

2.0 construction/moisture behaviour

MR plasterboard consists of a gypsum (calcium sulphate dihydrate) core with specific additives, enclosed in a multi-layered paper liner. Its enhanced moisture resistance is achieved through several key modifications:

- **Core Treatment:** The gypsum core is impregnated with silicone, wax, or other hydrophobic agents (e.g., paraffin or asphalt emulsion). These additives coat the gypsum crystals, reducing their natural hygroscopic tendency and significantly lowering the capillary action or "wicking" of liquid water into the board.

- **Paper Liner:** The paper facings are also treated to resist water penetration. This prevents surface water from immediately soaking into the paper and compromising its bond with the gypsum core, which is a common failure point in standard plasterboard.
- **Fungicides:** The core and/or paper often contain biocides to inhibit the growth of mould and mildew, which could otherwise thrive in the intended service environments.

Moisture Behaviour: Under normal service conditions, MR plasterboard maintains its dimensional stability and structural integrity when exposed to high ambient humidity (up to 90% RH per GIB specifications) and occasional splashing. However, its behaviour changes dramatically under water damage conditions (i.e., liquid water saturation from a leak or flood):

1. **Initial Resistance:** The treated paper and core provide initial resistance to water absorption. For a short-term, clean water event (Category 1), water may bead on the surface or be absorbed very slowly.
2. **Saturation Point:** With prolonged exposure, the hydrophobic treatments can be overcome. Water will eventually find paths through cut edges, fastener penetrations, or microscopic imperfections. Once saturation begins, the core will absorb water, though at a slower rate than standard plasterboard.
3. **Hysteresis and Trapping:** The same properties that repel water can inhibit its release. The hydrophobic additives reduce the material's vapour permeability compared to standard plasterboard. This means that once the core is wet, moisture vapour has a more difficult time escaping, potentially prolonging the drying process. This "trapping" effect is a critical consideration in devising a drying strategy.
4. **Strength Reduction:** Like all gypsum products, when the core becomes saturated, its compressive and flexural strength is significantly reduced. The bond between the paper and core weakens. The Gypsum Association (2025) notes that any gypsum board that has been wet to the point of softening or physical degradation should be replaced. While MR boards are more resilient than standard boards, they are not immune to sagging, swelling, or crumbling if left saturated for extended periods.

The primary behavioural characteristic distinguishing MR board from standard board in a water damage context is its slower rates of both wetting and drying.

3.0 exposure/contamination/salvage

The decision to dry or replace MR plasterboard is governed by the nature of the water exposure, the duration of saturation, and the potential for contamination. It is critical to understand that a product data sheet does not warrant a material's suitability for restoration after a water damage event; it only describes its performance in as-new condition. The decision to salvage must be based on site conditions and authoritative restoration guidance.

- **Category 1 Water (Clean):** Exposure to clean water presents the best-case scenario. The Gypsum Association (2025) and IICRC (2021) state that if the board can be dried thoroughly before microbial growth (typically 24-48 hours) and it remains structurally sound with no paper delamination, sagging, or fastener issues, it is a candidate for salvage.
- **Category 2 Water (Grey):** This water contains contamination. The porous nature of the gypsum core makes effective decontamination difficult. The IICRC S500 standard (2021) suggests that porous materials affected by Category 2 water often require removal. If the board is only lightly affected and can be thoroughly cleaned and sanitized on its surface, drying may be considered, but the risk of residual contamination is elevated.
- **Category 3 Water (Black):** This water is grossly contaminated. **MR plasterboard contaminated with Category 3 water must be removed and discarded.** This is a non-negotiable recommendation from both the IICRC (2021) and BRANZ (2021), as there is no reliable method to decontaminate the porous core and paper, posing a significant health risk.

Salvage Decision Matrix:

Condition	Decision	Rationale / Source
Category 1, < 24 hrs, structurally sound	**High potential for salvage.** Proceed with controlled drying.	Contamination is low and material integrity is likely intact. (Gypsum Association, 2025)
Category 1, > 48 hrs, or structural damage	**High potential for replacement.**	Prolonged saturation compromises core strength and elevates microbial risk. (IICRC, 2021)
Insulation behind wall is wet	**High potential for replacement.**	Plasterboard must be removed to access and replace wet insulation. (BRANZ, 2021)
Vinyl wallpaper or vapour-barrier paint	**Remove finish.** If board is sound, attempt drying. Otherwise, replace.	Vapour-impermeable finishes trap moisture, preventing drying. (IICRC, 2021)
Category 2 exposure	**Replacement is the default.** Salvage considered only if impact is minimal.	High risk of residual contamination and microbial amplification within the core. (IICRC, 2021)
Category 3 exposure	**Mandatory replacement.**	The material is considered a biohazard and cannot be safely decontaminated. (IICRC, 2021; BRANZ, 2021)

4.0 objectives/completion

The primary objective when drying MR plasterboard is to return the material to its pre-loss moisture content and structural condition without fostering microbial growth. This is defined by reaching a "drying goal" or "dry standard."

Establishing the Dry Standard: The dry standard is an equilibrium moisture content (EMC) reading taken from an identical, unaffected piece of MR plasterboard within the same structure. This baseline reading accounts for the normal ambient humidity conditions of the property. The IICRC S500 (2021) mandates this "unaffected material" comparison as the only scientifically defensible method for establishing a drying goal.

Completion Criteria: Drying is considered complete when the following conditions are met:

1. **Moisture Content:** All affected MR plasterboard panels have reached the established dry standard. Readings should be stable over a 24-hour period after drying equipment has been removed to ensure no moisture rebound.
2. **Structural Integrity:** The board must be physically inspected to confirm it is free from swelling, sagging, delamination, and fastener popping, consistent with guidance from the Gypsum Association (2025).
3. **Absence of Contamination:** There must be no visible mould growth or lingering odours.
4. **Substrate Readiness:** The dried plasterboard must be a suitable substrate for any subsequent repairs or finishes.

Meeting these criteria ensures that the material has been restored to a condition that does not compromise the health of the building or its occupants.

5.0 temperature

Temperature is a critical accelerator in the drying process, but excessive heat can cause irreversible damage to gypsum products.

Manufacturer Limitations: Major manufacturers like Knauf and GIB explicitly state that their products should not be exposed to sustained temperatures exceeding **52°C (125°F)**. This is a critical threshold for all gypsum-based boards.

Damage Mechanisms from Excessive Heat:

- **Calcination:** Gypsum is calcium sulphate *dihydrate* ($CaSO_4 \cdot 2H_2O$). Starting at around 66°C (150°F), calcination begins, where chemically bound water molecules are driven out of the gypsum crystal structure. This permanently damages the core, making it soft and chalky, destroying its structural strength.
- **Paper Delamination:** High temperatures can break down the adhesives bonding the paper liner to the gypsum core.

- **Dimensional Instability:** Rapid or uneven heating can cause warping or buckling.

Recommended Drying Temperature Range: To maximise the rate of evaporation while staying safely below the damage threshold, the ideal surface temperature for drying MR plasterboard is between **30°C and 40°C (86°F - 104°F)**. This aligns with the IICRC S500 (2021), which recommends a balance of temperature, humidity control, and airflow.

The **current MCA maximum of 38°C** is a well-judged, conservative upper limit. It provides a significant boost to the drying rate while maintaining a safe buffer of 14°C below the manufacturer-specified maximum. This is a sound MCA engineering control. Exceeding 40°C on the material surface should be avoided.

6.0 RH

Relative Humidity (RH) within the drying environment is a key indicator of the balance between evaporation and dehumidification. Low RH is essential for maintaining a steep vapour pressure differential between the wet material and the surrounding air.

Best Practice Targets: There are no manufacturer-specified ambient RH limits for drying water-damaged plasterboard. The goal is to make the RH as low as is practically achievable. The restoration industry has developed best-practice targets based on psychrometric principles.

- **Ideal Target Range:** For efficient drying, the target ambient RH is typically **30% to 40%**. In this range, dehumidifiers operate near peak efficiency.
- **Initial Stages:** In the first 24-48 hours, the RH may be higher (50-60%) as large amounts of water are evaporated. This is acceptable as long as the RH is consistently trending downwards.
- **Stagnation:** If the RH remains above 60% for an extended period, it indicates that the rate of evaporation is exceeding the rate of dehumidification, slowing drying and increasing the risk of microbial growth (IICRC, 2021).

MR plasterboard's treated surface is slightly less permeable to vapour than standard plasterboard. This makes achieving a low ambient RH even more important, as a stronger "pull" (vapour pressure differential) is needed to draw the moisture out of the core. An RH below 40% is the goal for the majority of the drying cycle.

7.0 GPP/dew point/vapour pressure/condensation

Specific humidity, expressed as Grams of Water Vapour per Kilogram of Dry Air (g/kg) or Grains per Pound (GPP), is an absolute measure that is more valuable for professional restorers.

Vapour Pressure Differential: Drying occurs when the vapour pressure within the wet material is higher than the vapour pressure of the surrounding air. We manipulate this differential by increasing material temperature and decreasing the air's vapour pressure (GPP) via dehumidification. A target GPP below 50 GPP (approx. 7 g/kg) is generally considered a good drying environment in restoration (IICRC, 2021).

Dew Point and Condensation: The dew point is the temperature at which water vapour condenses into liquid. It is critical to manage surfaces that may be colder than the dew point of the air in the drying chamber to prevent secondary damage. This can be done by ensuring powerful dehumidification and applying directed airflow to cold surfaces.

The **current MCA bulk caps of 10 pp/h and 35 pp/24h** are internal MCA metrics. They are not standard industry terms like GPP but appear to represent a target for the *volume* of water being removed by dehumidification equipment. They serve as a reasonable internal benchmark for progress, representing a specific MCA engineering control for managing drying projects.

8.0 airflow/equipment

Airflow moves the layer of cool, saturated air immediately adjacent to the wet plasterboard surface (the "boundary layer") and replaces it with warmer, drier air from the drying chamber.

Equipment and Placement:

- **Air Movers (Centrifugal or Axial Fans):** These are the primary tools. They should be positioned to create a vortex or circular airflow pattern around the room, blowing along the base of affected walls, not directly at them. Space air movers approximately every 3-4 linear metres of affected wall.
- **Dehumidifiers:**
- **LGR (Low-Grain Refrigerant) Dehumidifiers:** Most common and effective for most structural drying scenarios.
- **Desiccant Dehumidifiers:** Used for colder conditions or when extremely low GPP/RH levels are required.
- **Cavity Drying Equipment:** If the wall cavity is also wet (and insulation has been removed), specialized systems are required to force dry air into the cavity.

The effectiveness of the equipment setup is constantly monitored by checking moisture levels in the materials and the psychrometric conditions of the air, as per IICRC S500 (2021) procedures.

9.0 staged strategy

A successful drying project follows a structured, multi-stage approach.

Stage 1: Assessment and Setup (Day 0)

- Define scope, categorise water, and make salvage decisions based on IICRC S500 and Gypsum Association GA-231 guidance.
- Establish and document the dry standard from an unaffected control material.
- Perform necessary demolition (e.g., remove baseboards, wet insulation).
- Install containment and drying equipment.

Stage 2: Bulk Water Removal (Days 1-3)

- The primary goal is to remove the majority of the free water.
- The **MCA bulk caps (35 pp/24h)** are most relevant here, serving as an internal target for the volume of water removed. The **50% non-bulk stage factor** is a logical MCA internal metric to signify progress from "wet" to "damp".

Stage 3: Evaporative Drying (Days 3-5+)

- This stage is slower and focuses on removing "bound" water from the core.
- The **MCA utilisation hysteresis of 75/90/60** is a sophisticated MCA engineering control for optimising equipment energy use while maintaining drying effectiveness.

Stage 4: Finalisation and Monitoring (Final 24-48 hours)

- Once readings are stable at the dry standard for 24 hours *after* all equipment is shut down, the drying is officially complete (IICRC, 2021).

10.0 monitoring/sensor placement/material readings

Accurate monitoring provides the data to demonstrate that the completion criteria have been met.

Tools:

- **Non-Invasive Moisture Meter (Scanner):** For quickly mapping moisture extent and daily progress monitoring.
- **Invasive Moisture Meter (Pin-Type):** Provides quantitative Wood Moisture Equivalent (%WME) readings. Insulated pins are essential to measure moisture at the back of the board.
- **Thermo-Hygrometer:** Measures ambient temperature and relative humidity.

Strategy:

1. **Initial Mapping:** Use a non-invasive scanner to map the full extent of water migration.
2. **Establish Control Points:** Identify several locations for daily readings, including the wettest point, a mid-point, an edge point, and an unaffected control point.
3. **Documentation:** All readings must be meticulously documented in a daily log.

The **current MCA floor, target, and restart EMC values (25%, 28%, 35%)** appear to be based on a relative scale specific to MCA's monitoring equipment. As internal benchmarks, they are logical: Target (28%) and Floor (25%) represent a reasonable dry standard, and Restart (35%) is a logical threshold for moisture rebound. These are MCA engineering controls, not universal values.

11.0 damage/stop conditions

Drying should be stopped and the material replaced if certain conditions are observed.

Stop Conditions:

1. **Structural Failure:** Any visible sagging, bulging, or delamination. The Gypsum Association (2025) is clear that board with any physical degradation must be replaced.
2. **Widespread Fastener Failure:** "Popped" fasteners indicating the board has swollen or shifted.
3. **Discovery of Mould:** The project must transition to a mould remediation protocol (per IICRC S520), which involves containment and physical removal of the contaminated material (IICRC, 2021).
4. **Stagnant Drying:** If readings show no meaningful progress, it may indicate a hidden vapour barrier or persistent leak, and further drying is futile.

12.0 mixed materials

MR plasterboard is part of a larger wall assembly. A holistic approach is essential.

- **Timber Framing:** Must be dried to its own dry standard (typically <16% WME in NZ/Australia, per BRANZ, 2021).
- **Insulation:** If insulation is wet, it must be removed. This necessitates cutting out the plasterboard to access the cavity (BRANZ, 2021).
- **Bottom Plates and Flooring:** Skirting boards must always be removed to allow drying of the plasterboard and bottom plate behind them.
- **Paint and Finishes:** Vapour-impermeable finishes like gloss paints or vinyl wallpaper may need to be perforated or removed to allow moisture to escape.

13.0 current MCA assessment

The current MCA parameters for MR plasterboard are a well-considered framework.

Assessment of Values:

- **Max Temperature (38°C): Appropriate.** This is a safe and effective MCA engineering control, staying well clear of the 52°C damage threshold.
- **EMC Floor/Target/Restart (25%/28%/35%): Appropriate as internal relative values.** These represent a logical MCA system for defining the dry standard.
- **Bulk Caps & Stage Factors: Plausible as internal metrics.** These are MCA engineering controls for managing project progress and are not based on direct external evidence but are consistent with the goals of managed drying.

Overall Assessment: The MCA parameters are aligned with the principles of safe and effective drying. The temperature limit is scientifically sound. The other metrics are logical internal MCA engineering controls.

14.0 recommended app parameters

Based on the synthesis of manufacturer data, standards, and restoration science, the following parameters are recommended.

Claim-to-Source Table: Recommended Parameters

Parameter	Recommended Value/Range	Rationale / Primary Source
Max Surface Temperature	**40°C**	Provides rapid evaporation and a safe buffer below the 52°C calcination risk limit. (Source: Knauf/GIB Technical Literature)
Target Ambient RH	**30% - 40%**	Optimal range for LGR dehumidifier efficiency and maintaining a strong vapour pressure differential. (Source: IICRC S500)
Drying Goal (EMC)	**Unaffected Control Reading**	The only scientifically defensible drying target is the normal EMC of identical, undamaged material on site. (Source: IICRC S500, Gypsum Association GA-231)
Contamination Rule	**Replace if Category 3**	Non-negotiable health and safety requirement due to the porous nature of gypsum. (Source: IICRC S500, BRANZ 666)
Structural Rule	**Replace if swollen, sagged, soft**	The material's function is compromised and cannot be restored by drying. (Source: Gypsum Association GA-231)

15.0 evidence gaps/specialist overrides

- **Vapour Permeability Data:** Precise vapour permeability ratings for Australian/NZ MR plasterboard products are not readily published, making it difficult to precisely model drying times.
- **Long-Term Performance Post-Drying:** There is limited peer-reviewed research on the long-term performance of water-damaged, dried-in-place MR plasterboard. The current recommendation to replace if structural integrity is lost is a conservative approach.
- **Specialist Overrides:** An experienced restoration technician or certified Indoor Environmental Professional (IEP) may need to override standard procedures, especially in high-value or heritage buildings. If an IEP is involved, their protocol supersedes the general restoration standard.

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Plasterboard - Fire Rated

Research packet: gemini-g2-plasterboard-specialty.md | 3,556 words | 7 URL references | The packet is commentary for review, not a certified limit.

Scope: this chapter separates source-supported observations, operational assumptions, unresolved uncertainty, and field verification requirements for this material.

1.0 scope/identification

This profile applies to Fire Rated (FR) gypsum plasterboard, a specialised product designed to be a critical **component** in wall, ceiling, and structural steel protection systems that resist the passage of fire for a specified duration. Its primary and non-negotiable function is life safety and property protection through compartmentalisation.

Identification:

- **Australia & New Zealand:** Universally identified by a **pink or reddish-pink paper face**.
- **Common Trade Names:** CSR Gyprock Fyrchek™, Knauf Firestop®, Siniat FireShield™, Winstone Wallboards GIB Fyreline®.
- **Thickness:** Commonly 13mm and 16mm, with thicker and multi-layered applications often specified. The specified thickness is a fundamental and non-negotiable variable in the system's performance.

It is impossible to overstate the following principle: the fire rating—expressed as a Fire Resistance Level (FRL) in Australia or a Fire Resistance Rating (FRR) in New Zealand—**does not belong to the board itself**. The rating applies exclusively to the complete, tested **assembly** or **system** as constructed and validated under stringent test conditions, such as those prescribed by Standards Australia AS 1530.4 (2014). This concept of **component versus tested assembly** is the cornerstone of fire safety design. The system, as detailed in authoritative guides like the GIB Fire Rated Systems Manual (2024) or the Gyprock Red Book, is a precisely defined combination of elements: the specific FR board type and thickness, framing material and dimensions, fastener type and spacing, jointing compound and tape, and all fire-rated sealants for joints and penetrations.

Any deviation from the tested system specification, including substituting a component or altering its condition through water damage, will void the rating and introduce profound **post-wetting performance uncertainty**. A manufacturer's product datasheet for a single component does not, and legally cannot, warrant the performance of an entire life-safety system that has been compromised by water saturation and subsequently dried in place. The governance of these mixed-material systems is therefore a matter of regulatory compliance, not just material science.

2.0 construction/moisture behaviour

FR plasterboard derives its performance from critical modifications to its core and overall density, which directly influence its interaction with both fire and water.

- **Core Reinforcement:** The gypsum core is heavily reinforced with chopped glass fibres (rovings). In a fire, after the gypsum has calcined (lost its chemically bound water), these glass fibres act as a reinforcing mesh, holding the chalky, brittle core together. This prevents the formation of large cracks and the collapse of the barrier, maintaining its integrity and insulation. Other additives like vermiculite or clay may also be included to reduce shrinkage at high temperatures.
- **High-Density Core:** FR plasterboard has a significantly higher core density than standard or MR board. This increased mass serves two purposes: it provides a greater thermal barrier, slowing heat transfer, and it contains a larger volume of chemically bound water per unit of area, which provides the primary fire-resisting mechanism.

Moisture Behaviour: The very properties that enhance fire resistance make FR plasterboard highly vulnerable to water damage and difficult to dry.

1. **Rapid Absorption:** The paper **facings** are untreated and readily absorb water. The high-density **core**, while less porous than standard board, will absorb significant water through capillary action, especially at cut edges and fastener penetrations.
2. **Strength Reduction:** Upon saturation, the dense core loses a catastrophic amount of its structural and compressive strength. Given its increased weight (a 16mm sheet weighs up to 50% more than a 10mm standard sheet), it is highly susceptible to sagging, which places immense stress on **fasteners** and **joints**.
3. **Drying Behaviour:** The dense core holds a large volume of water and has lower vapour permeability than standard plasterboard. Consequently, FR board dries extremely slowly. This creates a significant risk of **contamination** issues like mould growth and fastener corrosion during the prolonged drying period.
4. **Component Interaction:** Water does not just affect the board. It can cause corrosion in steel **fasteners** and framing, reducing their tensile strength. It can degrade the bond of paper jointing tape and compromise the integrity of fire-rated sealants in control **joints** and penetrations. Wet **insulation** within wall **cavities** will slump and lose its thermal properties, creating another breach in the assembly's fire performance.

3.0 exposure/contamination/salvage

The decision to dry or replace FR plasterboard is far more stringent than for other gypsum products. Because it is a component of a life-safety system, any doubt about its post-drying integrity must default to replacement. The principle is to guarantee the system's specified performance, and drying introduces unquantifiable uncertainty.

- **Category 1 Water (Clean):** The Gypsum Association's technical bulletin GA-231 (2025) is explicit: if the board is softened, has sagged, or the paper facing is delaminated, it **must be replaced**. There is zero acceptable loss of structural integrity for a fire-rated component. Even with clean water, prolonged saturation can dissolve and redistribute binders within the gypsum core, potentially altering its behaviour under heat. This **post-wetting performance uncertainty** is a critical, unresolved issue.
- **Category 2 Water (Grey): Replacement is mandatory.** The risk of chemical or biological **contamination** degrading the core's structure, the reinforcing glass fibres, or the paper-to-core bond over time is unacceptably high (IICRC, 2021). Contaminants can act as fluxes, potentially lowering the temperature at which the core materials fuse or shrink in a fire.
- **Category 3 Water (Black): Mandatory, non-negotiable replacement.** The material is a biohazard, and its function as a reliable fire barrier is completely and irreversibly compromised (IICRC, 2021).

System Integrity Rule: The core principle is that the fire-rated *system* must be restored to its certified state (per AS 1530.4). Water damage introduces unseen risks: rusted fasteners with reduced shear strength, micro-cracking in the core from swelling and shrinkage, and delamination of paper facings that provide critical tensile strength to the board surface. The Gypsum Association's GA-225 (2025) on repairing fire-rated systems requires that damaged sections be fully cut out and replaced according to specific guidelines that emphasise correct materials and mechanical fastening. Ambient drying of a component in place cannot provide the same level of assurance as replacement, making it an unacceptable risk for a life-safety system. The default position of fire engineers, building certifiers, and responsible restoration professionals is **replacement**.

4.0 objectives/completion

The sole objective is the complete restoration of the specified Fire Resistance Level (FRL). This objective extends far beyond simply drying the plasterboard component.

Completion Criteria (if drying is attempted under specialist direction):

1. **Moisture Content:** The board must be returned to its dry standard EMC. This must be verified with deep-probe invasive readings to ensure the core is dry, not just the surface.
2. **Absolute Structural Integrity:** This is the critical physical test. The board must be hard, solid, and completely free from any softness, powdering, or chalkiness. Fasteners must be tight, with no signs of popping or pull-through. There is zero tolerance for any physical degradation.
3. **System Inspection:** A thorough, documented inspection of the entire affected assembly is required. This includes checking fastener heads for corrosion, inspecting fire-rated sealants for adhesion, and confirming the condition of framing and any in-cavity insulation.
4. **Formal Documentation and Certification:** A restorer's moisture log is insufficient evidence. Proper **repair documentation** is essential. The ultimate completion criterion is a formal acceptance or re-certification of the repaired assembly by a qualified third party. This requires a **fire engineer or**

certifier review. Without this, the building owner is left with an uncertified and potentially non-compliant fire-rated assembly. The process must generate a defensible audit trail confirming the system's integrity has been restored. For this reason, the default MCA status for any water-affected FR assembly is **`specialist_required`**.

5.0 temperature

Temperature management during drying is critical to preserve the chemical and physical structure of FR plasterboard, specifically the chemically bound water that is essential for its fire performance.

Manufacturer and Physical Limitations:

- **Upper Limit:** As a gypsum product, FR plasterboard is subject to the same **52°C (125°F)** maximum sustained temperature limit to prevent the onset of calcination (Knauf, 2024).
- **Calcination Risk:** Calcination is the process where chemically bound water (the dihydrate) is driven off by heat, converting the gypsum to a weaker hemihydrate or anhydrite form. This process is the primary source of the board's fire resistance, as it absorbs enormous thermal energy (latent heat of vaporisation). If this water is prematurely driven out by excessive drying heat, the board's FRL is permanently and invisibly reduced. Applying heat for prolonged periods, even below 52°C, can risk slowly driving off some of this bound water, introducing another layer of performance uncertainty.

Recommended Drying Temperature: A highly conservative approach is required to protect the material's chemical structure.

- **Ideal Range:** The recommended surface temperature for drying FR plasterboard is **25°C to 35°C (77°F - 95°F)**.
- **The MCA maximum of 35°C** is an excellent and highly appropriate MCA engineering control. It is aggressive enough to create a vapour pressure differential for effective drying but is conservative enough to provide a very wide safety margin against calcination, protecting the core chemistry that is fundamental to the product's life-safety function.

6.0 RH

Achieving and maintaining a low Relative Humidity is even more critical for FR plasterboard than for other types. The high-density core presents a significant barrier to vapour migration, requiring a powerful and consistent "pull" to draw moisture out.

- **Target Range:** The ambient RH in the drying chamber should be maintained relentlessly at **30% to 40%** for the entire duration of the evaporative drying phase (IICRC, 2021).
- **Stagnation is Unacceptable:** An environment with RH remaining above 50% after the initial bulk water phase will be completely ineffective for drying the dense FR core. Such conditions indicate insufficient dehumidification capacity and will lead to project failure, mandating a shift to a

replacement strategy. The prolonged dampness also significantly elevates the risk of fastener corrosion and mould growth.

7.0 GPP/dew point/vapour pressure/condensation

Specific humidity (GPP or g/kg) is the professional's metric for managing the challenging drying environment required for FR plasterboard.

- **Target GPP:** A target of **below 40 GPP (approx. 5.5 g/kg)** is necessary for effective drying (IICRC, 2021). This creates the significant vapour pressure differential needed to pull moisture from the deep core.
- **Condensation and Mixed-Material Governance:** Managing dew point is critical for the entire assembly. Condensation forming on cold metal components, such as steel studs or fasteners, can accelerate corrosion and degrade their structural capacity, directly impacting the fire rating. This highlights the need for a holistic **mixed-material governance** approach, where the drying plan considers the response of every component in the system, not just the plasterboard.

MCA Bulk Caps Assessment:

- **Current Caps (6 pp/h, 25 pp/24h):** These caps are lower than for MR board. This is **highly appropriate**. It correctly reflects that FR plasterboard has a much slower moisture release rate due to its core density. This is a well-calibrated and insightful MCA engineering control for managing project expectations and equipment sizing. These values remain review-only MCA controls.

8.0 airflow/equipment

Airflow strategy for FR board is focused on consistent, aggressive surface-level evaporation. The goal is to ensure that as moisture slowly and laboriously migrates from the dense core to the surface, it is immediately removed by a continuous supply of very dry, warm air.

- **Surface Focus:** Air movers should be positioned to scrub the entire affected surface, ensuring no stagnant boundary layers exist.
- **Cavity Management:** If the assembly has an open wall **cavity** (e.g., insulation removed), airflow must also be directed into the cavity to dry the framing and the back face of the FR plasterboard. This often requires specialised cavity drying systems. The entire system must be considered a single drying problem.

9.0 staged strategy

The drying strategy for FR board is a slow, steady, and meticulously documented process, often taking significantly longer than for standard or MR plasterboard.

Stage 1: Assessment and Setup (Day 0)

- The default decision is replacement. The decision to attempt drying must be explicitly authorised by the client and insurer, ideally with the preliminary assent of a building certifier or fire engineer. This decision must be based on a minor, short-duration, Category 1 water impact. Comprehensive **repair documentation** begins here, with photographic evidence and detailed notes.

Stage 2: Bulk Water Removal (Days 1-4+)

- This stage is typically much longer for FR board. The lower MCA bulk caps (25 pp/24h) serve as the guiding internal metric for progress.

Stage 3: Evaporative Drying (Days 4-10+)

- This is the longest and most critical phase. The environment must be held stable at the target psychrometric conditions. If moisture readings stall for more than 48 hours, replacement becomes the only viable option, and this must be documented as a key **monitoring and stop condition**.

Stage 4: Finalisation and Verification (Final 48-72 hours)

- A 48 to 72-hour monitoring period after shutdown, with stable readings at the dry standard, is recommended. This is followed by the final, critical step: obtaining clearance from the relevant authority (e.g., a fire engineer).

10.0 monitoring/sensor placement/material readings

Monitoring FR plasterboard requires an uncompromising focus on core moisture, as the surface can appear dry while the core remains saturated.

- **Invasive Moisture Meter with Insulated Pins: This is the only acceptable tool for determining moisture content.** Readings MUST be taken with insulated pins fully inserted to their maximum depth to get an accurate picture of the moisture content deep within the high-density core. Surface scans are dangerously misleading and must not be used to determine completion.
- **Monitoring and Stop Conditions:** The drying goal is met only when the **deep core reading** reaches the dry standard. Monitoring data should be reviewed daily to track progress. A stall in drying progress (e.g., less than a 5% relative drop in moisture content over a 48-hour period) is a critical **stop condition** that should trigger a project review and likely a switch to a replacement strategy.

11.0 damage/stop conditions

The conditions for stopping a drying attempt on FR plasterboard are far more stringent and must be acted on immediately.

Mandatory Stop Conditions and Triggers for Replacement:

1. **Any Structural Failure:** Any degree of sagging, bulging, fastener popping, or core softness detected through physical inspection is grounds for mandatory replacement (Gypsum Association, 2025). This is non-negotiable.

2. **Paper Delamination:** The paper **facings** provide crucial tensile strength and a stable surface for jointing. If the paper is peeling or its bond is compromised, the board must be replaced.
3. **Discovery of Mould:** Triggers mould remediation protocols (per IICRC S520) and immediate removal of contaminated materials (IICRC, 2021). The biocides that might be in an FR/MR board cannot be relied upon to prevent all mould growth.
4. **Fastener or Framing Corrosion:** If inspection reveals that fasteners or steel framing show any signs of new corrosion, the affected sheets must be replaced to allow for replacement of the compromised structural elements. Rusted fasteners have reduced strength and will fail prematurely under the stresses of a fire.
5. **Unresolvable Stagnation:** As a key **monitoring and stop condition**, if deep core readings show no meaningful progress over a 48-72 hour period, it indicates the drying effort is futile and replacement is the only path forward. Continuing to apply energy is wasteful and prolongs risks.

The guiding principle is: if there is any doubt—however small—that every component of the system can perform its life-safety function as specified, the affected area must be removed and replaced.

12.0 mixed materials

The integrity of a fire-rated system is an exercise in **mixed-material governance**, where every component must be returned to its specified condition.

- **Facings/Core:** The FR plasterboard itself, as discussed.
- **Fasteners:** The type, material, length, and spacing are rigorously specified in the fire system design (e.g., GIB, 2024). Water can cause corrosion on steel screws, weakening them. They must be inspected, and if any corrosion is present, the board must be removed to allow fastener replacement.
- **Joints:** The jointing system (tape and compound) is critical for creating a monolithic, fire-resistant surface. Water can weaken the compound and the tape's bond, leading to premature failure. Joints must be inspected for cracking or degradation.
- **Insulation:** Many fire-rated walls contain insulation, which itself may have a fire-resisting rating (e.g., rock wool). If this **insulation** gets wet, it can slump within the wall **cavity**, creating gaps that allow for rapid heat transfer, voiding the system's rating. Wet insulation must be removed, which necessitates removing the plasterboard.
- **Sealants:** Fire-rated acoustic or intumescent sealants are critical for preventing the passage of hot gases and smoke at perimeters and penetrations. Water can compromise their adhesion to the substrate. All fire-rated sealants in the affected area must be meticulously inspected.

The entire system must be restored to its as-tested specification (per AS 1530.4). This cannot be achieved if any single component remains compromised.

13.0 current MCA assessment

The current MCA parameters for FR plasterboard demonstrate a sophisticated, conservative, and safety-conscious understanding of the material.

- **Max Temperature (35°C): Excellent.** A perfectly judged conservative temperature that prioritises the avoidance of calcination and protects the board's core chemistry. This is a critical MCA engineering control.
- **EMC Floor/Target/Restart (25%/28%/35%): Appropriate as relative values,** but they absolutely must be paired with a non-negotiable procedural requirement for deep-probe invasive readings. Surface readings are not acceptable for validation.
- **Bulk Caps (6 pp/h, 25 pp/24h): Excellent.** These lower targets correctly account for the much slower moisture release rate of the dense FR core. They are insightful MCA engineering controls that help set realistic project timelines. These rate values remain review-only MCA controls.

14.0 recommended app parameters

Recommendations prioritise occupant life safety and system integrity above all else. The default recommendation for any water-affected fire-rated assembly is replacement unless a specific, documented, and authoritative approval to retain is granted.

Claim-to-Source Table: Recommended Parameters

Parameter	Recommended Value/Range	Rationale / Primary Source
Default Action	**Replace Material; `specialist_required`**	The risk of unseen damage compromising a life-safety system is unacceptably high. Ambient drying does not restore an FRL. Drying is the exception, not the rule, and requires expert oversight. (Source: Gypsum Association GA-231, Fire Engineering Principles)
Max Surface Temperature	**35°C**	A conservative limit providing the maximum safety margin against premature calcination of the core, preserving the chemically bound water essential for fire resistance. (Source: Gypsum Chemistry, Precautionary Principle)

Parameter	Recommended Value/Range	Rationale / Primary Source
Drying Goal (EMC)	**Unaffected Control Reading (verified with deep probe)**	Completion must be based on deep core moisture content, not surface scans, to avoid falsely declaring a wet board as dry. (Source: IICRC S500, Material Science)
Structural Rule	**Replace if ANY physical degradation is detected**	Zero tolerance for sagging, swelling, softness, or paper delamination. The component's physical form is essential to its function. (Source: Gypsum Association GA-231, GA-225)

15.0 evidence gaps/specialist overrides

- **Lack of Post-Drying Fire Tests:** The most significant evidence gap is the complete lack of research where water-damaged, dried-in-place FR plasterboard assemblies have been subjected to a full-scale fire test (e.g., to AS 1530.4). The current guidance to replace is based on sound material science, first principles of fire engineering, and expert consensus, but not on destructive testing of restored assemblies. No manufacturer will warrant the fire performance of a product that has been saturated and subsequently dried in situ. This creates significant **post-wetting performance uncertainty**.
- **Liability and Certification:** Restoring a fire-rated assembly without explicit manufacturer or regulatory approval transfers the liability for the system's performance directly to the restorer and the building owner. Attempting to do so without a **fire engineer or certifier review** and sign-off is professionally indefensible.
- **Specialist Overrides:** A qualified, certified, and insured fire engineer is the ultimate authority on fire-rated systems. Their professional judgement, which must be delivered in a formal report with clear instructions for any necessary repairs or validation testing, supersedes any generic restoration guideline. Similarly, the local Building Consent Authority or Authority Having Jurisdiction (AHJ) requirements are legally binding and will override any decision made by a restorer, client, or insurer. The engagement of such a specialist is not an override; it is the required procedure.

16.0 references

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Upholstery / Fabric

Research packet: gemini-g3-sensitive-contents.md | 3,576 words | 5 URL references | The packet is commentary for review, not a certified limit.

Scope: this chapter separates source-supported observations, operational assumptions, unresolved uncertainty, and field verification requirements for this material.

Profile Status: `packout_required`

1. Material Identification

Upholstery and fabrics represent a highly complex category of composite objects, primarily composed of organic fibres that are exceptionally vulnerable to water damage. Accurate identification is the foundational step in determining an appropriate response, as different materials exhibit vastly different behaviours when wet. A thorough assessment must consider every component of the assembly:

- **Primary (Show) Fabric:** This is the visible textile layer, which defines the object's aesthetic. Fibres can be broadly categorized as:
- **Plant-based (Cellulosic):** Cotton, linen, jute, hemp. These fibres are strong when dry but become significantly weaker when wet. They are highly hygroscopic and prone to cellulosic browning and mould growth.
- **Animal-based (Protein):** Wool, silk. These fibres are generally more resilient than cellulosic ones. Wool can absorb up to 30% of its weight in water without feeling damp but is prone to shrinking and felting. Silk is exceptionally strong for its weight but is weakened by water and is highly susceptible to UV and water staining.
- **Synthetic:** Rayon (a semi-synthetic), nylon, polyester. Early synthetics like rayon are notoriously weak when wet and can be easily damaged. More modern synthetics like polyester are hydrophobic and more resilient but may be blended with natural fibres.

Identification often requires microscopic fibre analysis for confirmation, as visual inspection can be misleading.

- **Under-upholstery/Internal Structure:** This is a hidden, layered system that provides the object's shape and comfort. These internal materials are often highly absorbent and can hold vast amounts of contaminated water for extended periods, making them the primary risk for mould and long-term damage. Common components include:
- **Support System:** Webbing made of jute or linen, and spring systems made of steel that are prone to rust.
- **Stuffing/Padding:** A wide variety of materials can be found, such as horsehair, coconut fibre, cotton batting, wool shoddy, and later, synthetic foams. Each has unique properties; for instance, horsehair is resilient, while cotton batting will compact and hold moisture tenaciously.

- **Structural Textiles:** Burlap (hessian) is commonly used to cover springs and contain stuffing.
- **Frame:** The wooden skeleton of the object, typically hardwoods like oak, mahogany, or walnut. Wood is itself a hygroscopic material that will swell upon water absorption. This swelling can stress and break joints, pop veneers, and compromise the entire structure. The wood's response to moisture must be managed concurrently with the textiles.
- **Finishings & Dyes:** Decorative elements like trimmings, braids, and buttons can be made of different, often more sensitive, materials. Crucially, the dyes used in the fabrics, particularly in older or non-commercial textiles, may be natural and water-soluble. Any contact with water can cause them to bleed, run, or be lost entirely, representing an irreversible form of damage.

2. Moisture Behaviour & Characteristics

The interaction of water with textiles is complex and almost universally damaging. Water acts as a plasticizer, lubricating the fibres, reducing their intermolecular bonds, and making them highly susceptible to mechanical damage.

- **Hygroscopicity & Absorption:** Natural fibres are highly hygroscopic, meaning they readily absorb water vapour from the air and liquid water from direct contact. This absorption causes the fibres to swell, primarily in diameter rather than length. This differential swelling is the root cause of much of the distortion seen in drying textiles.
- **Weight Gain & Weakness:** Wet textiles can be several times heavier than their dry weight. This added mass places enormous stress on the fabric structure. A wet curtain can tear from its hangings under its own weight; the show fabric of an armchair can pull away from its tacks. Handling wet fabric without full support can introduce permanent stretching and deformation.
- **Dimensional Instability:** The swelling and subsequent shrinking of fibres during the wetting and drying cycle leads to dimensional changes.
- **Shrinkage:** As water is removed, fibres draw closer together, causing the fabric to shrink. This is particularly problematic in tightly woven textiles and for materials like wool.
- **Distortion:** In a composite object like upholstered furniture, this is magnified. The show fabric may shrink while the burlap lining does not, causing puckering. The wooden frame swells and then shrinks at a different rate from the fabric, leading to detachment and stress.
- **Capillary Action & Wicking:** Water is wicked through the fine spaces between fibres and yarns, allowing moisture to spread rapidly. This is also the mechanism that creates "tidelines" or "tide marks." As water spreads, it dissolves dirt, degradation products, and soluble dyes. As the edge of the wet area evaporates, these dissolved materials are left behind in a concentrated, dark line that is often very difficult to remove.

3. Exposure, Contamination & Salvage Priorities

Upon water exposure, the priorities are speed, careful handling, and preventing irreversible changes. The primary threats are:

- **Microbial Growth:** Mould and mildew are the most immediate and destructive threat. In warm (>20°C), humid (>65% RH), and stagnant conditions, mould can begin to colonize within 24-48 hours. It causes permanent staining (foxing) and feeds on the fibres themselves, causing irreversible degradation and weakness.
- **Dye Bleed & Loss:** For many textiles, especially historic ones, dye bleed is the most immediate form of permanent damage. Once colours have run into adjacent areas, the original pattern is lost and the disfigurement is generally irreversible. This can happen within minutes of exposure.
- **Contamination:** Floodwater is rarely clean. It is often contaminated with silt, sewage (Category 3 water), oils, and chemicals. These contaminants can embed physically within the fibre weave and bond chemically, causing long-term degradation. Porous interior materials like cotton batting can trap this contamination deep within the object.
- **Structural Damage:** Beyond the fabric, the swelling of the wooden frame can break joints, lift veneers, and cause finish failure. Metal components like springs and tacks will begin to rust, which can cause deep, concentrated staining on the surrounding textiles.

Salvage Priority: High. Due to the high risk of mould, dye bleed, and the hidden retention of contaminated water, wet upholstery and fabrics must be addressed within the first 48 hours. They must be removed from the wet environment (packout) to a controlled space where a safe, methodical drying plan can be executed. If immediate treatment is not possible, freezing can be a viable option for some textiles to "pause" degradation, but this is extremely complex for large, composite upholstered objects.

4. Drying Objectives & Completion Criteria

The primary objective is **controlled moisture removal** to return the object to a stable state without causing secondary damage. This is a fundamental departure from the objective of structural drying, which prioritizes speed. For conservation, control is more important than speed. The key goals are:

1. **Prevent Microbial Growth:** The most urgent objective, achieved by creating an environment hostile to mould.
2. **Prevent Dimensional Change:** Minimize shrinkage, stretching, and distortion of the fabric, padding, and frame.
3. **Prevent Dye Bleed and Tideline Formation:** Control the rate and movement of moisture to prevent solubilized materials from migrating.
4. **Maintain Structural Integrity:** Ensure all components of the composite object (fabric, stuffing, frame, finishings) remain cohesive and undamaged.

Completion Criteria: Drying is considered complete when the object has returned to its normal Equilibrium Moisture Content (EMC) with a stable, appropriate environment (typically 45-55% RH). This is not determined by a set time or a feeling of "dryness" to the touch, as interior components can remain wet long after the surface feels dry. Completion is verified by:

- **Gravimetric Analysis:** Monitoring the object's weight until it plateaus over several consecutive measurements. This is the most reliable, non-invasive method.
- **Moisture Metering:** Using non-damaging moisture meters on the wooden frame (never on the fabric) to ensure the structural components are dry.
- **Physical Inspection:** Ensuring no damp pockets, odours, or signs of microbial growth remain.

5. Temperature Management

Temperature must be kept low and stable. This is a critical point of divergence from many commercial drying practices.

- **Ideal Range:** 18-20°C (65-68°F).
- **Rationale:** Lower temperatures are crucial for several reasons:
- They significantly slow the rate of mould growth, extending the safe working time.
- They reduce the speed of deleterious chemical reactions, including those that cause dyes to run.
- They lower the vapour pressure of water, naturally slowing the rate of evaporation and making it easier to control.
- **Contraindications: Never use heat to dry sensitive textiles.** The application of active heating (e.g., from heat guns, direct-fired heaters, or "warming" a room) is the single most damaging action one can take. Heat will:
- Permanently set many stains and drive dirt deeper into the fibres.
- Cause rapid, uneven, and catastrophic shrinkage of fibres, particularly wool.
- Denature protein fibres (silk, wool), making them brittle and weak.
- Create "case-hardening," where the surface dries and shrinks quickly, trapping a pocket of moisture within the object's core, which is a perfect recipe for a hidden mould colony.

6. Relative Humidity (RH) Management

RH management is the primary tool for controlling the drying process. The goal is not simply to "dehumidify," but to create a carefully controlled RH gradient that encourages the object to release its moisture slowly and evenly.

- **Target Ambient RH:** The ultimate goal is to bring the object to equilibrium with a stable room environment of **50-55% RH**.
- **Process:** The process must be gradual. Abruptly placing a saturated object into a very dry environment (<40% RH) is analogous to flash-heating it; the surface will dry too quickly, shrink, and crack or tear while the interior remains saturated.

1. **Stabilization:** Initially, the room's RH may be high. The first step is to stabilize it, perhaps around 70-80%, to stop active water movement.
2. **Gradual Reduction:** Using well-placed dehumidifiers (typically LGR or desiccant), the RH is lowered in steps, for example, by 5-10% every 12-24 hours. This slow reduction maintains a gentle vapour pressure differential, allowing moisture to migrate from the core of the object to the surface and then evaporate without stressing the materials.

7. GPP, Dew Point, Vapour Pressure & Condensation Control

While detailed calculations of Grains Per Pound (GPP) and vapour pressure are central to structural drying, their application in conservation is more conceptual. The focus is on maintaining a gentle, consistent drying force and preventing condensation.

- **Vapour Pressure Differential (VPD):** A lower GPP and vapour pressure in the ambient air provides the driving force for moisture to evaporate from the object. In structural drying, the goal is often to maximize this differential to speed up drying. In conservation, the goal is to create a small but persistent differential to ensure the drying is slow and controlled.
- **Condensation Control:** This remains a critical concern. All surfaces in the drying space must be kept above the dew point of the air. This is managed by maintaining constant air circulation and ensuring there are no cold surfaces (like single-pane windows or uninsulated walls) that can cause airborne moisture to condense and re-wet objects or create damp spots on walls where mould could grow.

8. Airflow & Air-Moving Equipment

Airflow is essential for disrupting the damp, stagnant boundary layer of air that naturally forms at an object's surface, which in turn facilitates evaporation. However, the *method* of airflow is critical.

- **Method:** The goal is to create gentle, ambient, whole-room circulation. This is best achieved using multiple low-velocity, oscillating fans, or by placing air movers so they are directed at walls or ceilings to create indirect airflow.
- **Volume, Not Velocity:** The aim is to exchange the air in the room, not to blast the object with a high-velocity stream of air. Think of a gentle breeze, not a focused jet.
- **Contraindications: Never aim a fan or air mover directly at the textile.** Direct, high-velocity airflow is incredibly damaging. It can:
- Cause rapid, localized drying, leading to stress and distortion.
- Physically dislodge or damage fragile, degraded fibres (e.g., rotted silk).
- Push dirt and contaminants deeper into the fabric's weave.
- Cause "windburn" on wooden finishes.

9. Drying Stages & Process

The process must be methodical, patient, and responsive to the object's condition.

1. **Assessment & Documentation:** Photograph the object extensively from all angles to document its pre-treatment condition. Note areas of particular concern.
2. **Surface Water Removal:** If there is standing water, gently blot accessible surfaces with clean, white, absorbent, lint-free towels or blotter paper. Do not rub or apply heavy pressure, as this can embed dirt and distort the weave.
3. **Establish Controlled Environment:** Move the object to a clean, controlled space. Set up environmental controls (dehumidifiers, fans) and monitoring equipment (data loggers for T/RH).
4. **Promote Evaporation:** Position the object to maximize air exposure. For example, an upholstered chair should be raised on blocks to allow air to circulate underneath it. Cushions should be removed and dried separately.
5. **Wicking:** Absorbent materials can be used to pull water out. For detached textiles, this may involve a full blotter paper sandwich. For upholstery, absorbent pads can be placed against surfaces, but they must be checked and changed frequently to avoid trapping moisture.
6. **Monitoring and Adjustment:** This is the longest phase. The object's weight and condition, along with the room's environment, must be checked daily. The drying rate should be slow and steady. If any signs of stress appear (warping, new tidelines, puckering), the process must be slowed by raising the ambient RH.
7. **Final Acclimatization:** Once gravimetric monitoring shows the object's weight has stabilized, it is considered dry. It should then be allowed to acclimatize in a stable environment (50-55% RH) for several more days to ensure there is no rebound.

10. Monitoring & Documentation

Continuous monitoring is the only way to ensure a safe and successful outcome. It is non-negotiable.

- **Photographic Documentation:** Before, during (at key stages), and after treatment.
- **Written Log:** A detailed log should be kept of all actions taken, environmental readings (T/RH), and visual observations.
- **Environmental Monitoring:** A calibrated data logger should continuously track temperature and RH in the drying space.
- **Object Monitoring:**
- **Visual Inspection:** Daily checks for mould, dye movement, and any dimensional changes (cupping, warping, puckering).
- **Weight (Gravimetric Analysis):** This is the most reliable, quantitative method. Weigh the object at the same time each day until the weight is stable for at least 3 consecutive readings.
- **Tactile and Olfactory Inspection:** Check for any "cool" feeling which indicates evaporation is still occurring, and any musty odours that signal microbial growth.

11. Halting Conditions & Potential for Damage

The drying process must be halted or significantly modified if any of the following are observed:

- **Active Mould Growth:** Indicates the drying process is too slow or the T/RH is too high. The object must be isolated and treated by a conservator.
- **Dye Bleeding or Tideline Formation:** Indicates that water is moving too freely or too quickly. The drying process needs to be slowed immediately by raising the ambient RH.
- **Dimensional Distortion:** Warping, puckering, splitting, or pulling away from the frame indicates the drying is too fast or uneven.
- **Fibre Damage:** The appearance of new tears, fraying, or splitting.

The greatest potential for damage comes from drying too quickly. An aggressive, uncontrolled drying rate, often championed in structural drying, is the primary vector of destruction for sensitive textiles.

12. Mixed Materials & Complex Assemblies

Upholstered furniture is the archetypal complex assembly. The drying plan must account for the needs of all its components simultaneously.

- **Wood Frame:** The frame will swell and can split or crack if it dries too quickly. Animal hide glues used in its construction may have been solubilized by the water and could fail.
- **Metal Components:** Springs and tacks will rust. This rust can migrate and cause deep, permanent staining on the surrounding fabric and stuffing.
- **Hidden Voids:** The interior of the object can hold vast amounts of moisture, making the surface feel deceptively dry. This hidden moisture can lead to catastrophic mould growth and rot long after the initial incident if not addressed.

The drying plan must be paced to the needs of the slowest-drying component, which is almost always the dense interior stuffing and the wooden frame.

13. Current App Profile Assessment

- **Profile:** 5 pp/24h (pounds per 24 hours), review-only.
- **Analysis:** This metric, and the methodology it implies, is **critically inappropriate, irrelevant, and dangerous** for upholstery and fabrics. It is a misapplication of an industrial process metric to a conservation challenge.
- **Reasoning:**

1. **It is an Environmental Metric, Not an Object Metric:** The profile measures the rate of water removal from the air in a room, not the rate of moisture safely released by the object. It is possible to meet this environmental target while causing catastrophic damage by drying the object's surface too quickly.

2. **It Encourages Speed Over Control:** The core principle of textile conservation drying is slowness and control. This metric incentivizes speed, which is the primary cause of damage.
3. **It Lacks Granularity:** The metric does not account for the object's size, material, or complexity. A small, lightly dampened silk cushion and a large, saturated wool sofa are treated identically, which is nonsensical.
4. **It Provides No Actionable Conservation Data:** Knowing that a dehumidifier is pulling 5 pounds of water out of the air does not inform a technician if the object itself is stable, if dyes are bleeding, or if the frame is cracking. It is a dangerously simplistic metric for a complex problem.

This profile is a relic of applying structural drying principles where they do not belong and must be completely abandoned for sensitive materials. These rate figures are strictly for review and do not constitute published damage thresholds.

14. Recommended App Parameters (Proposed Profile)

The profile must shift from a simplistic, rate-based target to a condition-based, environment-led approach focused on the stability of the object.

Parameter	Current "Review-Only" Profile	Proposed Profile (`packout_required`)	Justification
Primary Metric	Pounds of water removed from air per 24h (pp/24h).	Ambient RH (%) and Temperature (°C) stability.	Shifts focus from the environment's performance to the object's direct needs and stability.
Drying Rate	Fixed, aggressive target (e.g., 5 pp/24h).	Slow, variable, and object-led. Determined by gravimetric monitoring.	Recognizes that the object dictates the safe drying rate, which is always slow. Speed is the enemy.
Temperature	Not specified (often implies heat is used).	**18-20°C (65-68°F) Maximum.**	Prevents heat-related damage like shrinkage, embrittlement, and mould acceleration.
Relative Humidity	Not specified (implies rapid reduction).	**Gradual reduction from ambient to a stable 50-55%.**	Prevents surface-drying stress, cracking, and tideline formation by ensuring even drying.

Parameter	Current "Review-Only" Profile	Proposed Profile (`packout_required`)	Justification
Airflow	Not specified (implies direct/high velocity is acceptable).	**Low-velocity (<0.5 m/s), indirect, continuous, ambient.**	Prevents physical damage to fibres and localized over-drying.
Monitoring	Assumed complete when pp/24h rate is met.	**Daily visual inspection and object weight until stable (gravimetrics).**	Uses direct, object-focused data to determine completion, not arbitrary environmental data.

15. Gaps, Overrides & Specialist Consultation

- **Gaps:** The proposed profile is a guideline for stabilizing water-damaged textiles. It does not encompass conservation treatments such as cleaning, stain reduction, tear repair, or consolidation, which must be performed by a qualified conservator.
- **Overrides:** If the object is grossly contaminated with sewage or other hazardous materials (Category 3 water), it poses a health risk. Handling must be done with appropriate Personal Protective Equipment (PPE), and cleaning by a conservator is required before drying can begin.
- **Specialist Consultation is Mandatory For:**
- Objects with actively bleeding dyes or fugitive colourants.
- Highly fragile, degraded, or historic textiles.
- Objects of high artistic, cultural, or financial value.
- Complex objects with sensitive associated components (e.g., painted surfaces, gilding, ivory inlays).

16. References

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2. **Canadian Conservation Institute (CCI).** "Textiles and Costumes - Guidelines for care." *Guidelines for collections.* (https://www.canada.ca/en/conservation-institute/services/preventive-conservation/guidelines-collections/textiles-costumes.html)
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4. **U.S. Environmental Protection Agency (EPA).** "Table 2: Water Damage - Cleanup and Mold Prevention." (https://www.epa.gov/mold/water-damage-table-mold-prevention-mold-remediation-schools-and-commercial-buildings)

5. **International Inspection Cleaning and Restoration Council (IICRC).** *ANSI/IICRC S500 Standard for Professional Water Damage Restoration.* (Reference derived from press release: https://iicrc.org/wp-content/uploads/2025/04/AS-IICRC-S500-Published-Press-Release_March-2025.pdf)

Claim-to-Source Table: Upholstery & Fabric

Claim / Recommendation	Source (Reference #)	Justification / Corroboration
Mould can grow within 24-48 hours in damp conditions.	Source 4 (EPA)	Table 2 explicitly provides a 24-48 hour window as the critical time to prevent mould growth after water damage.
Wet textiles are heavy and weak; handle with full support.	Source 2 (CCI)	Guidelines emphasize supporting the entire object to prevent stress, distortion, and tearing when wet.
Never use heat to dry textiles; keep temperatures low (18-20°C).	Source 2 (CCI), Source 3 (AICCM)	Conservation guidelines universally warn against heat due to risk of shrinkage and embrittlement, recommending cool, controlled conditions.
Gradual RH reduction to a stable 50-55% is the target.	Source 2 (CCI)	Preventive conservation guidelines specify this range as ideal for long-term stability of textiles, making it the logical drying endpoint.
Use indirect, low-velocity airflow to aid evaporation.	Source 3 (AICCM)	Disaster recovery advice stresses gentle air movement to assist drying without causing physical damage or driving contaminants into the object.
The drying rate must be slow and object-led, monitored by weight.	Source 1 (CCI), G3 Synthesis	The principle of slowing deterioration (Source 1) underpins the need for slow drying. Gravimetrics is the standard museum practice for this.

Claim / Recommendation	Source (Reference #)	Justification / Corroboration
Rate-based environmental metrics like pp/24h are inappropriate.	G3 Synthesis	This is a conclusion derived from the universal conservation principle of "slow and controlled" vs. the industrial principle of "fast and efficient."
Contamination (e.g., sewage) requires specialist intervention.	Source 5 (IICRC), Source 3 (AICCM)	The IICRC S500 standard classifies water types; Category 3 (grossly contaminated) requires specialized handling, which for cultural objects falls to conservators.

Paper / Documents

Research packet: gemini-g3-sensitive-contents.md | 2,783 words | 6 URL references | The packet is commentary for review, not a certified limit.

Scope: this chapter separates source-supported observations, operational assumptions, unresolved uncertainty, and field verification requirements for this material.

Profile Status: `packout_required`

1. Material Identification

Paper, at its core, is a matted sheet of cellulose fibres. However, the specific composition and format of paper-based objects create a vast range of vulnerabilities to water. Key identification factors for risk assessment include:

- **Fibre Type:**
- **Rag Paper (Cotton/Linen):** Common in older documents (pre-19th century), these papers are inherently strong, durable, and more resistant to water damage.
- **Wood Pulp Paper:** Dominant from the mid-19th century onward. Can be mechanically ground (weaker, contains lignin, prone to yellowing) or chemically pulped (stronger). These papers are generally weaker than rag paper, especially when wet.
- **Sizing:** Additives that control the paper's absorbency.
- **Gelatin/Starch:** Traditional, neutral sizing.
- **Alum-Rosin:** Common in mass-produced 19th and 20th-century papers. This sizing is acidic and a primary driver of paper degradation, a process that is accelerated by water.
- **Coatings:** Many modern papers (e.g., for magazines or high-quality photo prints) have a clay or polymer coating to create a smooth, glossy surface. These coatings are extremely susceptible to water damage, as they can swell and fuse together, forming a solid, inseparable block if allowed to dry while in contact. This makes coated papers the highest priority for salvage.
- **Media:** The ink, pencil, or pigments on the paper. The solubility of the media is a critical factor.
- **Stable Media:** Carbon ink (India ink), pencil (graphite), most modern printer inks (pigment-based).
- **Water-Soluble Media:** Iron gall ink (can run and "burn" through paper when wet), fountain pen inks, markers, watercolours. Any object with these media requires immediate attention.
- **Format:**
- **Single Sheets:** Easiest to treat.
- **Bound Volumes (Books):** A complex composite object with paper, board, adhesives, and covering material (leather, cloth), all of which react to water differently.
- **Files/Complex Assemblies:** Documents held together with metal fasteners (staples, paper clips) which will rust and cause permanent staining.

2. Moisture Behaviour & Characteristics

Cellulose fibres are extremely hygroscopic and dimensionally unstable when wet.

- **Swelling and Weakness:** Paper fibres swell significantly in width but very little in length upon absorbing water. This anisotropic swelling is the cause of cockling, warping, and curling as the sheet dries unevenly. When saturated, paper loses the majority of its tensile strength and can disintegrate with even gentle handling.
- **Adhesion and Fusion:** This is the most catastrophic risk for coated papers. When wet, the clay coatings become a paste. If two sheets are pressed together as they dry, they will fuse into a single, inseparable layer, resulting in total information loss. For any stack of paper, there is a risk of pages sticking together, but for coated papers, it is a certainty.
- **Tideline Formation:** As water moves through the paper via capillary action, it dissolves inherent acidic degradation by-products, dirt, and sizing agents. As the water evaporates at the edge of the wet area, these dissolved materials are deposited in a dark, concentrated line. These tidelines are often disfiguring and can be very difficult or impossible to reduce.
- **Transparency:** Wet paper can become temporarily translucent. While this effect is reversible upon drying, it is an indicator of saturation.

3. Exposure, Contamination & Salvage Priorities

The immediate threats to wet paper are irreversible and require rapid, prioritized action.

- **Ink Bleed & Media Loss:** For documents with water-soluble inks, the loss of information begins the moment the water touches the page. The inks will feather, run, and can be wicked away entirely, rendering the document illegible.
- **Mould Growth:** Paper is a perfect food source for mould. In as little as 48 hours, mould can begin to grow, causing permanent staining, eating away at the paper itself, and posing a health risk.
- **Irreversible Adhesion of Coated Papers:** Coated (glossy) papers are the highest salvage priority. If they begin to dry while in a stack, they *will* fuse. They must be separated while wet or, more practically for large volumes, kept wet or frozen until they can be treated by a conservator.
- **Physical and Structural Damage:** The physical force of water can tear, delaminate, and distort paper. For books, the swelling of the text block can break the spine and detach the boards.

Salvage Priority: Very High. A 48-hour window for action is critical to prevent mould. The immediate priorities within a collection are:

1. **Coated Papers:** Must be frozen immediately if they cannot be separated and dried individually at once.
2. **Records with Soluble Media:** Must be stabilized (preferably by freezing) to prevent further information loss.
3. **All other paper-based materials.**

4. Drying Objectives & Completion Criteria

The objective is to dry the paper in a controlled manner that minimizes dimensional change, prevents media loss, and avoids adhesion.

1. **Stabilize Media:** Prevent inks from bleeding further, primarily through freezing.
2. **Prevent Mould:** Create an environment hostile to fungal growth.
3. **Minimize Cockling and Distortion:** Dry the paper under restraint or using a method (like freeze-drying) that keeps it flat.
4. **Avoid Adhesion:** Ensure individual sheets, especially coated ones, do not fuse together.

Completion Criteria: The paper is considered dry when it has reached its EMC with a stable environment (typically 35-50% RH). For single sheets, this is when they feel dry and are dimensionally stable. For books, it requires ensuring there is no dampness deep within the spine or text block. Gravimetric analysis (monitoring weight until stable) is the most reliable method for bound volumes.

5. Temperature Management

As with most conservation challenges, low temperature is a critical tool.

- **Ideal Range for Air-Drying:** Below 18°C (65°F). Colder temperatures dramatically slow mould growth and reduce the rate of chemical degradation of wet cellulose.
- **Freezing as a Primary Tool:** Freezing is the single most important technique in salvaging water-damaged paper collections.
- **Mechanism:** Freezing paper at or below -20°C (-4°F) "stops the clock." It halts microbial growth, stops ink from running, prevents further swelling, and buys invaluable time for a planned, methodical response.
- **Application:** It is the standard procedure for stabilizing large volumes of documents, books, and especially stacks of coated paper that cannot be dealt with immediately.
- **Contraindications:** Never use heat. Heat will accelerate acid hydrolysis, cause brittleness, and lead to catastrophic distortion. Certain photographic materials (e.g., glass plate negatives) should not be frozen; they require separate, specialized treatment.

6. Relative Humidity (RH) Management

A controlled RH environment is key for the air-drying method.

- **Target Ambient RH:** For air-drying, the goal is to maintain a stable environment between 35-50% RH. A lower RH risks making the paper brittle, while a higher RH prolongs drying time and increases the risk of mould.
- **Freeze-Drying (Lyophilization):** This advanced method bypasses ambient RH management entirely. In a vacuum chamber, the frozen water in the paper turns directly from a solid (ice) to a gas (water vapour) in a process called sublimation. This is the safest and most effective method for drying

large quantities of valuable paper or books, as it causes virtually no cockling or distortion and can even separate pages that were already slightly adhered. The RH of the room where the freeze-dryer is located is irrelevant to the process itself.

7. GPP, Dew Point, Vapour Pressure & Condensation Control

For air-drying, the principles are the same as for textiles: maintain a gentle vapour pressure differential to encourage evaporation while preventing condensation on surrounding surfaces. In the context of vacuum freeze-drying, vapour pressure is the critical variable that is precisely manipulated inside the chamber to facilitate sublimation. The pressure is lowered below the triple point of water, allowing ice to turn directly to gas.

8. Airflow & Air-Moving Equipment

For air-drying, gentle, indirect air circulation is vital.

- **Method:** Use oscillating fans or place air movers to bounce off walls, creating ambient air movement. This prevents pockets of stagnant, humid air from forming around the wet paper, which would encourage mould growth.
- **Placement:** Single sheets of paper can be laid out on absorbent surfaces. Fans must never be pointed directly at them, as this will cause them to fly around and will create uneven drying, leading to severe cockling. For books, air should be circulated around them as they stand on end, fanned open.

9. Drying Stages & Process

The choice of method depends on the volume, value, and type of material.

1. **Triage and Stabilization:**

- Separate wet materials from damp and dry.
- Identify high-priority items (coated paper, soluble ink).
- Immediately freeze anything that cannot be treated within the 48-hour window. This is the default, safest action for large collections. Pack items in wax paper-lined crates before freezing.

1. **Air-Drying (for small quantities of non-coated paper):**

- Create a drying "sandwich." Lay the wet sheet on a clean, absorbent, non-woven material (e.g., blotter paper, Spunbond Pellon).
- Place another absorbent layer on top.
- Change these absorbent layers frequently (every hour at first, then less often as the paper dries).
- Dry the paper under light restraint (e.g., a piece of glass or acrylic) to keep it flat.

1. **Book Drying:**

- If saturated, stand the book on its head on an absorbent surface to allow water to drain.
- When damp, stand the book on its end and fan the pages open to allow for air circulation.
- Interleaving with absorbent paper can speed the process, but should only be done if it does not bulk the book to the point of damaging the spine.
- Once just slightly damp, the book can be closed and placed under a light weight to dry flat.

1. **Vacuum Freeze-Drying (the preferred method for large quantities, coated papers, or valuable items):**

- Items are frozen solid.
- They are placed in a vacuum chamber.
- A vacuum is pulled, and a controlled amount of heat is applied to a platen, which causes the ice in the paper to sublimate. The water vapour is then collected on a super-chilled condenser plate.
- The result is dry, flat paper with minimal to no additional water damage.

10. Monitoring & Documentation

- **Inventory:** Create a detailed list of all affected items before any action is taken.
- **Photographs:** Document damage before treatment.
- **Environmental Logs:** Track temperature and RH in the drying space or freezer.
- **Visual Inspection:** Regularly check for any signs of mould during air-drying. Do not try to brush away wet mould, as this will smear it and spread spores. Mould on dry paper can be addressed later by a conservator.
- **Moisture Content:** For books, a moisture meter with long probes can be used (in a non-critical area like a flyleaf) to confirm dryness deep inside the text block.

11. Halting Conditions & Potential for Damage

- **Mould Growth:** If mould appears during air-drying, the item should be frozen immediately to halt growth.
- **Media Activation:** If inks begin to run or feather during air-drying, the item should be frozen immediately.
- **Adhesion:** If pages are found to be sticking, do not attempt to separate them by force. Freeze the item; a conservator may be able to separate them later, or they may require freeze-drying.

The greatest risks are inaction (leading to mould) and improper handling (trying to separate fused pages, or air-drying coated paper in a stack).

12. Mixed Materials & Complex Assemblies

Files and books are complex assemblies.

- **Bindings:** Leather or cloth bindings will react differently to water than the paper text block. Animal-hide adhesives will soften or dissolve. This can cause the boards to detach.
- **Metal Fasteners:** Staples, paper clips, and prong fasteners will rust, causing deep, irreversible staining and cementing pages together. These should be removed by a conservator if possible.
- **Photographs:** Photos mixed in with paper files have unique needs and must be separated and treated according to photographic conservation guidelines. They should not be freeze-dried with paper.

13. Current App Profile Assessment

- **Profile:** 5 pp/24h, review-only.
- **Analysis:** This metric is **even more dangerous and inappropriate for paper than for textiles.** It is fundamentally disconnected from every accepted best practice in paper conservation.
- **Reasoning:**

1. **Irrelevant to Freezing & Freeze-Drying:** The two most important, large-scale techniques for salvaging paper—freezing and vacuum freeze-drying—are entirely independent of ambient air moisture removal rates. The metric is meaningless in these contexts.
2. **Actively Harmful in Air-Drying:** For the one method where it might seem relevant (air-drying), it promotes damaging behaviour. Achieving a 5 pp/24h rate requires aggressive dehumidification, which would cause paper to dry too quickly, leading to extreme and irreversible cockling, embrittlement, and case-hardening of books.
3. **Ignores Physical Restraint:** The most critical factor in successful air-drying of paper is keeping it flat under physical restraint. The drying *rate* is secondary to the physical *control* of the object. This metric ignores the physical aspect entirely.

This metric demonstrates a profound misunderstanding of paper conservation principles and should be expunged. These rate figures are strictly for review and do not constitute published damage thresholds.

14. Recommended App Parameters (Proposed Profile)

The profile must be method-dependent, prioritizing stabilization and physical control.

Parameter	Current "Review-Only" Profile	Proposed Profile (`packout_required`)	Justification
Primary Metric	Pounds of water removed from air per 24h (pp/24h).	Method Selection: **Air-Dry vs. Freeze & Hold vs. Freeze-Dry.**	Prioritizes the critical decision-making process based on material type and scale of damage.

Parameter	Current "Review-Only" Profile	Proposed Profile (`packout_required`)	Justification
Drying Rate	Fixed, aggressive target.	**Air-Dry:** Slow, under physical restraint. **Freeze-Dry:** Determined by chamber cycle.	Aligns the rate with established, safe conservation methodologies.
Temperature	Not specified.	**Air-Dry:** <18°C. **Freeze:** <-20°C. **Freeze-Dry:** Chamber-specific.	Uses temperature as a critical tool for preservation (slowing mould) and stabilization (freezing).
Relative Humidity	Not specified.	**Air-Dry:** Stable at 35-50%. **Freeze-Dry:** N/A (vacuum).	Creates a safe, stable environment for the air-drying process.
Airflow	Not specified.	**Air-Dry:** Gentle, indirect, ambient.	Prevents physical damage and uneven drying.
Monitoring	Assumed complete when pp/24h rate is met.	Visual inspection for mould/adhesion; confirm physical dryness.	Focuses on the actual condition of the object, not an arbitrary environmental number.

15. Gaps, Overrides & Specialist Consultation

- **Gaps:** This profile is for stabilization. It does not include conservation treatments like page separation, stain reduction, mending, or rebinding.
- **Overrides:** Do not freeze certain photographic materials like glass-plate negatives, daguerreotypes, or tintypes. These require immediate, specialized attention from a photographic conservator.
- **Specialist Consultation is Mandatory For:**
- Large-scale incidents requiring freeze-drying logistics.
- Original manuscripts, artworks on paper, or records with high intrinsic value.
- Items with running inks, damaged seals, or other complex attachments.
- All photographic materials.

The environmental values in this chapter are triage conditions, not universal object limits. Paper collections can contain coated stock, water-soluble media, adhesives, seals, photographs, parchment, leather and mixed bindings that respond differently to water, freezing and drying. A decision to air-dry, freeze, vacuum freeze-dry or isolate must be recorded against the actual collection and incident. The room controller cannot infer those properties from temperature, RH or GPP, and an apparently stable room reading cannot establish that a bound volume or packed file is dry internally.

16. References

1. **U.S. National Archives and Records Administration (NARA).** "Wet Records." *Preservation.* (https://www.archives.gov/preservation/holdings-maintenance/wet-records)
2. **Library of Congress (LoC).** "Recovery." *Preservation, Emergency Management.* (https://www.loc.gov/preservation/emergprep/recovery.html)
3. **Library of Congress (LoC).** "Preservation Guidelines for Wet Collections." *Guides.* (https://guides.loc.gov/wet-collections)
4. **Library of Congress (LoC).** "Freezing and Drying of Wet Books and Records." *Guides.* (https://guides.loc.gov/wet-collections/freezing)
5. **Canadian Conservation Institute (CCI).** "Paper Objects - Guidelines for care." *Guidelines for collections.* (https://www.canada.ca/en/conservation-institute/services/preventive-conservation/guidelines-collections/paper-objects.html)
6. **Australian Institute for the Conservation of Cultural Material (AICCM).** "Flood." *Disaster Recovery.* (https://aiccm.org.au/disaster/flood/)

Claim-to-Source Table: Paper & Documents

Claim / Recommendation	Source (Reference #)	Justification / Corroboration
Coated papers will fuse if allowed to dry in a block; they are top priority.	Source 1 (NARA), Source 3 (LoC)	NARA and LoC both explicitly warn of this danger and prioritize the treatment of coated stock.
Freezing is the primary method for stabilizing large volumes of wet records.	Source 1 (NARA), Source 4 (LoC)	Both the National Archives and the Library of Congress detail freezing as the standard and essential first step for managing large-scale incidents.
Vacuum freeze-drying is the safest and most effective drying method.	Source 4 (LoC)	The LoC guide describes freeze-drying as the preferred method for minimizing damage and distortion, especially for valuable materials.

Claim / Recommendation	Source (Reference #)	Justification / Corroboration
Air-dry paper under light restraint (blotting) to prevent cockling.	Source 3 (LoC), Source 5 (CCI)	Standard conservation practice outlined by major institutions is to use absorbent materials and light pressure to keep paper flat as it dries.
Rust from metal fasteners causes irreversible staining.	Source 5 (CCI)	Care guidelines warn that metals in contact with wet paper will corrode and cause permanent damage.
The 48-hour window is critical to prevent mould.	Source 1 (NARA)	NARA's emergency guidelines stress the urgency of action within this timeframe to avoid microbial outbreak.
Rate-based environmental metrics are inappropriate for paper.	G3 Synthesis	This conclusion is derived from the fact that best practices (freezing, freeze-drying, drying under restraint) are entirely unrelated to ambient air dehumidification rates.

Artwork / Canvas

Research packet: gemini-g3-sensitive-contents.md | 2,747 words | 5 URL references | The packet is commentary for review, not a certified limit.

Scope: this chapter separates source-supported observations, operational assumptions, unresolved uncertainty, and field verification requirements for this material.

Profile Status: `specialist_required`

1. Material Identification

A painting on canvas is a complex, sensitive laminate structure, where each layer has a different chemical composition and responds to moisture and drying at a different, often conflicting, rate. Understanding this structure is key to understanding its vulnerability.

- **Support:** The backbone of the painting, typically a woven fabric of linen or cotton, stretched over a wooden frame (stretcher or strainer). The canvas provides the painting's tension but is also the component that reacts most dramatically to water.
- **Sizing:** A thin layer, traditionally animal hide glue, applied to the canvas. Its purpose is to shrink the canvas and reduce its absorbency. As a water-soluble glue, this layer is the painting's Achilles' heel; if it is compromised by water, everything on top of it will detach.
- **Ground:** One or more layers of primer (e.g., gesso, an oil-based primer) applied over the size. The ground provides a smooth, non-absorbent, and often white surface on which to paint. It is typically brittle and inflexible.
- **Paint Layer:** The image itself, composed of pigments suspended in a binder. The binder can be oil (linseed, poppy), egg (tempera), or a synthetic polymer (acrylic). Oil paint layers become increasingly brittle with age.
- **Varnish:** A final, transparent coating (traditionally a natural resin like dammar, now often a synthetic resin). The varnish is meant to saturate the colours and protect the paint layer, but it can also yellow, crack, and trap moisture, causing a cloudy appearance called blanching.

Each of these layers absorbs and releases moisture at a different rate. This differential movement is the fundamental cause of damage.

2. Moisture Behaviour & Characteristics

The entire painting structure is highly responsive to changes in relative humidity, and direct water exposure is a catastrophic event.

- **Canvas Shrinkage:** This is the most powerful and destructive force. The canvas support, being a textile, will swell when wet and then shrink with considerable force as it dries. The ground and paint layers, which are brittle and inflexible, cannot shrink with the canvas. The result is that the canvas shrinks *underneath* the paint, putting the paint layer under immense compressive stress.

- **Loss of Adhesion:** The sizing layer (hide glue) is hygroscopic and can soften or dissolve with prolonged exposure to water or high humidity. When this happens, the bond between the canvas and the ground/paint layers is lost. This is the root cause of flaking and paint loss.
- **Mechanical Stresses and Damage:** The forces described above manifest as specific, recognizable forms of damage:
- **Cracking:** The initial failure of the brittle upper layers.
- **Cupping:** The paint flakes between cracks form concave "dishes."
- **Tenting:** The paint lifts up along the crack lines, forming small "tents." This is a sign of imminent paint loss.
- **Flaking:** The paint detaches from the canvas entirely. Once a flake of paint is lost, the damage is permanent.
- **Varnish and Paint Layer Damage:** Moisture can become trapped in or under the varnish layer, causing a cloudy or milky appearance known as blanching. Some paint binders may also swell or soften with prolonged water exposure.

3. Exposure, Contamination & Salvage Priorities

Water damage to a painting is a conservation emergency of the highest order.

- **Primary Threat:** Irreversible paint loss due to loss of adhesion and mechanical stress. The goal of all first response is to prevent this.
- **Secondary Threats:**
- **Canvas Distortion:** Severe shrinking can cause the entire painting to warp and ripple.
- **Mould Growth:** Mould can grow on the reverse (back) of the canvas, on the wooden stretcher, or even within the paint layers themselves.
- **Contamination:** Dirt and contaminants from floodwater can become embedded in the softened paint or varnish layers, requiring painstaking cleaning by a conservator.
- **Staining:** Water can leach acidic materials from the wooden stretcher or backing boards, causing dark, disfiguring stains on the canvas.

Salvage Priority: Immediate and Absolute. A painting with active, lifting, or flaking paint is the highest possible priority in any salvage situation. The object must be stabilized to prevent any further loss. **This work requires a specialist.** On-site personnel should focus on stabilizing the environment and handling the object as little as possible.

4. Drying Objectives & Completion Criteria

The sole objective is to **dry the painting as slowly, evenly, and gently as humanly possible.** The goal is to allow the different layers of the complex structure to release moisture and adjust to their new dimensions at a uniform, less stressful rate. Speed is the enemy.

1. **Prevent Paint Flaking:** This overrides all other considerations. The entire process must be geared towards minimizing the mechanical stresses that cause paint loss.
2. **Maintain Planarity:** Avoid the canvas shrinkage and distortion that puts the upper layers at risk.
3. **Prevent Blanching and Staining:** Control moisture movement to avoid visual changes to the varnish and paint layers.
4. **Prevent Mould Growth:** Stabilize the environment to be inhospitable to mould.

Completion Criteria: A painting is considered dry when all its components have reached Equilibrium Moisture Content (EMC) with a stable environment (45-55% RH). This cannot be rushed and is determined only through careful, expert visual inspection, including checking the reverse of the canvas for any feeling of coolness (which indicates active evaporation) and ensuring the canvas tension is even.

5. Temperature Management

Cool and stable conditions are mandatory.

- **Ideal Range:** 18-20°C (65-68°F).
- **Rationale:** Low temperatures slow the rate of evaporation, which is the key to a slow, gentle drying process. It also slows mould growth and reduces the speed of chemical reactions.
- **Contraindications:**
- **NEVER freeze a painting.** The expansion of water into ice crystals within the porous structure of the ground and paint layers will cause them to physically shatter and turn to powder.
- **NEVER use heat.** Heat will cause rapid and catastrophic shrinkage of the canvas support, guaranteeing widespread cracking and flaking of the paint. It is the most destructive action possible.

6. Relative Humidity (RH) Management

This is the primary tool for controlling the drying rate. The process is one of extremely slow, gradual dehumidification.

- **Target Ambient RH:** The final goal is to stabilize the painting in an environment of 45-55% RH.
- **Process:** The change must be slow. A saturated painting should be moved to a room with a moderately high RH (e.g., 70-80%) to begin. Then, using a dehumidifier, the RH is lowered by no more than 5-10% per 24-hour period. This extremely slow pace allows the canvas, ground, and paint layers to release moisture and shrink back at a more uniform rate, minimizing the

differential stresses that cause damage. The entire process could take days or even weeks. An abrupt drop in RH is the equivalent of applying heat and will cause immense damage.

7. GPP, Dew Point, Vapour Pressure & Condensation Control

These technical parameters are managed simply by ensuring gentle air circulation and a slow, controlled reduction in RH. The goal is to maintain a very small, sustained vapour pressure differential between the painting and the air, encouraging a very slow release of moisture.

8. Airflow & Air-Moving Equipment

Airflow must be minimal, gentle, and completely indirect.

- **Method:** Use fans pointed away from the artwork, at walls or ceilings, simply to keep the room's air from becoming stagnant. The goal is gentle, ambient circulation.
- **Positioning:** A wet painting should be laid flat, face up, and raised on blocks to allow air to circulate underneath it. This prevents moisture from being trapped against a surface.
- **Contraindications:** Direct airflow is extremely dangerous. It will cause localized, rapid drying, leading to cracking. For a painting with actively flaking paint, even a gentle breeze can dislodge and blow away loose flakes of paint, resulting in permanent loss.

9. Drying Stages & Process

1. **Specialist Consultation:** The first step is to call a paintings conservator. All subsequent steps are about stabilizing the object until they arrive.
2. **Stabilization of Flaking Paint:** If paint is actively lifting or flaking, the painting must be kept horizontal, face up. Do not touch the surface or attempt to remove any debris. Any vibration or movement can cause more loss.
3. **Surface Water Removal:** If there is pooled water on the surface, it can be wicked away from the edges using the corner of an absorbent blotter, *without touching the paint surface*. The reverse of the canvas can be gently blotted to remove excess water.
4. **Controlled Environment Drying:** Move the painting to a dedicated, secure space. Set up a data logger to monitor T/RH. Use dehumidifiers and fans to execute the extremely slow RH reduction protocol described above.
5. **Monitoring:** Constant, careful visual inspection is the key. This requires a trained eye.

10. Monitoring & Documentation

- **Raking Light Examination:** This is a critical diagnostic tool. By shining a light source at a very low, oblique angle to the painting's surface, a conservator can see subtle changes in topography, such as the first signs of lifting or tenting paint, which might be invisible in normal, direct light.

- **Photographic Record:** Extensively document the condition of the painting from all angles, including with raking light, before and during the drying process.
- **Environmental Data:** Maintain a continuous log of the temperature and RH in the drying space.

11. Halting Conditions & Potential for Damage

The process must be immediately halted and a conservator consulted if:

- **Any new lifting, flaking, or tenting of paint is observed.** This is a red-alert condition. It may be necessary to raise the RH again to relax the painting before the paint can be consolidated (re-adhered) by a conservator.
- **The canvas begins to visibly distort, ripple, or draw.** This indicates the drying rate is too fast.

The greatest potential for damage is a rapid drying rate. The bond between the ground and the canvas is the weak link in the structure, and any differential stress will cause it to fail. There is no "safe" fast way to dry a painting.

12. Mixed Materials & Complex Assemblies

A painting is the quintessential complex assembly. The entire conservation challenge stems from the different rates of expansion and contraction of the canvas, glue size, gesso ground, oil paint, and varnish. Modern paintings can be even more complex, incorporating materials like paper collage, metal, wood, or found objects, each with its own unique and often conflicting drying needs, further underscoring the need for expert intervention.

13. Current App Profile Assessment

- **Profile:** 3 pp/24h, review-only.
- **Analysis:** This profile is **catastrophically inappropriate and guarantees damage.** It represents a profound and dangerous lack of understanding of the material science of paintings.
- **Reasoning:**

1. **Encourages Rapid Drying:** While nominally "slower" than the 5 pp/24h profile, this is still an astronomically aggressive drying rate for a painting. A painting may need to dry over a period of weeks, meaning its actual moisture release rate is a tiny fraction of this target. Attempting to meet this environmental target would destroy the painting.
2. **Ignores the Unanimous Conservation Principle:** All conservation literature, without exception, is clear on this point: paintings must be dried as slowly as possible. This metric encourages the opposite.
3. **Creates a False Sense of Security:** A technician might believe they are being "careful" by using a lower pp/24h rate, while in reality they are implementing a procedure that ensures damage will occur. It is dangerously misleading.

4. **Uncontrollable and Irrelevant:** There is no way to correlate a bulk air-moisture removal rate with the safe, differential release of moisture from a complex laminate object like a painting.

This metric must be deleted. It has no place in any procedure involving cultural artifacts. These rate figures are strictly for review and do not constitute published damage thresholds.

14. Recommended App Parameters (Proposed Profile)

The profile must be based on a principle of minimal environmental change over a long duration. It must be controlled by a human expert.

Parameter	Current "Review-Only" Profile	Proposed Profile (`specialist_required`)	Justification
Primary Metric	Pounds of water removed from air per 24h (pp/24h).	**Rate of RH Change (% per 24h) and Visual Stability.**	Focuses on the direct cause of damage (rate of change) and the actual object condition.
Drying Rate	Fixed, aggressive target (e.g., 3 pp/24h).	**Extremely Slow.** Maximum RH drop of **5% per 24 hours.**	This is the core principle. The process must be incredibly slow to prevent differential shrinkage.
Temperature	Not specified.	**18-20°C (65-68°F), stable.**	Prevents heat damage and slows evaporation to a controllable rate.
Relative Humidity	Not specified.	**Extremely gradual reduction from ambient to a stable 45-55%.**	This is the primary control mechanism for slowing the drying process.
Airflow	Not specified.	**Minimal, indirect, ambient circulation only.**	Prevents physical damage to loose paint flakes and avoids localized over-drying.
Monitoring	Assumed complete when pp/24h rate is met.	**Daily visual inspection with raking light by a paintings conservator.**	Emphasizes that expert human judgment, not an environmental metric, is the only way to assess completion.

15. Gaps, Overrides & Specialist Consultation

- **Gaps:** This profile is solely for the *first aid and stabilization* of a water-damaged painting. It is not a conservation treatment. It does not include essential conservation work like consolidating flaking paint, relaxing a distorted canvas, removing blanched varnish, or cleaning the surface, all of which require a trained conservator.
- **Overrides: Do not touch the surface of a wet painting.** If the paint surface is damaged or has debris on it, it is safer to leave the debris in place than to risk grinding it into the softened paint.
- **Specialist Consultation is Mandatory in ALL cases of water-damaged paintings.** There is no scenario in which a non-conservator should be managing the drying of a water-damaged painting. The role of on-site personnel is to create a stable environment and prevent further harm until the expert arrives.

The numeric examples in this chapter must not be converted into an unattended room-control profile. They describe conservation environments and triage concepts, while each painting's support, ground, media, varnish, frame, prior treatment and present condition determine the safe response. The app should record the selected specialist workflow and the environmental observations, but should keep structural-drying equipment control blocked. Any temporary environmental plan must identify its author, approval time, monitoring interval, stop observations and superseding instructions so later reviewers can distinguish specialist direction from the app's default policy.

16. References

1. **Canadian Conservation Institute (CCI).** "Emergency Treatment for Water-Damaged Paintings on Canvas." *Canadian Conservation Institute Notes 10/5.* (https://www.canada.ca/en/conservation-institute/services/conservation-preservation-publications/canadian-conservation-institute-notes/emergency-treatment-water-damaged-paintings.html)
2. **Canadian Conservation Institute (CCI).** "Paintings - Guidelines for care." *Guidelines for collections.* (https://www.canada.ca/en/conservation-institute/services/preventive-conservation/guidelines-collections/paintings.html)
3. **Canadian Conservation Institute (CCI).** "Environmental and Display Guidelines for Paintings." (https://www.canada.ca/en/conservation-institute/services/conservation-preservation-publications/canadian-conservation-institute-notes/environmental-display-guidelines-paintings.html)
4. **Australian Institute for the Conservation of Cultural Material (AICCM).** "Flood." *Disaster Recovery.* (https://aiccm.org.au/disaster/flood/)
5. **U.S. Environmental Protection Agency (EPA).** "Mold Remediation in Schools and Commercial Buildings." Chapter 2. (https://www.epa.gov/mold/mold-course-chapter-2)

Claim-to-Source Table: Artwork & Canvas

Claim / Recommendation	Source (Reference #)	Justification / Corroboration
Canvas shrinkage under the brittle paint/ground layer is the primary cause of damage.	Source 1 (CCI)	Note 10/5 describes this mechanism of canvas drawing and causing cleavage and cracking in the upper layers.
Never freeze a painting; Never use heat.	Source 1 (CCI)	Note 10/5 explicitly lists these as actions "What Not To Do," as they cause catastrophic damage.
Drying must be as slow as possible, with a very gradual RH reduction to 45-55%.	Source 1 (CCI), Source 3 (CCI)	Note 10/5 details the "Controlled Drying" procedure, which is slow. The target RH is based on general environmental guidelines for paintings.
Specialist consultation is mandatory in all cases of wet paintings.	Source 1 (CCI), Source 4 (AICCM)	Both CCI's emergency guide and AICCM's disaster advice stress that paintings require immediate professional conservation attention.
Use raking light to inspect for flaking or lifting paint.	Source 2 (CCI)	General care guidelines for paintings recommend raking light as a standard examination technique for assessing surface topography.
Keep paintings with flaking paint horizontal and face up.	Source 1 (CCI)	Note 10/5 specifies this orientation to prevent gravity from pulling loose flakes off the surface.
Rate-based pp/24h metrics are catastrophic for paintings.	G3 Synthesis	This is a conclusion derived from the universal conservation principle that paintings must be dried extremely slowly. Any metric that encourages speed is antithetical to this.

Claim / Recommendation	Source (Reference #)	Justification / Corroboration
Mould can grow on the back of the canvas or stretcher bars.	Source 5 (EPA)	General principles of mould growth on porous materials (wood, fabric) in damp conditions apply directly to the components of a painting.

Cross-cutting psychrometric method

Psychrometric Principles and Control Strategies for an Automated Structural Drying Controller

A Technical Report for the Australian Structural Drying Industry

Author: Gemini Research Agent G4 (Psychrometrics and Equipment Specialist) **Date:** 22 July 2026
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Executive Summary

This report provides a comprehensive technical analysis of the psychrometric principles, equipment specifications, and control strategies essential for an advanced, automated structural drying controller tailored for the Australian market. It establishes a framework grounded in authoritative sources—including IICRC/AS-IICRC standards, ASHRAE fundamentals, and peer-reviewed literature—to ensure drying processes are rapid, efficient, and safe for building materials.

The core of effective drying is the management of energy to manipulate the **vapour pressure differential** between wet materials and the surrounding air. This is achieved by controlling four key environmental factors: dehumidification, airflow, temperature, and extraction. The report details the critical psychrometric variables that must be tracked, including temperature, relative humidity (RH), humidity ratio (GPP), dew point, and vapour pressure. It strongly recommends using **humidity ratio (Grains Per Pound - GPP)** and **Vapor Pressure Deficit (VPD)** as the primary drivers for control logic, as these absolute metrics are not susceptible to the situational ambiguity of relative humidity.

A critical assessment of the proposed controller design reveals a solid foundation but identifies key areas for improvement. The design's reliance on RH-based caps and simple timers can be enhanced with more dynamic, physics-based logic. Recommendations focus on shifting the control strategy towards GPP depression, VPD targets, and real-time rate-of-drying estimations. This approach allows the controller to be more responsive to the actual drying progress and less prone to premature shutdowns or material-damaging "over-drying."

The report puts forward a new controller decision hierarchy that prioritizes material safety through dew point and surface temperature monitoring, while optimizing for speed. It includes specific equations, recommended parameter values with confidence levels, and a robust validation and commissioning plan. By implementing these strategies, the controller can achieve faster, more predictable drying outcomes, reduce energy consumption, and provide a verifiable, data-driven record of the drying process, consistent with the highest standards of the Australian restoration industry.

1.0 Introduction

1.1 Purpose and Scope

The purpose of this document is to provide a rigorous engineering and scientific foundation for the development of an automated structural drying controller. It is specifically tailored to the diverse climatic conditions and building materials found in Australia. The scope of this report encompasses:

1. **Foundational Science:** A detailed review of the psychrometric principles that govern the movement of moisture in building systems.
2. **Equipment Analysis:** An examination of the operational envelopes and best-use cases for drying equipment, including dehumidifiers, air movers, and heating elements.
3. **Measurement and Sensors:** Best practices for sensor placement, calibration, sampling cadence, and material moisture measurements, aligned with AS-IICRC S500 standards.
4. **Controller Design Critique:** A critical assessment of the proposed controller logic, identifying strengths, weaknesses, and potential failure modes.
5. **Advanced Strategy Proposal:** The development of an improved controller hierarchy, complete with equations, recommended parameters, and strategies for handling system dynamics like hysteresis, lag, and sensor noise.
6. **Validation Framework:** A plan for the commissioning and validation of the controller in real-world scenarios.

1.2 Target Audience

This report is intended for software engineers, control systems designers, and project managers involved in developing the structural drying controller. It assumes a technical background but provides the specific domain knowledge required for the water damage restoration industry.

1.3 Methodology

The findings and recommendations in this report are synthesized from a range of authoritative sources, including but not limited to:

- **Industry Standards:** IICRC and AS-IICRC S500 Standard for Professional Water Damage Restoration.
- **Scientific Handbooks:** ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) publications on the fundamentals of psychrometrics.
- **Government Metrology:** Research from NIST (National Institute of Standards and Technology) on humidity and moisture measurement.
- **Peer-Reviewed Literature:** Academic journals focusing on drying kinetics, hygrothermal stress in materials, and advanced control systems.
- **Manufacturer Specifications:** Technical manuals from leading equipment manufacturers (e.g., Dri-Eaz, Phoenix, Seibu Giken).

2.0 Fundamentals of Psychrometrics for Structural Drying

Psychrometrics is the science of the physical and thermal properties of moist air. In structural drying, it is the toolkit used to create an environment where water moves from wet materials into the air, where it can be captured and removed. An effective controller must be built on a solid understanding of these principles.

2.1 Key Psychrometric Variables

Variable	Definition	Unit	Role in Drying Control
Temperature (Dry-Bulb)	The measure of sensible heat in the air.	°C	**Primary Driver.** Warmer air increases the energy and carrying capacity for moisture. Warmer materials release moisture faster.
Relative Humidity (RH)	The amount of water vapour in the air, as a percentage of the maximum it could hold at that temperature.	%	**Secondary/Safety Metric.** Useful for microbial risk (mold grows >60% RH) but misleading for drying progress. A poor primary control variable.
Humidity Ratio / Grains	The absolute weight of water vapour in a given weight of dry air.	GPP	**Primary Control Metric.** Unaffected by temperature, it is the most accurate measure of how much water is actually in the air. Used to measure dehumidifier performance.
Dew Point	The temperature at which air becomes 100% saturated and water condenses out.	°C	**Critical Safety Metric.** Surface temperatures must be kept above the air's dew point to prevent secondary condensation damage.

Variable	Definition	Unit	Role in Drying Control
Vapour Pressure	The pressure exerted by water vapour in the air.	kPa	**The "Engine" of Drying.** Moisture moves from high vapour pressure (wet materials) to low vapour pressure (dry air). The differential dictates the speed of drying.
Enthalpy	The total heat energy (sensible + latent) in the air.	kJ/kg	**Efficiency Metric.** Represents the total energy that must be removed by a dehumidifier's cooling coils. Useful for performance calculations.

2.2 The Superiority of Absolute Humidity (GPP/g/kg) over Relative Humidity (RH)

A common and critical mistake in environmental control is to use Relative Humidity (RH) as the primary measure of "dryness." RH is a measure of how saturated the air is with water vapor *relative* to its maximum capacity at its *current* temperature. This temperature dependency makes it a deeply misleading metric for tracking drying progress.

2.2.1 The Flaw of Relative Humidity: An Illustrative Example

Consider two isolated rooms undergoing drying:

- **Room A:** 20°C (68°F) and 70% RH
- **Room B:** 30°C (86°F) and 70% RH

An RH-only meter would suggest both environments are equally "humid." However, calculating the **absolute humidity**—the actual mass of water vapor present in a mass of air (measured in grams per kilogram (g/kg) or grains per pound (GPP))—reveals the truth:

- **Room A (20°C, 70% RH):** Contains approximately **10.2 g/kg** (71 GPP) of water vapor.
- **Room B (30°C, 70% RH):** Contains approximately **18.8 g/kg** (132 GPP) of water vapor.

Despite having the same 70% RH, Room B contains over 84% more actual water vapor than Room A. This means Room B has a much higher moisture load, a higher dew point, and requires significantly more dehumidification to dry out. Relying on RH alone would lead to a gross underestimation of the work required in Room B.

2.2.2 The "Dry Air" Illusion

The temperature dependency of RH can also create a false sense of progress. Let's continue with the example of Room A. If we use a heater to warm the air from 20°C to 30°C but perform no dehumidification, the amount of water in the air remains unchanged at 10.2 g/kg. However, the Relative Humidity would plummet:

- **Heated Room A (30°C, 10.2 g/kg of water):** The new RH is approximately **38.5%**.

The air would now *feel* much drier, and an RH-based control system might incorrectly shut off the dehumidifier, believing the drying target has been met. In reality, not a single drop of water has been removed from the room. This demonstrates that using RH as a shut-off trigger is a flawed strategy that can lead to premature termination of the drying process, leaving residual moisture hidden within structural materials.

2.2.3 GPP as the True Metric

Absolute humidity (g/kg or GPP) is the only reliable metric for managing a structural drying project. It is an objective measure of the mass of water vapor in a given mass of air, independent of temperature fluctuations. By tracking g/kg, a controller can:

- **Accurately measure progress:** A decreasing g/kg value confirms that water is being physically removed from the closed drying system.
- **Gauge equipment performance:** The difference in g/kg between the air entering and leaving a dehumidifier is the most direct measure of its real-world water removal efficiency.
- **Set reliable drying targets:** Achieving a target g/kg ensures the project is complete, regardless of the temperature inside the structure.

Conclusion: The controller must use **GPP (or g/kg)** to track actual moisture removal and **RH** as a secondary check for microbial risk (e.g., keeping RH < 60% where possible) and to avoid material damage at very low RH levels (<20-25%).

3.0 The Physics of Drying

3.1 Vapor Pressure Deficit (VPD) - The Engine of Drying

Evaporation—the process that underpins all structural drying—is driven by a difference in vapor pressure between the wet material and the surrounding air. **Vapor Pressure Deficit (VPD)** is the physical quantity that measures this difference and thus represents the "drying power" or "thirst" of the air.

It is formally defined as the difference between the **saturation vapor pressure (`es`)** at a given air temperature and the **actual vapor pressure (`e`)** of the air.

```
VPD = es - e
```

- **Saturation Vapor Pressure (`es`):** The maximum pressure that water vapor would exert if the air were fully saturated at its current temperature. `es` is a direct function of temperature; it increases exponentially as temperature rises.
- **Actual Vapor Pressure (`e`):** The pressure that the water vapor in the air is currently exerting. It is determined by the absolute amount of moisture in the air (i.e., the dew point).

Water at the surface of a wet material exerts a vapor pressure that is at or very near the saturation point (`es`) for that material's surface temperature. The surrounding air has a lower, actual vapor pressure (`e`). Because systems in nature seek equilibrium, this pressure differential forces water molecules to leave the material's surface and enter the air as vapor. Therefore, the VPD of the air is the direct measure of this drying potential. A larger VPD indicates a greater pressure difference and results in a faster rate of evaporation.

3.1.1 How the Controller Manipulates VPD

The core task of an intelligent drying controller is to create and maintain the maximum *safe* VPD to accelerate drying. It accomplishes this by manipulating the two variables in the VPD equation:

1. **Lowering Actual Vapor Pressure (`e`):** This is achieved through **dehumidification**. As dehumidifiers remove water vapor from the air, the mass of water decreases, which directly reduces the actual vapor pressure (`e`). This increases the `es - e` differential, enhancing the air's thirst.
2. **Increasing Saturation Vapor Pressure (`es`):** This is achieved through **heating**. Since `es` is solely dependent on temperature, warming the air and the wet materials significantly increases the saturation vapor pressure. This dramatically increases the `es - e` differential, boosting the potential for evaporation.

An example demonstrates how temperature impacts VPD, even when relative humidity is constant.

- **Scenario 1: Cool, Dry Air:** 20°C, 40% RH
- `es` (at 20°C) ≈ 2.34 kPa
- `e` (at 40% RH) ≈ 0.94 kPa
- **VPD** = 2.34 - 0.94 = **1.40 kPa**
- **Scenario 2: Warm, Dry Air:** 30°C, 40% RH
- `es` (at 30°C) ≈ 4.25 kPa
- `e` (at 40% RH) ≈ 1.70 kPa
- **VPD** = 4.25 - 1.70 = **2.55 kPa**

By increasing the temperature by just 10°C, the drying power of the air (its VPD) has increased by over 82%. The controller's ultimate function is to find the optimal and safest balance: applying as much heat as possible to maximize the VPD, while using aggressive dehumidification to keep the actual vapor content low enough to prevent condensation.

3.2 Dew Point, Surface Temperature, and Condensation Risk

3.2.1 The Physics of Condensation

Condensation is the physical process of water vapor in the air changing into liquid water. Its occurrence is governed by the relationship between air temperature, water vapor content, and the temperature of surfaces within an environment. If a surface within the environment is at a temperature equal to or below the dew point of the surrounding air, the air in direct contact with that surface will be cooled to its saturation point. This forces the excess water vapor out of the air and onto the surface in the form of liquid water.

3.2.2 Condensation as a Risk in Structural Drying

In a water damage restoration project, uncontrolled condensation represents a significant risk that can undermine the drying effort and introduce new problems, often referred to as "secondary damage."

- **Secondary Water Damage:** Condensation can form on previously unaffected, non-porous surfaces like vinyl flooring, vapor barriers, or window frames, creating new areas of damage.
- **Mold Growth:** The introduction of moisture to previously dry organic materials creates ideal conditions for mold amplification.
- **Damage to Fixtures and Systems:** Condensation on metal surfaces can lead to corrosion, rust, and potentially hazardous electrical short circuits.

Example Scenario: A restorer uses aggressive heating in a basement with cool concrete walls. The air becomes warm and laden with moisture. However, the concrete foundation walls remain cold, with a surface temperature far below the elevated dew point of the hot, humid air. As the moisture-rich air circulates, it makes contact with the cold concrete, causing large amounts of condensation to form on the walls, soaking previously dry materials.

3.2.3 Active Condensation Management

A sophisticated drying controller must actively prevent condensation. The control strategy involves three key elements:

1. **Real-Time Dew Point Calculation:** The controller must constantly calculate the dew point of the air.
2. **Surface Temperature Monitoring:** The system relies on data from surface temperature sensors, or manual input from a technician using an infrared (IR) thermometer, to know the temperature of high-risk materials.
3. **Defining a Condensation Safety Margin:** The controller operates based on a "Dew Point Differential." A common standard is to ensure the surface temperature is always a minimum of 3°C (approx. 5°F) above the dew point of the air (`Surface Temperature >= Dew Point + 3°C`).

When this safety margin is breached, the controller must execute a priority-based response:

- **Priority 1: Eliminate Auxiliary Heat:** The controller immediately shuts down all heating elements.

- **Priority 2: Maximize Dehumidification:** The controller ensures all dehumidifiers are operating at maximum capacity to directly lower the dew point.

4.0 Core Psychrometric Equations

Accurate environmental control requires precise, repeatable calculations. The controller must use well-established formulas rather than simple approximations.

4.1 Dew Point and Vapor Pressure

For high precision, the **Arden Buck equations** are a preferred standard for calculating saturation vapor pressure (`es`) and, subsequently, actual vapor pressure (`e`). They offer very low error over the range of temperatures encountered in drying scenarios.

- **Saturation Vapor Pressure (`es`) over water (T > 0°C):**

`es = 0.61121 * exp((18.678 - T/234.5) * (T / (257.14 + T)))` (where `es` is in kPa, T is in °C)

- **Actual Vapor Pressure (`e`):**

`e = es * (RH / 100)` (where RH is in %)

- **Dew Point (`Td`):**

A precise calculation of Dew Point involves inverting the saturation vapor pressure formula. A common and accurate implementation is the **Magnus-Tetens formula**: `Td = (b * α(T, RH)) / (a - α(T, RH))` where: `α(T, RH) = (a * T / (b + T)) + ln(RH / 100)` and constants `a = 17.27`, `b = 237.7 °C`.

4.2 Humidity Ratio (W)

The humidity ratio is the mass of water vapor per unit mass of dry air. This is the critical absolute measure of moisture content.

- **Calculation:**

`W = (621.98 * e) / (P - e)` (where W is in g/kg, `e` and atmospheric pressure `P` are in the same units, e.g., kPa. `P` can be assumed to be 101.325 kPa at sea level).

- **Conversion to Grains Per Pound (GPP):**

`W_gpp = W_g_kg * 7` (since 1 g/kg ≈ 7 GPP)

5.0 Equipment and Measurement for Drying Control

5.1 Dehumidifier Types and Operating Envelopes

Dehumidifier Type	Operating Principle	Optimal Range (Australia)	GPP Floor	Use Case
Conventional Refrigerant	Single-stage condensation coil.	20°C - 32°C, >60% RH	~55 GPP	Early-stage drying in warm, humid climates (e.g., QLD summer). Prone to frosting in cool conditions.
Low-Grain Refrigerant (LGR)	Dual-stage cooling (pre-cooler + main coil) for greater efficiency.	10°C - 35°C, >40% RH	~34 GPP	**Industry Standard.** Versatile for most Australian conditions. Essential for achieving low GPP targets.
Desiccant (Adsorption)	Silica gel wheel adsorbs moisture; a heater "reactivates" the gel.	-10°C - 40°C	<10 GPP	**Specialty.** Required for cold environments (e.g., VIC/TAS winters), dense materials (concrete, hardwood), and achieving very low humidity levels.

5.2 Airflow and Air Changes

Air movers (fans) are essential for accelerating evaporation by disrupting the cool, saturated "boundary layer" at a wet material's surface. The goal is not just to "exchange" the air, but to ensure all wet surfaces are exposed to direct, turbulent airflow.

5.3 The Role of Heat

Heat is a powerful accelerator but also a significant risk.

- **Benefits:** Increases the VPD, dramatically increasing the rate of evaporation.

- **Risks:** Can cause permanent damage to materials, accelerate microbial growth if humidity is not controlled, and push LGR dehumidifiers outside their optimal temperature envelope.

5.4 Material Moisture Measurements

The ultimate goal is to dry the materials, not just the air. As per AS-IICRC S500, a "dry standard" must be established by measuring an unaffected reference material on site. The controller should have a feature to log these manual readings to track progress and verify completion.

6.0 Sensor Uncertainty and Error Propagation

6.1 Typical Sensor Specifications

The controller will likely utilize CMOS MEMS sensors with typical specifications of:

- **Temperature Accuracy:** ±0.2°C
- **Relative Humidity Accuracy:** ±1.8% RH

While precise (repeatable), this small accuracy tolerance in the primary measurements can propagate into larger errors in the derived psychrometric values.

6.2 Error Propagation Analysis: A Quantitative Example

Let's consider a drying environment with sensor readings of **25.0°C** and **60.0% RH**. We will analyze how the calculated Dew Point and GPP vary across the sensor's tolerance range.

Parameter	Lower Bound (T-0.2°C, RH-1.8%)	Nominal Reading	Upper Bound (T+0.2°C, RH+1.8%)	Total Uncertainty
Temperature (°C)	24.8	25.0	25.2	**0.4**
Rel. Humidity (%)	58.2	60.0	61.8	**3.6**
Dew Point (°C)	16.04	16.71	17.37	**1.33**
GPP (grains/lb)	79.63	83.26	86.99	**7.36**

Analysis: A small, acceptable sensor tolerance can create an uncertainty of **7.36 GPP**. If the controller's hysteresis band is narrower than this, it may make incorrect decisions based entirely on this propagated error.

6.3 Mitigation Strategies

1. **Use High-Quality Sensors:** Specify high-quality, individually calibrated sensors.
2. **Sensor Calibration Offset:** Allow a technician to apply a correction factor to the sensor readings.

3. **Time-Series Analysis:** Use rolling averages over a 30-60 minute window to smooth out fluctuations and sensor noise, ensuring decisions are based on stable trends.

7.0 Advanced Control Strategies

7.1 The Primary Control Variable: GPP Depression

The single most effective measure of drying system performance is **GPP Depression**: the difference between the GPP of the air entering and leaving the dehumidifiers (`GPP_depression = GPP_in - GPP_out`). The controller should aim to *maximize* GPP depression. A falling depression indicates either struggling equipment or a slowing evaporation rate.

7.2 Measuring and Optimizing for Efficiency

An advanced controller can move beyond simple setpoint management by calculating and optimizing for drying efficiency.

- **Moisture Removal Rate (MRR):** The volume of water removed over time, typically in Liters per Day.
- **Energy Factor (EF):** The energy efficiency of the dehumidifier, measured in Liters per Kilowatt-hour (L/kWh).

By monitoring these metrics (requiring airflow and power sensors), the controller can:

- **Track Peak Efficiency:** Keep the dehumidifier in its most efficient operating band.
- **Detect Diminishing Returns:** Identify when running the equipment is no longer cost-effective.
- **Inform Equipment Selection:** Provide data to suggest switching from a refrigerant to a desiccant unit when conditions warrant.

8.0 Equipment Cycling, Hysteresis, and Protection

An intelligent controller must manage equipment to preserve its lifespan and account for its mechanical realities.

8.1 Compressor Protection

For refrigerant dehumidifiers, the leading cause of premature compressor failure is **short cycling** (turning on and off too frequently). This leads to lubrication failure and overheating. The controller **must** enforce non-negotiable timing rules:

- **Minimum Off-Time:** A 3-5 minute lockout period after shutdown to allow for refrigerant pressure equalization.
- **Minimum On-Time:** A 5-10 minute minimum run time once started to ensure proper oil return.

8.2 Hysteresis (Differential/Deadband)

To prevent the system from "hunting" around a setpoint, a **hysteresis band** is essential. It introduces two different setpoints: one to turn equipment ON and another to turn it OFF.

- **Example:** With a target of **50 GPP** and a **5 GPP hysteresis band**:
- **Turn ON Condition:** `Ambient_GPP > 55 GPP`
- **Turn OFF Condition:** `Ambient_GPP < 50 GPP`

The hysteresis band must be wider than the maximum expected propagated sensor error (>7.4 GPP in our example) to ensure the control loop is not just reacting to sensor noise.

8.3 Handling Dehumidifier Defrost Cycles

Coil frosting is a normal reality for refrigerant dehumidifiers. During a defrost cycle, the unit will release a plume of cool, humid air. The controller must be able to handle this event intelligently:

1. **Detect the Cycle:** Use a digital status signal from the dehumidifier if available.
2. **Suspend Control Logic:** Temporarily suspend the normal GPP/temperature control loop.
3. **Log the Event:** Record the defrost as a normal event.
4. **Wait and Reassess:** After the cycle, wait for a stabilisation period (e.g., 10-15 minutes) before resuming control.

9.0 Critical Analysis of the Proposed Controller Design

Proposed Feature	Assessment	Recommended Improvement
Fresh environmental sensor required	**Good.**	Define a "stale data" timeout (e.g., 60-90 minutes) after which the system enters a safe/idle state.
Minimum 5 readings spanning 30 mins	**Good.**	Use a rolling average as discussed in Mitigation Strategies.
Rolling ambient RH-drop caps	**Weak.**	**Replace with GPP-based caps.** The primary metric for progress must be the reduction in absolute humidity.

Proposed Feature	Assessment	Recommended Improvement
Warn at 75% RH, OFF at 90% RH	**Insufficient.**	**Replace with a Dew Point-based override.** If `Surface_Temp - Current_Dew_Point < Dew_Point_Safety_Margin`, the system must take immediate action.
Restart below 60% RH	**Acceptable, but can be improved.**	The restart logic should be based on the GPP level rising above the control band, not just RH.
Drying Caps (50%, 100%, 50%)	**Conceptually Good, Implementation Weak.**	**Re-implement caps based on GPP and Rate of Drying.** The "bulk" phase should focus on maximum GPP reduction. The "equalising" phase should begin when the *rate* of GPP reduction slows significantly.
Absolute temp ceiling and RH floor	**Excellent.**	The temperature ceiling should be configurable based on the primary materials.
Mixed rooms use most conservative limits	**Excellent.**	No change needed.
Completion requires comparative material readings	**Excellent.**	The controller should require at least two stable readings, taken at least 12-24 hours apart with the equipment off, to confirm the material is at equilibrium.

10.0 Proposed Controller Decision Hierarchy

This hierarchy prioritizes safety, then effectiveness, then efficiency.

Level 1: Safety Overrides (Checked every cycle)

1. Is `Current_Temp` > `Material_Max_Temp`? -> **Turn OFF all heaters.**
2. Is `Current_RH` < `Material_Min_RH`? -> **Turn OFF all dehumidifiers and heaters.**
3. Is `Surface_Temp` - `Current_Dew_Point` < `Dew_Point_Safety_Margin`? -> **Turn OFF all heaters.**
4. Is sensor data stale? -> **Enter safe/idle mode and alert user.**

5. Is dehumidifier compressor in a minimum off-time state? -> **Prevent restart.**

Level 2: Primary Drying Loop (Operating Mode)

1. **Calculate Rolling Averages:** Determine the stable, averaged `Ambient_GPP`, `Ambient_Temp`.
2. **Determine Target GPP:** Based on the current drying phase (Bulk, Equalising, Finishing).
3. **Compare Ambient vs. Target:**

- If `Ambient_GPP` > `Target_GPP` + `Hysteresis_Band`:
- Engage Dehumidifiers.
- Engage Air Movers.
- If `Ambient_Temp` < `Target_Temp` AND dew point safety margin is healthy, engage heaters.
- If `Ambient_GPP` < `Target_GPP` - `Hysteresis_Band`:
- Disengage Dehumidifiers and Heaters.
- Keep Air Movers running for a short "coast" period (e.g., 15 mins) to circulate air, then disengage.

Level 3: Phase Transition Logic (Checked periodically, e.g., every 4-6 hours)

1. **Calculate Rate of GPP Change:** `GPP_Rate = ΔGPP / Δtime`.
2. **Check for Phase Change:**

- If in **Bulk Phase** and `GPP_Rate` falls below a threshold (e.g., < 2 GPP/hour) for a sustained period -> **Transition to Equalising Phase.**
- If in **Equalising Phase** and manual material moisture readings are close to the dry standard -> **Transition to Finishing Phase.**

1. **Check for Completion:**

- If two consecutive manual material readings (at least 12 hours apart, with equipment off) are at or below the dry standard -> **Declare Completion.**

11.0 Recommended Parameters

Parameter	Recommended Value	Confidence	Justification
Safety Temp Ceiling (General)	35°C	High	Prevents damage to most common household materials.
Safety RH Floor	25%	High	Prevents over-drying of hygroscopic materials like wood.
Dew Point Safety Margin	3°C	Medium	A conservative value. Can be lowered with more precise surface temp data.

Parameter	Recommended Value	Confidence	Justification
Sensor Cadence	5 minutes	High	Balances responsiveness with noise reduction.
Decision Averaging Window	30 minutes	High	Ensures stability and prevents reaction to transient fluctuations.
Compressor Min OFF Time	3 minutes	High	Standard industry practice for equipment protection.
Compressor Min ON Time	5 minutes	High	Standard industry practice for equipment protection.
GPP Hysteresis Band	10 GPP	Medium	Must be wider than the propagated sensor error.
Initial Target GPP (Bulk Phase)	40-50 GPP	Medium	An aggressive but achievable initial target for LGR dehumidifiers.
Stale Data Timeout	90 minutes	Medium	A reasonable timeframe; depends on desired responsiveness vs. fault tolerance.

12.0 Expanded Validation and Commissioning Plan

This section outlines a two-phase plan to safely validate, deploy, and tune the controller, ensuring its logic is sound, its performance is reliable, and its operation is optimized for real-world conditions.

Phase 1: Pre-Deployment (Laboratory/Benchtop) Validation

Objective: To verify the controller's core logic and hardware I/O in a controlled, off-site environment before it is exposed to live project conditions.

12.1. Sensor and I/O Component Testing This initial step ensures the physical hardware is functioning as expected.

- **Sensor Calibration Check:** Each sensor (temperature and relative humidity) will be tested against a calibrated, independent reference instrument. For example, a certified sling psychrometer will be used to get baseline wet-bulb and dry-bulb readings, and a Fluke thermocouple with a surface probe will be used for temperature. Sensor readings from the controller must fall within a ±2% tolerance of the reference instrument.

- **Relay and Output Verification:** The controller's output relays, which control the drying equipment, will be connected to low-voltage indicators like LEDs or a multimeter set to continuity mode. Each relay will be programmatically cycled (On/Off) to verify that it actuates correctly and corresponds to the correct software command.

12.2. Algorithm and Logic Simulation The controller's firmware will be subjected to a battery of simulated data inputs to test its decision-making logic against a wide range of plausible and edge-case scenarios. A simulation harness will feed data directly to the controller's logic board, bypassing the physical sensors. Scenarios include:

- **Rapid Environmental Swings:** Simulate a sudden influx of humid air (e.g., a door being opened to the outside on a rainy day) to ensure the controller responds appropriately without rapid, unnecessary equipment cycling.
- **Sensor Failure Modes:** Test the logic's response to out-of-bounds sensor readings. This includes simulating a sensor failing to a zero value, a maximum value (e.g., 65535), or becoming unresponsive (stuck on a single reading for an extended period). The controller should enter a safe/standby mode and flag the specific sensor failure.
- **External Signals:** Simulate an incoming signal from a dehumidifier's defrost cycle. The controller should recognize this signal and temporarily halt any GPP reduction calculations until the defrost cycle is complete.
- **Safety Limit Breaches:** Feed data that surpasses the configured safety limits for temperature, relative humidity, or dew point margin. The controller must demonstrate that it deactivates the relevant equipment (e.g., heaters) to prevent damage to sensitive materials.
- **Stalled Drying Simulation:** Input a data stream representing a stalled drying job, where the Grains Per Pound (GPP) reduction rate flatlines over several hours. The controller must correctly identify this stall condition and transition its operational phase, for example by recommending or activating a change in equipment configuration.

12.3. Power-Fail and Recovery Testing The controller's resilience to power interruption will be validated.

- **Procedure:** While the controller is in the middle of a simulated drying cycle, its main power will be abruptly disconnected. After a waiting period of 1-5 minutes, power will be restored.
- **Expected Behavior:** Upon reboot, the controller must return to a safe, predictable state. The preferred behavior is for the controller to reboot into a "standby" or "paused" mode, requiring user intervention to resume the drying program. This prevents the controller from unexpectedly reactivating equipment after a power outage without a technician confirming the site is still safe. All logs up to the point of failure must be preserved in non-volatile memory.

Phase 2: In-Situ (Live Field) Commissioning

Objective: To validate the controller's performance in a real-world drying environment, tune its operational parameters, and establish a baseline for its effectiveness.

12.4. Initial Deployment & "Shadow Mode" The first on-site deployments will be conducted in a data-logging-only mode.

- **Concept:** The controller is installed alongside the standard drying equipment and connected to all its sensors. It actively logs environmental data and records the control decisions it *would* have made (e.g., "Request Heat: ON," "Change Phase: Aggressive to Balanced"). However, it does not physically control the equipment. A senior restoration technician manages the job manually as they normally would.
- **Data Comparison:** After the job, the controller's decision log is compared against the actions taken by the technician. Key comparison points include:
- Did the controller recommend adding or removing heat at the same GPP levels as the technician?
- Did the controller identify "stalled" periods correctly?
- Were the controller's phase-change decisions (e.g., switching from aggressive drying to balanced drying) consistent with the technician's judgment?

12.5. Supervised Live Control After successful shadow mode trials, the controller is deployed in active control for the first time, under the constant supervision of a qualified technician.

- **Procedure:** The technician remains on-site or available 24/7 to monitor the job's progress and the controller's behavior. They are responsible for overriding the controller if it makes a decision that could compromise the job's safety or efficiency.
- **Verification Data Logging:** The technician will manually log key data points to validate the controller's sensor readings and calculations:
- Manual surface temperature readings of key materials compared against the controller's calculated dew point to ensure a safe drying margin is maintained.
- Actual equipment cycle times (manually timed or from equipment hour-meters) compared against the controller's activity logs.
- Periodic GPP readings using a handheld psychrometer to confirm the controller's sensor accuracy over time.

12.6. Performance Baselining Over the first 5-10 live, supervised jobs, data will be collected to measure the controller's impact using clear Key Performance Indicators (KPIs).

- **Time-to-Dry:** Total job duration from equipment setup to achieving the dry standard, compared against company and industry averages for jobs of a similar class and size.
- **Energy Consumption:** If power monitoring equipment is available, track the total kilowatt-hours (kWh) consumed. The key metric is kWh per liter of water removed, providing a measure of energy efficiency.

- **Equipment Cycles:** Log the number of on/off cycles for major equipment like heaters and dehumidifiers. Fewer, longer cycles are generally more efficient and cause less wear on the equipment than frequent, short cycles.
- **Manual Interventions:** Record every instance where a technician had to manually override the controller's decision. A successful deployment will see this number trend towards zero over time.

12.7. Parameter Tuning The KPI data will inform the fine-tuning of the controller's internal parameters to optimize performance across a range of conditions.

- **Example Adjustments:**
- If jobs are consistently stalling, the `GPP_Rate_Threshold` for detecting a stall may be too low and could be raised to trigger a configuration change sooner.
- If energy consumption is high, the target temperature deadbands could be widened to reduce heater cycling.
- If the Time-to-Dry is longer than average, the criteria for transitioning between drying phases may need to be made more aggressive.

13.0 Companion Application Recommendations

The controller is a headless unit; therefore, a companion mobile/web application is essential for user interaction, data visualization, and job management. The following recommendations are based on an analysis of existing market solutions and the controller's specific capabilities.

13.1. Market Analysis & Feature Benchmarking

A review of existing applications like the "PSA Psychrometric Calculator" and remote monitoring platforms like "Dri-Eaz Command Center Pro" reveals a set of expected "table-stakes" features for restoration professionals:

- Instant psychrometric calculations (GPP, Dew Point, etc.).
- Job and moisture data logging.
- Equipment tracking and performance validation (e.g., water removal rates).
- Reporting and documentation generation for insurance and client sign-off.
- Remote monitoring and alerts for modern, IoT-enabled hardware.

Our proposed application must meet these expectations while tightly integrating with the unique automated control features of the controller.

13.2. Core Feature Recommendations for the Controller App

a. Dashboard / Job Overview A high-level, at-a-glance view of the live job status. This should be the first screen the user sees.

- **Key Data:** Prominently display Current Temperature, Relative Humidity, GPP, and Vapor Pressure for both the affected area and ambient air.

- **Controller Status:** Clearly indicate the current drying phase (e.g., "Aggressive Evaporation"), the controller's current goal (e.g., "Reducing GPP"), and the real-time status of all connected equipment (On/Off/Standby).
- **Safety Margins:** Display a visual indicator of the current dew point margin to prevent condensation.

b. Real-Time and Historical Charting The ability to visualize all sensor data over the entire job duration.

- **Functionality:** Users should be able to plot any combination of variables (Temp, RH, GPP, Dew Point, etc.) on a timeline. This is critical for diagnosing performance issues (e.g., seeing GPP spike when a door was opened) and for providing visual proof of the drying process to insurance carriers.
- **Significance:** Historical charts are indispensable for justifying equipment choices and demonstrating that the drying environment was maintained within safe limits, forming a core part of the legal and insurance documentation.

c. Job Setup and Configuration Wizard A simple, step-by-step process for initiating a new drying job.

- **Inputs:**

1. **Job Information:** Job Name/ID, Address, Client Name.
2. **Material & Safety Limits:** Allow the technician to select the primary material being dried (e.g., Hardwood, Drywall, Carpet). The app would then recommend default safety limits for temperature and RH, which the technician can override.
3. **Dry Standard:** Define the drying goal, either by manually entering a GPP target or by using an unaffected reference area as a baseline.
4. **Initial Readings:** A section to log the initial moisture content readings from materials.

d. Manual Data Entry A dedicated interface for technicians to log data that the controller cannot sense automatically.

- **Moisture Content Log:** A simple form to select a material, enter its moisture content reading (from a moisture meter), and log it with a timestamp. This creates the drying curve for the structure itself.
- **Surface Temperature Log:** An area to log manual surface temperature readings, which can be plotted alongside the controller's calculated dew point on the historical charts.

e. Alerts and Notifications The application should use push notifications to alert technicians to critical events, reducing the need for constant on-site supervision.

- **Critical Alerts:**
- "Warning: Dew Point margin is below 3°C on [Surface]."
- "Alert: Safety limit for temperature has been breached."
- "Notice: Sensor [ID] appears to be offline or has failed."
- **Performance Alerts:**
- "Notice: Drying has stalled. GPP reduction is below threshold."
- "Job Complete: The dry standard has been met and maintained for 2 hours."

f. Reporting The ability to generate and export comprehensive job reports directly from the application.

- **Format:** Reports should be available as both PDF (for clients/insurance) and CSV (for data analysis).
- **Content:** The report must include all job setup details, a complete log of all sensor data, a chart of the key psychrometric variables over time, a log of all manual readings, and a log of all controller actions and alerts. This creates a complete, indisputable record of the drying process.

13.3. User Interface (UI) and User Experience (UX) Philosophy

The application must be designed for the realities of a restoration job site.

- **UI Philosophy:** The UI should be high-contrast and legible in both bright and low-light conditions. Interactive elements like buttons and controls must be large enough to be accurately pressed with gloves on. Information density should be minimized on operational screens, showing only what is necessary for the task at hand.
- **UX Philosophy:** The UX should prioritize speed and efficiency. A technician should be able to start a new job and have the controller running in under 60 seconds. The workflow should be intuitive, requiring minimal training. The primary goal is to provide technicians with actionable intelligence, not to overwhelm them with raw data.

14.0 Conclusion

An automated structural drying controller offers the potential for significant improvements in efficiency, consistency, and verifiability over manual methods. However, its effectiveness is entirely dependent on the quality of its underlying control logic.

By rejecting simplistic, unreliable metrics like Relative Humidity in favor of a robust, physics-based approach centered on **Grains Per Pound (GPP)**, **Vapor Pressure Deficit (VPD)**, and **Dew Point management**, the controller can make intelligent, data-driven decisions. The proposed hierarchy prioritizes the safety of the structure and its contents while aggressively pursuing drying goals. It accounts for the real-world dynamics of the equipment and the environment, ensuring stability and protecting assets.

Successful implementation requires not only sophisticated software but also a commitment to using high-quality sensors and following industry best practices for measurement, as defined by the AS-IICRC S500 standard. Through a careful process of validation, commissioning, and tuning, this controller can become a powerful tool for the modern Australian restoration professional.

Evidence, records, and legal review notes

Framework for an Evidentiary Record in Automated Structural Drying

Report by: Gemini Research Agent G5 (Analysis of Australian Evidence Governance) **Date of Current Version:** 22 July 2026 **Status:** Research Report v2.0

1. Overarching Disclaimer and Statement of Purpose

1.1. Not Legal or Professional Advice

This document is a research report and is provided for informational and discussion purposes only. It **does not constitute legal advice, engineering advice, electrical certification, insurance counsel, a restoration scope of works, or a professional opinion** for any specific circumstance. The authoring AI is not a qualified legal practitioner, chartered engineer, licensed electrician, certified restoration professional, or registered certifier in any Australian jurisdiction.

1.2. Purpose of this Report

The purpose of this report is to survey and synthesise publicly available Australian legal, technical, and professional practice sources relevant to the creation of a robust evidentiary record for a water damage restoration project, specifically one utilising an automated drying system. It aims to identify the principles, standards, and legislative obligations that would inform a "standard of care" against which such a system and its records would likely be assessed in a commercial or legal context.

1.3. Mandatory Requirement for Independent Professional Review

This framework is a roadmap for discussion and is not a substitute for independent, professional certification and advice. Before implementing any system, process, or documentation based on the contents of this report, the user **must** seek independent advice from appropriately qualified and registered Australian professionals, including but not limited to:

- **Legal Counsel:** To ensure compliance with relevant Commonwealth, State, and Territory legislation regarding evidence, record-keeping, privacy, and consumer law.
- **Workplace Health & Safety (WHS/OHS) Consultants:** To ensure all processes and equipment meet duties of care under relevant safety legislation.
- **Chartered Engineers (Relevant Disciplines):** To certify the structural and mechanical integrity and safety of any hardware system.
- **Licensed Electricians and Electrical Engineers:** To review and certify all electrical components and control systems for compliance with Australian electrical standards (e.g., AS/NZS 3000).
- **Certified Restoration Professionals:** (e.g., IICRC-certified Applied Structural Drying Technicians or Indoor Environmental Professionals) to validate the restoration methodology.

- **Insurers and Loss Adjusters:** To ensure the evidentiary record meets their requirements for claims assessment.
- **Materials Conservators and Heritage Architects:** In any case involving heritage-listed properties or culturally significant materials.

1.4. Jurisdictional Limits and Document Currency

This report references legislation and standards applicable within the Commonwealth of Australia and its states and territories. These frameworks are complex, vary significantly between jurisdictions, and are subject to frequent amendment. All sources were accessed on 22 July 2026, and their currency is not guaranteed beyond this date. The user bears sole responsibility for verifying the current state of any law or standard mentioned herein.

1.5. No Guarantee of Legal Defensibility

Adherence to the principles in this report does not guarantee that any specific action or record will be deemed legally defensible or admissible in a court of law, tribunal, or dispute resolution forum. Such determinations are made solely by the relevant adjudicative body on a case-by-case basis. This document should not be claimed as a "certified" or "legally-approved" manual.

Executive Summary

This report provides a detailed framework for establishing a defensible evidentiary record for an automated structural drying system operating within Australia. It synthesises and separates the distinct layers of obligation imposed by Australian law, national technical standards, and professional codes of practice. The core finding is that a defensible record is not merely a data log; it is a complete, auditable, and context-rich project file that proves a competent professional standard of care was met at every stage.

Legal Framework: The report establishes the legal basis for digital evidence admissibility under the uniform **Evidence Acts**, the non-delegable duties of care under the **Work Health and Safety (WHS/OHS) Acts**, and specific legislative requirements for record retention (e.g., **Limitations Acts**) and environmental protection (e.g., **EPBC Act 1999**).

Technical Standards: It confirms the primacy of **AS-IICRC S500:2025** as the nationally endorsed technical benchmark for water damage restoration. This is supplemented by mandatory Australian standards for electrical work (**AS/NZS 3000:2018**), equipment safety (**AS/NZS 3760:2022**), and reliable records management (**AS ISO 15489.1:2017**). These standards are not optional; they define the minimum acceptable technical parameters for a professional operation.

Professional Practice: This layer includes authoritative guidance from bodies like Safe Work Australia, whose **model Codes of Practice** (e.g., for noise and biological hazards) are admissible in court as evidence of the "state of knowledge." It also incorporates state-specific regulator guidance (e.g., from WorkSafe WA on mould remediation), which clarifies how legal duties should be discharged in practice.

Governance Recommendations: Based on the obligations identified, the report provides a series of actionable governance designs. These are not requirements in themselves but are recommended internal processes to help meet the mandatory legal and technical obligations. These include:

- A **Claim-to-Source Traceability Matrix** to ensure all system logic is verifiably linked to an authoritative source.
- A structured **Human Override Protocol** to ensure manual interventions are documented and defensible.
- A detailed **Document Retention Schedule** aligned with varying statutory limitation periods.

The report concludes that while a detailed materials manual and automated log are essential components, they are insufficient on their own. Defensibility is only achieved when these components are embedded within a comprehensive governance framework, validated by the mandatory external professional reviews outlined in the disclaimer.

Part 1: The Australian Legal Framework

This section outlines the primary legislation that governs the creation, admissibility, and retention of records, as well as the fundamental duties of care for safety and environmental protection. Compliance with these laws is mandatory.

1.1. Admissibility of Digital Evidence

For the data log from an automated system to be useful in a legal dispute, it must first be admissible as evidence. In Australia, this is primarily governed by the uniform Evidence Act framework.

- **Governing Legislation:**
- **Commonwealth:** *Evidence Act 1995 (Cth)*
- **States/Territories:** Near-identical Acts in NSW, VIC, ACT, TAS, and NT. Other jurisdictions (QLD, WA, SA) have their own Acts and common law principles that lead to similar outcomes.
- **Key Principles for Admissibility:**

1. **Relevance (s 55):** The evidence must be able to rationally affect the assessment of a fact in issue. An automated drying log would almost certainly be relevant in a dispute about drying efficacy or property damage.
2. **Reliability and Authenticity:** The proponent of the evidence (the restoration company) bears the burden of proving that the record is what it purports to be and is a reliable record of the events. This is the most critical hurdle.

- **Provisions Aiding Admissibility:**
- **Business Records (s 69):** This provides an exception to the rule against hearsay. A document that is part of the records of a business, made in the course of that business by a person with knowledge of the events, is generally admissible. An automated log generated as a standard part of every

restoration project would likely qualify, provided the system's inputs (e.g., technician IDs, manual notes) are entered by personnel with direct knowledge.

- **Presumption of Mechanical/Electronic Soundness (s 146):** The court will presume that a machine or process of a kind that ordinarily produces a particular output (e.g., a calibrated sensor measuring temperature) did so correctly at the time it was used. However, this is a rebuttable presumption. An opponent could challenge the evidence by questioning the device's calibration, maintenance, or operation.
- **Practical Implications for System Design:**
- **Calibration Records are Essential:** To rely on the s 146 presumption, a complete and auditable history of calibration for every sensor and measuring device is non-negotiable. These records must be linked to each project the equipment was used on.
- **Data Integrity is Paramount:** The system architecture must prevent unauthorised or untraceable alteration of data after it has been recorded. Logs must be stored securely with clear audit trails for any (authorised) additions or annotations.
- **Chain of Custody:** The record must be able to prove its origin and history—which sensor, at which location, at what time, recorded by which system, and stored securely without tampering.

1.2. Work Health and Safety (WHS/OHS)

This is the most critical area of legal duty. The harmonised Work Health and Safety (WHS) framework places a primary, non-delegable duty of care on the Person Conducting a Business or Undertaking (PCBU).

- **Governing Legislation:**
- **Commonwealth:** *Work Health and Safety Act 2011 (Cth)*
- **Harmonised Jurisdictions:** NSW, QLD, SA, TAS, ACT, NT have Acts that mirror the Commonwealth model.
- **Victoria (Distinct but Similar):** Operates under the *Occupational Health and Safety Act 2004 (Vic)*, which imposes a similar primary duty of care on employers.
- **Western Australia:** Operates under the *Work Health and Safety Act 2020 (WA)*, bringing it broadly in line with the harmonised model.
- **Primary Duty of Care:** The PCBU must ensure, so far as is reasonably practicable, the health and safety of workers and any other persons (e.g., clients, the public) who may be put at risk from the work.
- **Key Hazards in Structural Drying:** The evidentiary record must prove that the PCBU has systematically identified and managed the following foreseeable hazards:
- **Electrical Hazards:** The use of mains-powered electrical equipment in wet environments is inherently high-risk. This is arguably the most severe safety risk.
- **Biological Hazards:** Water-damaged environments are breeding grounds for mould and bacteria, which can pose significant health risks from infection or allergic reaction.

- **Structural Hazards:** Water can compromise the integrity of building materials (e.g., ceilings, floors), creating risks of collapse.
- **Chemical Hazards:** Use of cleaning agents or disinfectants.
- **Physical Hazards:** Slips, trips, and falls from cables and wet surfaces; ergonomic injuries from moving heavy equipment; and hazardous noise from air movers and dehumidifiers.
- **Evidentiary Requirement:** The project file must contain a specific risk assessment (e.g., a Safe Work Method Statement - SWMS) for each site, demonstrating that these hazards were considered and that appropriate control measures were implemented and communicated to the work team.

1.3. Record Retention (Limitation Periods)

The law prescribes time limits within which legal action can be taken. These "limitation periods" dictate the minimum time that evidentiary records must be kept. These periods vary significantly by jurisdiction and cause of action.

- **Governing Legislation (Examples):**
- *Limitation Act 1969 (NSW)*
- *Limitation of Actions Act 1958 (Vic)*
- *Limitation of Actions Act 1974 (Qld)*
- **Common Retention Drivers:**
- **Breach of Contract:** A client dispute over the quality or cost of the work. Most states have a limitation period of **6 years** from the date the breach occurred.
- **Tort (Negligence):** A claim that the restoration work caused property damage or personal injury. This is also typically **6 years** from the date the damage became known. For personal injury, this can be shorter (e.g., 3 years).
- **Statutory Requirements:** Specific legislation may impose other retention periods. For example, financial records must be kept for **5 years** for tax purposes, and WHS records related to a notifiable incident may need to be kept for **5 years**.
- **Practical Implication:** A "one-size-fits-all" approach is risky. A conservative policy is to retain all project records for a minimum of **7 years** after project completion to cover most contractual and tortious claim periods across all states. For projects involving significant WHS incidents or personal injury, records should be kept for longer, subject to legal advice.

1.4. Environmental and Heritage Protection

In certain circumstances, national and state laws protecting the environment and cultural heritage can be triggered, imposing strict obligations.

- **Governing Legislation (Example):**
- *Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act)*
- State-based Heritage Acts (e.g., *Heritage Act 1977 (NSW)*).
- **Key Triggers:**

- **Heritage Status:** If a property is on a national, state, or even local heritage register, any work (including drying) can be considered a controlled action. Unauthorised work can lead to severe penalties.
- **Contamination:** A large-scale water loss event (e.g., from a flood) may involve contaminated water that, if discharged improperly, could pollute a waterway, triggering environmental protection laws.
- **Asbestos/Hazardous Materials:** Water damage may disturb hazardous materials like asbestos, which is subject to its own strict regulatory framework for handling and disposal.
- **Evidentiary Requirement:** The initial project assessment must include a checklist item to determine the heritage status of the property and to assess the risk of hazardous materials or environmental contamination. If any triggers are met, the evidentiary record must show an immediate **cessation of work** and a documented escalation to the relevant authorities (e.g., Heritage Council, EPA) and qualified specialists (e.g., conservators, hygienists).

Part 2: Mandatory Technical and Industry Standards

This section details the formal Australian Standards that define the minimum acceptable level of technical quality and safety. These documents are published by bodies like Standards Australia and are often called up in legislation or contracts, making compliance effectively mandatory. In a dispute, a court will refer to these standards to define what a "reasonable and competent professional" should have done.

2.1. Water Damage Restoration Methodology

- **Primary Standard: AS-IICRC S500:2025, Standard for Professional Water Damage Restoration**
- **Status:** This is the nationally endorsed standard in Australia, formally adopted from the global IICRC S500. It is the single most important technical document.
- **Key Requirements that Must be Evidenced:**
- **Initial Assessment and Categorisation:** The project log must show a methodical assessment of the water, classifying it into **Category 1 (Clean)**, **Category 2 (Grey)**, or **Category 3 (Black)** based on the source and level of contamination. This decision dictates the entire safety and remediation approach.
- **Assessment of Intrusion Class:** The log must justify the **Class of Intrusion (1, 2, 3, or 4)**, which quantifies the amount of water and the likely evaporation load based on the types of materials affected (e.g., carpet vs. hardwood).
- **Establishment of a Dry Standard:** The process must not stop at an arbitrary moisture level. The standard requires the technician to establish a "Dry Standard" by measuring the moisture content of similar, unaffected materials on the same property. The goal is to return the wet materials to this established equilibrium moisture content. The evidentiary log must record the location and readings of this comparison area.

- **Psychrometric Management:** The core of the standard. The log must demonstrate that a "balanced drying system" was established, where the rate of evaporation (promoted by air movers) is matched by the rate of dehumidification. This requires continuous monitoring of temperature, humidity, and grain-per-pound (GPP) to manage vapour pressure.
- **Monitoring:** The standard requires regular (e.g., daily) monitoring of affected materials and the drying atmosphere to ensure progress toward the Dry Standard. The log must contain these regular, timestamped readings.

2.2. Electrical Safety

- **Primary Standards:**

1. **AS/NZS 3000:2018, Electrical installations (The "Wiring Rules")**: This standard governs all electrical installation work. For restoration, it means the technician must ensure that the electrical circuits in the property are safe and capable of handling the load of the drying equipment without creating a fire or electrical hazard.
2. **AS/NZS 3760:2022, In-service safety inspection and testing of electrical equipment and RCDs**: This standard governs the "Test and Tag" regime.

- **Key Requirements that Must be Evidenced:**
- **Equipment Compliance:** Every piece of electrical equipment used on site (dehumidifiers, air movers, extension cords, control units) must have a current, valid electrical safety test tag as required by AS/NZS 3760. The evidentiary framework must include a central register of all equipment, linking serial numbers to their test and tag history.
- **RCD Protection:** All equipment must be protected by a properly functioning Residual Current Device (RCD). The site risk assessment should note the verification of RCD protection.
- **No Overloading Circuits:** The technician must assess the number of circuits available and distribute the equipment load accordingly. The project log should note how many devices were placed on each circuit to demonstrate this was managed.
- **Control System Certification:** The automated control system itself is an item of electrical equipment and must be certified as compliant with all relevant Australian electrical safety and electromagnetic compatibility (EMC) standards. This certification documentation is a foundational part of the evidence base.

2.3. Records and Information Management

- **Primary Standard: AS ISO 15489.1:2017, Information and documentation – Records management**
- **Status:** This is the Australian and international standard for creating reliable and trustworthy records. While not a law in itself, its principles are endorsed by the National Archives of Australia and are considered best practice. Adhering to it strengthens the argument that a record is reliable under the Evidence Act.
- **Key Principles that Must be Evidenced by the System's Design:**

- **Authenticity:** The system must be able to prove that a record is what it claims to be and was created by the person or system that purports to have created it (e.g., via secure user logins and system IDs).
- **Reliability:** The record must be a full and accurate representation of the event it documents. This means capturing sufficient metadata (see below) to provide context.
- **Integrity:** The record must be complete and protected from unauthorised alteration.
- **Usability:** The record must be locatable, retrievable, and interpretable throughout its entire retention period. This means using stable file formats and having a logical indexing system.
- **Metadata:** The system should automatically capture metadata for every record, such as the creator, date of creation, equipment used, and relationship to other records (e.g., this photo relates to that moisture reading).

Part 3: Professional Practice and Authoritative Guidance

This section covers materials, such as Codes of Practice and regulator guidelines, that sit between legislation and technical standards. While not always legally binding in themselves, they represent the "state of knowledge" for an industry. In a WHS/OHS prosecution, a court will accept an approved Code of Practice as evidence of what was reasonably practicable to ensure safety. A failure to follow the Code would require the PCBU to prove they implemented an alternative safety measure that was at least equivalent.

3.1. Safe Work Australia Model Codes of Practice

Safe Work Australia develops model Codes of Practice that are then adopted by the harmonised jurisdictions. They provide practical guidance on how to meet the duties of care under the WHS Act.

- **Key Guidance Document 1: Model Code of Practice: Managing the risks of biological hazards at work**
- **Relevance:** Directly applicable to water damage restoration, which inherently involves managing risks from mould and bacteria in Category 2 and 3 water losses.
- **Practical Implications for the Evidentiary Record:**
- The risk assessment must explicitly identify the potential biological hazards based on the Category of water.
- For Category 2/3 losses, the record must show what control measures were used, such as containment of the affected area, use of appropriate Personal Protective Equipment (PPE) by technicians (e.g., P2 respirators, gloves), and safe disposal of contaminated materials.
- It reinforces the escalation protocol: for widespread or hazardous contamination, the record must show a hand-off to a specialist mould remediator or hygienist.
- **Key Guidance Document 2: Model Code of Practice: Managing noise and preventing hearing loss at work**

- **Relevance:** Restoration sites using multiple large air movers and dehumidifiers can easily exceed the workplace noise exposure standard (an 8-hour average of 85 dB(A)).
- **Practical Implications for the Evidentiary Record:**
- The site risk assessment must consider noise hazards, particularly if the property remains occupied by clients or other workers during the drying process.
- The record should document the controls used to mitigate noise risk, such as placing equipment so as to minimise noise in occupied areas, providing hearing protection (PPE) to technicians, and erecting warning signs at the entrance to high-noise areas.

3.2. State-Based Regulator Guidance

State and territory WHS/OHS regulators (e.g., WorkSafe, SafeWork) often publish their own guidance documents that clarify how the law and standards apply in their jurisdiction. These are highly authoritative.

- **Example 1: WorkSafe WA - "Mould at work" Guidelines**
- **Relevance:** Provides clear, practical steps for mould remediation that are endorsed by both the safety regulator and the state Department of Health.
- **Practical Implications:** A restoration company operating in WA should ensure its procedures and documentation align with this guidance. For example, the WA guideline distinguishes between small ($<1m^2$) and large ($>1m^2$) areas of contamination, recommending professional hygienists for larger jobs. The evidentiary log should reflect this distinction in its assessment and action plan. It also provides specific advice on cleaning solutions, which can be incorporated into the system's procedural checklists.
- **Example 2: WorkSafe Queensland - Guidance on Zoonotic Diseases (e.g., from floodwaters)**
- **Relevance:** In scenarios like widespread flooding, floodwater (Category 3) can be contaminated with animal waste, carrying diseases like Leptospirosis.
- **Practical Implications:** For projects in regions prone to such events, the risk assessment in the evidentiary record must show that these specific biological hazards were considered and that technicians were equipped with appropriate PPE and hygiene protocols (e.g., access to clean water for decontamination) as recommended by the local health and safety regulator.

3.3. Manufacturer's Instructions

- **Status:** The instructions, specifications, and warnings provided by the manufacturer of every piece of equipment form a part of the web of professional obligations.
- **Relevance:** Operating equipment outside of its specified parameters (e.g., using a dehumidifier in an environment that is too hot or cold) can not only damage the equipment but can be considered negligent if it leads to ineffective drying or a safety incident.
- **Evidentiary Requirement:** The automated system's logic should be programmed with the operational limits of the equipment it controls. The evidentiary log must show that the

environmental parameters on the project remained within the allowable range for the equipment being used. If a parameter goes out of range, the system should generate an alert that is recorded in the log, along with the corrective action taken.

Part 4: Recommended Governance and Documentation Frameworks

This section proposes a series of internal governance frameworks and documentation designs. These are **recommendations** intended to help an organisation create the robust, auditable records needed to demonstrate compliance with the mandatory legal and technical requirements outlined in Parts 1, 2, and 3.

4.1. Design: Claim-to-Source Traceability Matrix

To ensure the logic of the automated system is defensible and not arbitrary, every critical parameter must be traceable to an authoritative source. This matrix is a core governance document, maintained internally.

Claim ID	System Claim / Parameter	Authoritative Source Document	Section / Clause	Source Tier	Verification Date
CL-001	The Dry Standard is achieved when material moisture content equals that of an approved, unaffected comparison area.	AS-IICRC S500:2025	Section 10.6.3	Australian Standard	15/06/2026
CL-002	Electrical equipment must be tested and tagged at intervals specified in the standard.	AS/NZS 3760:2022	Table 4	Australian Standard	12/01/2026

Claim ID	System Claim / Parameter	Authoritative Source Document	Section / Clause	Source Tier	Verification Date
CL-003	Max operating ambient temperature for Dehumidifier Model 'X' is 38°C.	'X' Manufacturer Spec Sheet XYZ-123	Page 4, "Operating Limits"	Manufacturer Instruction	01/02/2026
CL-004	For sewage backflow (Cat 3), escalate to a qualified environmental hygienist.	Model Code of Practice: Biological Hazards	Part 3.2	Professional Guidance	20/07/2026
CL-005	Plasterboard drying goal is <1% moisture content difference from the established dry standard.	MCA-DRY-MANUAL-v2	Page 17	Internal Professional Practice	21/07/2026

This matrix demonstrates a healthy governance structure. It shows that core principles (CL-001) are tied directly to national standards, safety rules (CL-002) are tied to their specific standard, and equipment limits (CL-003) are tied to manufacturer instructions. It also correctly classifies an internal best-practice rule (CL-005) as "Internal Professional Practice," acknowledging it has a lower evidentiary standing than a formal standard and must be supported by robust internal validation data.

4.2. Design: Structured Human Override Protocol and Record

An automated system must allow for manual override by a competent professional. However, each override must be rigorously documented to justify why the automated logic was insufficient for the specific circumstance.

Override Record (To be filled out in the system for every override event):

Field	Description	Example
Override Event ID:	Unique identifier.	OVR-PJ123-001

Field	Description	Example
Date and Time:	Timestamp of the override.	22/07/2026 14:35
Technician ID:	Name and IICRC certification of the technician.	T. Jones (IICRC ASD #98765)
System State Before:	What was the system's automated action/goal?	"System was operating at maximum dehumidification to target 35 GPP."
Reason for Override:	Why was professional judgement required?	"Excessive drying rate was causing cupping in heritage timber flooring. The building envelope was too tight, creating an overly aggressive drying vortex."
Action Taken:	What specific parameter was changed?	"Manually reduced dehumidifier operation to achieve a target of 50 GPP, slowing the drying rate."
Justification (cite source if possible):	Why was this the correct action?	"To prevent iatrogenic (secondary) damage to sensitive heritage materials, consistent with the conservation principles that override standard structural drying rates. This balances the need to dry with the need to preserve."
Override End Time:	When was the system returned to automated control?	23/07/2026 09:00

4.3. Design: Document Retention Schedule

This schedule should be programmed into the records management system to ensure compliance with the varying minimum retention periods under Australian law.

Record Type	Governing Instrument / Primary Reason	Minimum Retention Period
Project Evidentiary Log (incl. all data, photos, notes)	*Limitations Act* (various states, for contract/tort claims)	**7 years** after project completion

Record Type	Governing Instrument / Primary Reason	Minimum Retention Period
WHS Risk Assessments (SWMS)	WHS Regulations (to demonstrate compliance)	**7 years** after project completion
WHS Notifiable Incident Reports	Model WHS Regulations	**5 years** from date of notification
Financial Records (Invoices, payment records)	*Income Tax Assessment Act 1997*	**5 years** after end of financial year
Equipment Calibration Records	To support evidence reliability under *Evidence Act 1995*	**Life of equipment + 7 years**
System Commissioning & Validation Docs	To support evidence reliability	**Life of system version + 7 years**
Client Work Authorisation (The Contract)	*Limitations Act*	**7 years** after project completion
Technician Training & Competency Records	WHS Act (to prove competency of personnel)	**Duration of employment + 7 years**

Appendix A: Source Register (Key Legislation and Standards)

This register provides stable, direct URLs to the official sources for the key documents referenced in this report. All links were verified as active on 22 July 2026.

| ID | Document Title | Authoritative Body | Official URL | | :- | :--- | :--- | :--- | | **L-01** | *Evidence Act 1995 (Cth)* | Australian Government | `https://www.legislation.gov.au/Series/C2004A02396` | | **L-02** | *Work Health and Safety Act 2011 (Cth)* | Australian Government | `https://www.legislation.gov.au/Series/C2011A00137` | | **L-03** | *Occupational Health and Safety Act 2004 (Vic)* | Victorian Government | `https://www.legislation.vic.gov.au/in-force/acts/occupational-health-and-safety-act-2004/045` | | **L-04** | *Limitation Act 1969 (NSW)* | NSW Government | `https://legislation.nsw.gov.au/view/html/inforce/current/act-1969-031` | | **L-05** | *Environment Protection and Biodiversity Conservation Act 1999 (Cth)* | Australian Government | `https://www.legislation.gov.au/Series/C2004A00485` | | **S-01** | AS-IICRC S500:2025, Professional Water Damage Restoration | Standards Australia / IICRC | `[Purchase required] https://store.standards.org.au/` | | **S-02** | AS-IICRC S520:2025, Professional Mould Remediation | Standards Australia / IICRC | `[Purchase required] https://store.standards.org.au/` | | **S-03** | AS/NZS 3000:2018, Electrical installations ("Wiring Rules") | Standards Australia | `[Purchase required] https://store.standards.org.au/` | | **S-04** | AS/NZS 3760:2022, In-service safety

inspection and testing of electrical equipment | Standards Australia | `[Purchase required]` `https://store.standards.org.au/` | | **S-05** | AS ISO 15489.1:2017, Information and documentation – Records management | Standards Australia | `[Purchase required]` `https://store.standards.org.au/` | | **G-01** | Model Code of Practice: Managing the risks of biological hazards at work | Safe Work Australia | `https://www.safeworkaustralia.gov.au/` | | **G-02** | Model Code of Practice: Managing noise and preventing hearing loss at work | Safe Work Australia | `https://www.safeworkaustralia.gov.au/` | | **G-03** | Information Management Standard for Australian Government | National Archives of Australia | `https://www.naa.gov.au/information-management` | | **G-04**| Guidelines for Managing Mould (WA) | WA Department of Health | `https://ww2.health.wa.gov.au/Articles/M_R/Mould-and-dampness` |

(Note: Direct URLs to specific Safe Work Australia codes of practice change; the root URL is provided. Australian Standards are copyrighted documents that must be purchased from Standards Australia or an authorised distributor.)

Implementation trace

The application implementation corresponding to this manual is held in the repository under `lib/material-automation.ts`, `lib/material-drying-stage.ts`, `lib/psychrometric.ts`, `lib/drying-log.ts`, and `app/api/cron/poll-env/route.ts`. The material selector reads the versioned profile records, the controller selects the lowest current staged cap across selected materials, and the drying log records the rule, reason, material snapshot, and psychrometric diagnostics for each adjustment.

The automated tests cover the profile migration, governing-limit selection, staged material transitions, rate guard, temperature cascade, psychrometric calculations, drying-log snapshot, and manual plug safety paths. Runtime production behavior still requires supervised canaries, sensor calibration, power-state confirmation, and job-specific approval.