The Renormalised Standard Model Parameter-Closure Theorem in VERSF

One Frozen Microscopic Boundary, Coupled Renormalisation-Group Transport, Threshold Decoupling, Electroweak Breaking, Flavour Reconstruction, Pole Extraction and Cross-Sector Closure

▲ Programme Milestone — Renormalised Standard Model Assembly and Observable-Extraction Series

Gate RPC-1 / Immutable Boundary Contract, Common Scheme Bridge, Coupled RG Flow, Threshold Ledger, Broken-Phase Reconstruction, Pole Observables, Uncertainty Propagation and Non-Insertion Audit

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Six sector-completion papers → MASD-1 → HMGBC-1 → HFB-1 → RPC-1 → Final Derivation Audit

Tier A conditional renormalised-transport and physical-observable theorem. The structural certificate is issued. The numerical certificate is conditional on an admitted HFB-1 boundary return and is not issued here.

General Reader Summary

The earlier VERSF papers ask whether the structures underlying the Standard Model can be derived rather than assumed. They address the Higgs vacuum, the gauge strengths, fermion completion, the flavour matrices, neutral-sector structure, confinement, the global quantum measure and the strong phase.

A successful answer to those questions does not by itself finish the programme.

A microscopic calculation returns parameters at one particular scale, in one particular convention, in one particular regularisation. Experiments probe a different scale, a broken phase, unstable resonances, permanently confined quarks and mixed flavour states. The microscopic answer must therefore be carried through renormalisation-group evolution, particle thresholds, symmetry breaking and self-energy corrections before it can meet an observation at all.

That final carriage is where derivation programmes usually fail, and they fail in a characteristic way. It is easy to begin with an incomplete microscopic result, quietly insert a known low-energy value at some matching step, transport the mixture forward, and present the outcome as a prediction. The inserted value is laundered by the machinery. Nothing in the final table records where it entered.

This paper is built to make that impossible, and to make the impossibility checkable by a third party who does not trust the author.

Before any HFB-1 number is opened, RPC-1 freezes:

- the input schema and the admission test;
- the renormalisation scheme and the convention group;
- the loop-order ledger, sector by sector;
- the matching-scale rule;
- every threshold prescription and its ordering rule;
- the treatment of Dirac, Majorana, pseudo-Dirac and mixed neutral branches;
- the vacuum reconstruction rule and its acceptance conditions;
- the mass, frame and phase conventions;
- the pole definitions and the confinement qualification;
- the QCD-scale extraction and the strong-phase invariant;
- the uncertainty model, category by category;
- the cross-sector consistency identities;
- the PASS, DEGENERATE, FAIL, UNRESOLVED and NOT ADMITTED conditions.

Once the HFB-1 package arrives, the paper has no remaining authority to choose a different path because one path looks more like the observed world.

The result may agree with experiment. It may disagree. It may fail to produce a stable vacuum. It may return the wrong number of light neutral states. It may return several branches that survive equally well and describe physically different low-energy worlds. Each of those is a result, and each is reportable.

The single inadmissible outcome is one produced by changing the rules after the answer becomes visible.

The protocol has not sat idle waiting for that package. Part IX (§§64–80) records the audit era: everything in the corpus that could be run has been run, blind, under the frozen rules — and the record it produced is the strongest argument for the machinery itself.

The machine caught its own mistakes, repeatedly and verifiably. A wrong way of reading the generation-holonomy was tried twice, failed twice, and was replaced by a proved readout that agrees with an independent construction to fourteen decimal places (§69, §74.2). Two candidate "resolution ladders" for the theory were excluded — one numerically, one in closed form — before either could contaminate a result (§66.8, §71.3). A two-level test that could not fail by construction was exposed as testing nothing (§74.4). A forgery tool capable of fabricating the missing inputs was built, recognised, and quarantined by the system it was built to fool (§72.4). Five falsifier firings stand across the arc; every one is documented, and every repair used mathematics that was frozen before the failure occurred.

Real mechanisms were derived along the way. The once-mysterious gauge triple (24/5, 35/6, 3/2) now has an exact mechanical explanation — closure stiffness plus partially relaxed link–record stiffness, $Z = c + br/(b+r)$ (§71.1). The transport law behind three matter generations was repaired and cross-checked by a strictly positive construction into which no phase was ever inserted (§69). The first diagnostic irreversible branch has been executed: it switches the TPB clock on under a one-bit step convention, generates the score coupling mechanically, and produces sector-dependent screening without fitting any Standard Model observable — and it carries the orientation imprint that the sign of the generation winding requires, though the drive's direction is itself still a branch input (§75). And that channel has now been lifted, uniquely under one named symmetry premise, onto the theory's full defect carrier — where a safety rule frozen long before the calculation existed predicted exactly how the lift could fail, the unguarded version failed exactly that way, and the guarded version passed. For the first time the force sectors themselves are screened — by amounts that are derived rather than fitted, under that premise, though not yet the physical ones: the premise deliberately ignores structure inside each sector, and that structure is where the real force-strength separation must come from (§76).

Equally important are the exact negative certificates. The identity gauge response that survived three "independent" derivations was proved to be a whitening tautology — one algebraic identity observed three times, carrying no physics (§71.2). The entire current history sector was certified *pre-temporal*: it produces randomness but zero irreversibility, so physical time does not yet run on it at all (§73). And the terminal result, Theorem 72.1, proves by explicit witnesses that the current corpus admits a *continuum* of inequivalent boundaries in every sector at once — so the refusal to issue a numerical certificate is not caution. It is a theorem.

The most recent step changed the shape of the ending (§77). What had been a list of six missing pieces — the bath structure, the commitment dynamics, the generation-occupancy law, the absolute scale, the boundary operators, the resolution ladder — was shown, under two named assumptions, to collapse into just **two** primitive objects the theory's action must produce: one commitment-maintenance operator, and one absolute length. The occupancy question dissolves on the way: if a primitive fact is genuinely a *change* — a nonidentity transition — it necessarily carries the winding that makes generations exist, so the zero-generation sector was never a competitor to be outbid. Along the way, the reduction produced its own best exhibit of the paper's discipline: a gauge-strength candidate assembled with no fitted quantity anywhere, which *failed* the programme's own internal threshold — and was published as a failure and kept, exactly as the rules require. It also returned the first candidate for the absolute scale (a coherence length of 88 micrometres, from which the electroweak scale is reproduced to ten decimal places — and a second, fully independent construction has since landed within 4.5% of the same length, §78) and a demonstration that a mass hierarchy spanning three-and-a-half orders of magnitude can arise from maintenance structure alone, with no fermion mass ever entering. All of it carries the same honest grade: candidate — the reduction is proved for these constructions, and the proof that no *alternative* constructions were available is now the named remaining task.

One consistency result stands out on the positive side: a stability ceiling computed by this paper's transport agrees with an independently derived ceiling from a completely different pipeline to seven significant figures — and the derived fermion-matching operator lands strictly inside that bound with 12.8% margin, the first time a derived VERSF operator has satisfied a constraint this paper published before the operator existed (§72.2, §74.7).

The current status is therefore exact rather than vague:

structural transport theorem: COMPLETE and frozen audit era: EXECUTED — five falsifier firings, all documented and repaired unique boundary from the current corpus: IMPOSSIBLE — non-closure proved (Thm 72.1) what is missing: one theorem and one structural fact. Candidate constructions for both primitive objects — the commitment-maintenance operator and the absolute length — exist, built forward with no measured quantity entering, the length reached by two independent routes agreeing to within five percent. The uniqueness proofs were then attempted with an unusually honest outcome: everything provable was proved, and the tempting shortcuts were *disproved* by explicit counterexamples that now guard the record. One hinge has since fallen almost entirely — rebuilding the length calculation on the theory's own finite-distinguishability axiom *proved* the record-keeping choice and the threshold outright, leaving only a yes/no question about whether the substrate commits before it glues. What remains is therefore: one theorem — that new facts arrive independently, one bit at a time — and that one construction-order fact. Everything else has been shown to be a compression, consequence or spectral reading of the two primitive objects, and none of it is recoverable by any downstream inversion

When those returns exist, the machinery runs to completion mechanically, and the theory either matches the world or is cleanly falsified. Nothing in between remains possible.

Principal Claim

The programme does not culminate in a collection of sector calculations. It culminates in one renormalised Standard Model constructed from one microscopic boundary at one declared scale, or it does not culminate at all.

The input to this paper is therefore not a menu of preferred sector values. It is one immutable HFB-1 return:

$$\mathcal{P}_{SM}^{VERSF}(\mu\star) = \{ g_s, g, g', \mu_H^2, \lambda, Y_u, Y_d, Y_e, \mathcal{B}_\nu, \bar{\theta}\}|_{\mu\star}$$

together with the branch, scheme, regulator, covariance, threshold and provenance certificates specified in §4.

Here 𝓑_ν is the complete neutral-completion object returned by the selected physical branch. It is not silently replaced by a Dirac Yukawa matrix when the substrate returns a Majorana, seesaw, pseudo-Dirac or mixed neutral structure.

The complete physical-observable map is

𝔒_phys = 𝓟_pole ∘ 𝓔_EWSB ∘ 𝓜_thr ∘ 𝓤_RG ∘ 𝓢_bridge [𝔥_HFB1^pass]

The five maps have distinct and non-overlapping roles:

Map	Domain → Codomain
𝓢_bridge	HFB native boundary → declared continuum scheme
𝓤_RG	boundary parameters → coupled running parameters
𝓜_thr	full theory → successive effective theories
𝓔_EWSB	symmetric-phase parameters → broken-phase masses and frames
𝓟_pole	running quantities → physical poles and invariant observables

No map may repair an incomplete predecessor. No measured coupling, mass, mixing angle, phase, vacuum scale, threshold or QCD parameter may be introduced upstream of the point at which it is claimed as an output.

The governing principle is:

Assembly is transport, not rescue.

Scope and Closure Box

Claim	RPC-1 status
One immutable Standard Model input package	Defined
Admission test with no substitution clause	Defined
Common matching scale and scheme	Frozen by manifest
Convention group and physical quotient	Defined and proved invariant (Thm 14.2)
HFB-to-continuum finite bridge	Defined; numerical bridge conditional on HFB-1

Claim	RPC-1 status
Coupled gauge, scalar and flavour RG transport	Reference system defined; well-posedness proved (Thm 22.1); production truncation open
Branch-specific neutral RG transport	Defined
Threshold census and matching	Defined; existence criterion proved (Thm 24.2)
Electroweak vacuum reconstruction	Defined with acceptance conditions
Gauge-boson and Higgs complex poles	Defined; gauge-independence order stated (Thm 41.2)
Charged-lepton pole masses	Defined
Quark running and short-distance masses	Defined
Exact isolated light-quark poles	**Not claimed**; obstructed by confinement
CKM and invariant charged CP sector	Defined
PMNS, neutral masses and nonunitarity	Defined branchwise
QCD scale and strong-sector handoff	Defined
Physical strong phase	Defined as one invariant
Complete uncertainty decomposition	Defined as joint nuisance (Σ_O , $\mathcal{E}$_O); envelope models open
Shared-substrate consistency audit	Defined, twelve identities
Formal non-insertion (measurability) theorem	Proved (Thm 7.3)
Numerical admission audit and preflight	Executed; BLOCKED on 15 physical arrays + M_R_direct
Master-vacuum differential and kinematic quotient	Executed upstream; analytic J_D, potential Hessian and exact kinematic quotient frozen
Continuous-amplitude	Conditionally derived from operational heat flow and the minimum-norm defect lift; finite-cell W_core evaluated with rank 183

Claim	RPC-1 status
microscopic proposal kernel	
Physical typed history metric	$W\_prim = W\_core - C^\dagger A\_Q^+ C$ fixed structurally; first irreversible instance executed (ISG-1, §75) and lifted faithfully to the 243-carrier under Premise FB (§76); action-derived Σ_commit, sector-internal generators (D41) and multi-cell return open
Physical G_red	Diagnostic screened response executed (§76: split 2.6%, non-predictive under whitening); physical G_red blocked on the D35 weights, the action-derived Σ_commit, the sector-internal generators, the multi-cell census and the selected branch
Upstream return ladder for W_prim, scales and branch	Proposal-kernel and W_core stages conditionally executed; physical bath, scales, branch and regulator stages remain under P10 and P11 (§64.4)
Conditional corpus RG stress test	Executed; **FAIL** (rejects DCS-1, §65)
Integrated eight-gate conditional execution	Executed (§66); boundary assembled, NOT ADMITTED
Bath non-identifiability certificate	**Proved**: $G\_red = (1-\eta) I_3$ continuum admissible pending A_Q, C (§66.2)
Holonomy sector and branch	$k\_\Omega = \pm 1$ selected conditionally, sign-degenerate (§66.4)
Local regulator candidate	8→16 multi-wheel chain excluded — F34 fired (§66.8)
Canonical master-history generator	Derived (§67); bath spectrum { ½, ½, 1, 1, 31/28, 5/4 } exact; C = 0 by spectral-projector identity
Physical screening	Zero on the canonical branch (§67); scalar commitment block derived but orthogonal to gauge (§68.8); gauge/flavour screening now provably requires non-scalar QP blocks
Scalar commitment QP block	Rank-one shape, exact $\mathcal{D}\_J/\mathcal{D}\_T$ support and positivity interval $0 \leq \eta\_\kappa \leq 1$ derived; $\hat{g}\_\kappa$, ω_0 open (§68)
Terminal record transport	Repaired by log-before-polar (Thm 69.1); basicness $\rho\_vac = q^*\rho\_\Omega$ exact; skew-product cross-check R^{k_Ω} exact; occupancy conditional
Sign non-identifiability	Proved (Thm 70.1); certified DEGENERATE at operator level (§71.4)
Non-scalar screening mechanism	Derived (Thm 71.1): exact link–current–record Schur formula reproduces the wheel triple; physical weights open (D35)
Identity gauge response	Whitening tautology — D12d negative certificate (Thm 71.2); independent-readout obligation replaces it
Continuum regulator	Diamond family excluded analytically; K_{N,N} antichain family passes conditionally with uniform gap ½ (§71.3)

Claim	RPC-1 status
Lepton-frame provenance	Audited: open candidate benchmark, FAIL for blind promotion, sealed-manifest repair specified (§71.5)
Current-corpus closure	**Non-closure proved** (Thm 72.1): continuum of admissible boundaries in gauge, scalar-bath, completion-scale, occupancy, neutral and flavour sectors; certificate refusal is a theorem
Colour-scale repair	Demonstrated in-family: NQTC branch gives $\Lambda_3 = 0.226$ GeV; selection, not capability, is what remains
Stability ceiling	r_{u,crit} = 0.666093460291 on the colour-completed branch; seven-figure independent cross-check (eighth digit distinguishes the pipelines); derived R_u inside it
TPB calibration	Implemented and validated; current corpus certified PRE-TEMPORAL ($\Sigma = 0$ on every frozen kernel); clock cannot supply force ratios, η_κ or branch selection (§73)
Unified temporal debt	Sign (D27), occupancy (D32) and absolute scale converge on one operator: Σ_commit (D36), with ξ (D37) for GeV calibration
Stage-A integrated run	Executed and refereed: Gate 7 re-graded PASS (Thm 74.1), Requirement 2 NOT TESTED (Lemma 74.2, F39), Gate 8 = determinant-sign only; manifest-currency gap closed (F26 ext., D39)
FRGM-1C fermion matching	R_u = $0.580788\cdot\mathbb{1}_3$ derived, 12.8% inside the blind ceiling; fixed point by Banach contraction; §65 instability re-diagnosed as scale typing
One-bit irreversible score branch	Executed and assembler-verified (§75): $\Sigma = \ln 2$, λ_TPB = 1, rank-4 coupling reaching all six sectors, m2 pair exactly dark, screening 0.4–48.6% by sector, orientation imprinted; gauge readback DIAGNOSTIC_ONLY; action-derived Σ_commit open
Faithful typed score lift	Executed (§76): unique under Premise FB, rank/range/null faithful, realizability projection proved load-bearing (§64.4.1F confirmed), gauge sectors screened for the first time, response split 2.6% non-predictive; residue = sector-internal generators (D41)
Six-input reduction	Executed at candidate grade (§77): closure problem = { H_CMR, ξ }; occupancy premise-derived (PF + FP); κ pair score-matched ($\omega_0^2 = 4/3$); no-fit gauge candidate published as a fail ($Z_q/Z_2 = 116.8$); Route-A ξ = 88 μm; hierarchy capability at condition 3333 without fermion input; uniqueness open (D44, D45)
H_CMR / ξ forward closure	Both primitive returns executed conditionally (§78): six-premise H_CMR with floorless positivity (floor proved removable), gap-stable six-level fixed point repairing the hierarchy test ($Z_q/Z_2 = 153.2 > 140$) while failing physical gauge admission (published); ξ by two independent routes within 4.46%; residue = two named microscopic proofs (D44, D45 sharpened)
D44–D45 proof attempt	Consumers closed (§79): Fisher-uniqueness at scale ln 2 (Thm 79.1) and the universal-cover threshold $p_c = \rho(B)^{-1}$ (Thm 79.2); shortcuts disproved by counterexample (tanh J channels, unequal rates, free cubics,

Claim	RPC-1 status
	trace-monoid quotients); debts transformed to D44′ Primitive Innovation Factorisation and D45′ Persistent Provenance Covering
D45 finite revision	Strong conditional pass (§80): ontology corrected to the finite-distinguishability axiom; record-distinct gluing PROVED under A2* (quotient kernel = the four provenance differences exactly); finite PF threshold $p\star = \rho(B\_D)^{-1}$; nonbacktracking derived; trace-monoid adversary dissolved with re-entry guard; residue = D45″, one construction-order clause
Embedding uniqueness	Proved under factor-exchange covariance; else reduced to one derived weight vector (Lemma 70.2)
Derived constraint on the R_u matching operator	σ_max suppression ≤ 0.615 at one loop
Numerical physical outputs	Conditional on HFB-1
Numerical Parameter-Closure certificate	Not issued

Contents

Part 0 — Premises and Falsifiers

RPC-1 rests on eleven named premises. Each carries an explicit falsifier. A premise that fails does not degrade the theorem into a weaker claim; it removes the theorem.

P1 — Boundary sufficiency. The ten primary rows of $\mathcal{P}$_SM^VERSF(μ⋆) together with the declared operator basis constitute a complete specification of the low-energy effective theory of the selected branch at μ⋆. *Falsifier:* HFB-1 returns, or the substrate requires, **any operator contributing at the claimed truncation order** — relevant, marginal or irrelevant — that is absent from the declared basis. Higher-dimensional operators generated by threshold matching (§26) are included in this test; their omission falsifies P1 even where they are formally suppressed, because the claim is finite-accuracy, not leading-order.

P2 — Continuum representability. The selected VERSF branch admits a local, unitary, Lorentz-invariant continuum effective field theory description on the transported interval, with a positive-definite kinetic metric on the classified physical support. *Falsifier:* a null or negative direction of the kinetic metric survives classification; or the branch requires a nonlocal or non-unitary representation on the transport interval.

P3 — Perturbative validity. All couplings remain within the domain in which the declared truncation of the beta functions and matching coefficients controls the error to the stated order, on every transported interval. *Falsifier:* any coupling exits the declared domain; a Landau pole or coefficient-growth breakdown occurs before the target scale.

P4 — Scheme bridge existence. A finite, invertible-to-order map $\boldsymbol{S}$_{⋆→R} exists between the HFB native scheme and the declared continuum scheme, and is computable from the frozen manifest without reference to any observed value. *Falsifier:* ε_bridge > τ_bridge, or the bridge is non-invertible to the declared order.

P5 — Threshold identifiability. Every entry of the threshold census admits an isolated self-consistent decoupling scale under the frozen spectral rule. *Falsifier:* no isolated solution, or a solution whose multiplicity changes under precision refinement.

P6 — Vacuum admissibility. The effective potential of the transported branch possesses an isolated stationary point with $v^2 > 0$, λ_eff > 0 on the declared domain, and unbroken colour and electromagnetism. *Falsifier:* absence of such a point; or spontaneous colour/charge breaking; or non-isolation.

P7 — Pole isolation. Each observable claimed as a pole corresponds to an isolated complex zero of the inverse propagator on the declared Riemann sheet, stable under gauge-parameter and precision variation to the retained order. *Falsifier:* non-isolation, sheet ambiguity, gauge-parameter drift exceeding the retained order, or precision instability.

P8 — Non-insertion. The composed observable map depends on no datum outside ɧ_HFB1^pass and the frozen manifest. *Falsifier:* any measured Standard Model quantity is measurable with respect to the execution environment before Stage 13 (§57); formalised in Thm 7.3.

P9 — Branch persistence. The physical branch label $\beta^\star$ is preserved under the whole transport; no bifurcation or phase transition of the substrate occurs on the transported interval. *Falsifier:* a branch-changing bifurcation, detected as a discontinuity or multi-valuedness of the flow that the threshold protocol does not account for.

P10 — Metric–branch ordering. The Doob normalisation used to define the scores of W_prim is taken with respect to the same operator whose component structure supplies the selected branch $\beta^\star$, and the order in which the two are computed is declared before execution. *Falsifier:* W_prim is normalised against the full T_n^{hist} while $\beta^\star$ is selected from a component $P_\beta T_n^{hist} P_\beta$, or vice versa, so that the metric prices defect directions using history the selected branch does not carry.

P11 — Uniform spectral gap. A spectral gap δ, uniform across the transported regulator levels, separates the Perron eigenvalue of T_n^{hist} from the remainder of its spectrum. *Falsifier:* δ_n shrinks under refinement, voiding the $O(\varepsilon_n/\delta)$ and $O(\varepsilon_n/\delta^2)$ bounds of §64.4.7 and hence the content of two-level agreement.

Part I — The Frozen Assembly Problem

1. Aim and Programme Position

The role of RPC-1 is final assembly.

The sector papers are responsible for calculating the microscopic boundary objects. HFB-1 is responsible for returning them from one history-selected physical branch. RPC-1 does not revisit those derivations and does not adjudicate among candidate microscopic constructions.

Its dependency chain is

HMGBC-1 sealed execution → HFB-1 physical boundary → RPC-1 renormalised transport → Final Derivation Audit

The HFB-1 output comprises the coupling, scalar, charged-flavour, neutral and strong-phase boundary objects, accompanied by the common Hessian, Ward, CY3′, triality-wall, branch, regulator and provenance certificates. The HFB protocol requires the *operators themselves* to be published, not merely masses or mixing angles; RPC-1 consumes operators and will not accept a spectral summary in their place.

RPC-1 executes numerically only on a passing HFB-1 return. The protocol, the proofs and the acceptance criteria stand independently of whether that return exists, and are stated so that they cannot be adjusted once it does.

2. Assembly Is Transport, Not Rescue

Definition 2.1 — Import. An *import* is any quantity entering the calculation from observation or phenomenological convention before the calculation has independently returned it.

Representative imports:

- setting v from the measured Fermi constant;
- setting g_s from measured $\alpha_s(m_Z)$;
- setting g and g′ from measured m_W, m_Z or $\sin^2\theta_W$;
- setting λ from the observed Higgs mass;
- setting a Yukawa singular value from a measured fermion mass;
- choosing a neutrino ordering from oscillation data;
- placing a heavy-neutral threshold at an experimentally suggested scale;
- selecting a branch because its CKM matrix looks preferable;
- shifting $\bar{\theta}$ by an untracked determinant-line convention;
- adjusting a matching scale until agreement improves;
- enlarging an uncertainty after comparison with data.

Lemma 2.2 — Imports are not laundered by transport. Let $O = F(x)$ be an observable computed from a boundary vector x, and let x contain a component x_j fixed by observation. If $\partial O/\partial x_j \neq 0$ to the retained order, then O is not a prediction of the substrate, irrespective of the number or complexity of maps composing F. *Proof.* Immediate from the chain rule: the dependence of O on the observed datum is not removed by composition with deterministic maps that do not annihilate the j-th coordinate. Passing an imported value through an RG solver changes its numerical value and not its provenance. ■

The practical corollary is that the audit tracks *provenance*, not *magnitude*. A small imported quantity is as fatal as a large one.

Definition 2.3 — Rescue operation. A *rescue operation* is any post-boundary modification that changes a physical prediction by altering an upstream input, bridge, threshold, branch, convention, loop order or uncertainty rule after the unmodified prediction has been inspected.

Definition 2.4 — Transport operation. A *transport operation* applies a pre-registered deterministic map to the frozen boundary package without changing the package or the map in response to the resulting observables.

RPC-1 permits transport and forbids rescue.

3. Claim Grades

R1 — Exact mathematical transport statement. Existence, uniqueness and composition of the finite scheme map, the coupled RG flow, the threshold maps, the singular-value and Takagi decompositions, the pole equations and the covariance pushforward; and the invariance of the output under the convention group.

R2 — Conditional physical transport theorem. The claim that the HFB boundary is complete (P1) and that the declared continuum EFT is the correct low-energy representation of the selected VERSF branch (P2).

R3 — Numerical execution. The actual transported couplings, masses, mixings, poles, QCD scale and strong-phase invariant.

R4 — Empirical comparison. Comparison with measured quantities after every prediction and every uncertainty has been frozen and hashed.

This paper closes R1 and specifies R2, R3 and R4. It advances no R3 or R4 claim.

4. HFB-1 Input Contract

The complete input is

$$\mathfrak{h}_{HFB1}^{pass} = \{ \mathcal{P}_{SM}^{VERSF}(\mu\star), \mathfrak{A}_{anc}, \beta\star, \mathfrak{S}\star, \Sigma\star, \mathfrak{T}\star, \mathfrak{C}\star, \mathcal{M}_{hash} \}$$

with members:

Symbol	Content
$\mathcal{P}_{SM}^{VERSF}(\mu\star)$	$\{ g_s, g, g', \mu_H^2, \lambda, Y_u, Y_d, Y_e, \mathcal{B}_\nu, \bar{\theta} \}$
$\mathfrak{A}_{anc}$	ancillary HFB objects and cross-checks
$\beta\star$	selected physical branch, or a certified degenerate branch set
$\mathfrak{S}\star$	native HFB scheme and convention ledger
$\Sigma\star$	complete input covariance and interval package
$\mathfrak{T}\star$	threshold and spectrum census
$\mathfrak{C}\star$	Ward, CY3′, positivity, null, determinant-line, triality and convergence certificates
$\mathcal{M}_{hash}$	immutable data, source, code and convention manifest

Admission Rule 4.1. Numerical execution is admitted only when all of the following hold:

1. every primary parameter row is populated;
2. every row originates in the same HFB branch, or in a certified degenerate branch set transported in full;
3. all rows are quoted at the same $\mu\star$;
4. all rows share one native scheme ledger;
5. the input covariance is supplied, including cross-sector correlations;

6. the threshold and spectrum census is supplied;
7. the HFB certificate reads PASS;
8. no candidate-wheel, CFB or measured substitute appears anywhere in the package;
9. the manifest contains real content hashes that resolve;
10. the HFB output has not been modified after publication, as verified by hash comparison against the sealed record.

A missing row produces **NOT ADMITTED**. It does not produce an invitation for RPC-1 to supply the row.

Remark 4.2. Condition 8 is checked mechanically, not editorially. The admission script scans the package for numerical proximity to a quarantined constant list held outside the execution environment; a proximity hit raises a provenance query that must be resolved by derivation trace, not by assertion.

5. Primary and Ancillary Objects

The primary scalar basis is $\{ \mu_H^2, \lambda \}$.

The electroweak vacuum is **not** an additional independent input:

$\mathbf{v^2 = \mu_H^2 / \lambda}$ (leading order; loop-corrected relation in §30)

If HFB-1 also returns v_{cl}, it is an ancillary cross-sector certificate. It may not be counted as a third adjustable scalar parameter, and its disagreement with the reconstructed vacuum is reported as the residual ε_v rather than absorbed.

Ancillary objects and their roles:

Object	Role
Z_H	kinetic-normalisation certificate
B_τ	nonperturbative strong-sector certificate
$P_Y^{L,R}$, R_{fX}, $\mathcal{E}_{fX}$	operator provenance objects
$\hat{H}_{cl}^{red}$	common reduced-Hessian object
CY3′	route-agreement certificate
Ward / Slavnov–Taylor residuals	gauge-consistency certificates
regulator data	uncertainty and stability objects

Ancillary objects constrain and audit the transport. They do not enlarge the independent Standard Model parameter set. The count of independent inputs is fixed at admission and published; any increase in that count during execution is a falsifier (F27).

6. Scale, Branch and Scheme Identifiers

Every transported object carries the label

$O = O(\mu, \beta^\star, \mathfrak{S}, n, \mathscr{M}\_hash)$

where n is the regulator level. An object without a complete label is not publishable.

The matching scale $\mu^\star$ is inherited from HFB-1. RPC-1 does not choose it. The numerical package must state whether $\mu^\star$ is

- a common spectral window,
- a substrate inverse-length scale,
- a completion threshold,
- a regulator matching surface, or
- another pre-registered invariant,

and its definition may not refer to any measured Standard Model scale.

The physical branch label $\beta^\star$ is retained throughout. A branch change during RG evolution is not permitted. A genuine phase transition or bifurcation is a physical failure (P9) or a declared new effective-theory transition, and is never treated as a routine threshold.

7. Firewalls and the Non-Insertion Theorem

Firewall R1 — No missing-input substitution. A blank HFB row remains blank. **Firewall R2 — No observed-scale calibration.** Measured m_Z, m_W, G_F, α, α_s and particle masses are not matching inputs. **Firewall R3 — No scheme shopping.** The continuum scheme is selected before outputs are opened. **Firewall R4 — No loop-order shopping.** The perturbative order is frozen sector by sector in the manifest. **Firewall R5 — No threshold shopping.** Threshold locations follow the declared self-consistent rule. **Firewall R6 — No neutral-branch replacement.** $\mathcal{B}_\nu$ is transported in its returned type. **Firewall R7 — No branch shopping.** Every member of a degenerate HFB set is transported. **Firewall R8 — No pole fiction for confined states.** A formal quark propagator pole is not called a physical observable where confinement forbids an isolated asymptotic quark. **Firewall R9 — No strong-phase double counting.** The determinant line is not an independent third additive phase unless its independence is proved. **Firewall R10 — No uncertainty rescue.** Error prescriptions are frozen before empirical comparison. **Firewall R11 — No parameter-count inflation.** The independent input count is fixed at admission. **Firewall R12 — No silent relabelling.** A running mass is never published under a pole-mass label, and a formal pole conversion is never published under a short-distance label.

The firewalls are procedural. The following theorem states the same content structurally, which is what makes it auditable.

Definition 7.1 — Execution environment. Let $\mathcal{E}$ denote the σ-algebra generated by every datum readable by the execution process: the boundary package $\mathfrak{h}$, the frozen manifest $\mathscr{M}$, the code, and any external datum D that the process can access.

Definition 7.2 — Admissible output. An output O is *admissible* if it is measurable with respect to $\sigma(\mathfrak{h}, \mathscr{M})$ alone.

Theorem 7.3 — Non-insertion. Under the quarantine of §56 and the read-only import of Stage 1, every output of the composed map $\mathfrak{O}$_phys is admissible; that is,

$$\boldsymbol{\sigma(\mathfrak{O}\_\mathrm{phys}) \subseteq \sigma(\mathfrak{h}\_\mathrm{HFB1}^\wedge\mathrm{pass}, \mathscr{M}\_\mathrm{hash})}$$

and consequently, for any quarantined observed datum D, the conditional law satisfies $\mathfrak{O}$_phys ⊥ D given $(\mathfrak{h}, \mathscr{M})$.

Proof. Quarantine removes every measured Standard Model quantity from the environment before Stage 0, leaving $\boldsymbol{\mathcal{E}} = \sigma(\mathfrak{h}, \mathscr{M})$ together with the unit ledger $\boldsymbol{\mathfrak{U}}$. Each of the five composed maps is a deterministic function of its argument and of manifest-frozen coefficients; a deterministic function of a $\sigma(\mathfrak{h}, \mathscr{M})$-measurable argument is $\sigma(\mathfrak{h}, \mathscr{M})$-measurable. The unit ledger $\boldsymbol{\mathfrak{U}}$ enters only through dimensionful conversion factors and, by construction (§56), no dimensionless VERSF output depends on $\boldsymbol{\mathfrak{U}}$. Composition of measurable maps preserves measurability, so $\mathfrak{O}$_phys is $\sigma(\mathfrak{h}, \mathscr{M})$-measurable. Independence from D follows because $D \notin \boldsymbol{\mathcal{E}}$. ■

Corollary 7.4 — Auditability. Any insertion is detectable as a dependence of a published output on a datum absent from the manifest, and is therefore visible in the execution trace without recourse to the author's intent. Sincerity is not part of the protocol.

Remark 7.5. Theorem 7.3 is conditional on the quarantine actually holding. Its practical content is that the audit reduces to a single verifiable question — *what could the process read?* — rather than to a diffuse review of the author's reasoning.

Part II — Common Scheme Bridge

8. HFB Native Scheme

Let the HFB-1 boundary be expressed in the native scheme

$\mathfrak{S}$⋆ = { field normalisation, current normalisation, generator basis, subtraction prescription, finite-regulator convention }

The target comparison scheme is $\mathfrak{S}$_R. The default target for perturbative transport may be MS-bar, but the choice is frozen before any HFB numerical value is opened, and both the default and any declared alternative (§50) are named in the manifest.

The finite bridge is

$$p_R(\mu\star) = \mathcal{S}_{\star\to R}[\,p\star\,]$$

For a perturbative bridge,

$$p_R = p\star + \Sigma_{\ell=1}^{L_S} \Delta^{(\ell)}p / (16\pi^2)^\ell$$

The order L_S, the finite coefficients, the basis maps and the covariance propagation are manifest-frozen. The bridge coefficients are computed from the HFB action and the declared continuum action; they are never fitted.

9. Canonical Field Normalisation

Suppose the HFB quadratic action contains

$$Z_H (D_\mu H)^\dagger (D^\mu H) + \bar{\psi}_L K_L\, i \not{D} \psi_L + \bar{\psi}_R K_R\, i \not{D} \psi_R$$

The canonical fields are

$$H_c = Z_H^{1/2} H,\quad \psi_{Lc} = K_L^{1/2} \psi_L,\quad \psi_{Rc} = K_R^{1/2} \psi_R$$

and the canonically normalised Yukawa matrices are

$$Y_f^c = Z_H^{-1/2} K_{fL}^{-1/2} Y_f^\star K_{fR}^{-1/2}$$

All square roots are the positive square roots on the classified physical support, taken in the frozen ordering of the spectral decomposition of K.

Lemma 9.1 — Normalisation is a similarity, not a fit. The map $Y_f^\star \mapsto Y_f^c$ is determined entirely by (Z_H, K_{fL}, K_{fR}), which are HFB outputs. It therefore adds no free parameter, and the singular values of Y_f^c are those of $Y_f^\star$ conjugated by fixed positive operators; in particular rank is preserved.

A non-positive kinetic metric is a **FAIL** under P2. A singular metric is admissible only after every null direction has been classified by HFB-1, and the classification travels with the package.

10. Gauge-Normalisation Bridge

The gauge kinetic action at $\mu\star$ is

$$\mathcal{L}_{gauge} = -\tfrac{1}{4} Z_3 G^a_{\mu\nu} G^{a\mu\nu} - \tfrac{1}{4} Z_2 W^i_{\mu\nu} W^{i\mu\nu} - \tfrac{1}{4} Z_q F^q_{\mu\nu} F_q^{\mu\nu}$$

so that the canonical couplings are

$$g_s = Z_3^{-1/2},\quad g = Z_2^{-1/2},\quad g_q = Z_q^{-1/2}$$

If the primitive Abelian generator is $q = 6Y$, then the conventional hypercharge coupling satisfies $g'Y = g_q q = 6 g_q Y$, hence

$$g' = 6 g_q$$

This factor is a basis conversion between generator normalisations, not a fitted normalisation. It is fixed by the charge lattice returned upstream and carries no freedom.

The electric coupling and the weak angle are **derived**, not supplied:

$$e = g g' / \sqrt{g^2 + g'^2} \quad \sin^2\theta_W = g'^2 / (g^2 + g'^2)$$

in the declared running scheme, at the declared scale. Neither is an independent input at any stage.

11. Scalar and Yukawa Finite Matching

The scalar finite bridge:

$$\mu^2_{H,R} = \mu^2_{H,\star} + \Delta\mu_H^2, \quad \lambda_R = \lambda_\star + \Delta\lambda$$

The Yukawa bridge is matrix-valued:

$$Y_{f,R} = L_f^\dagger \left(Y_{f,\star} + \Delta Y_f \right) R_f$$

where L_f and R_f are fixed canonical basis maps declared in the manifest. They are explicitly **not** mass-diagonalising transformations selected after the result is known; using a diagonalising frame here would smuggle the output into the bridge.

The bridge must preserve:

- gauge covariance;
- flavour-basis covariance (§21);
- determinant phases;
- rank within the declared numerical-rank tolerance;
- CY3′ route agreement to the declared order.

Each preservation property is published as a residual, not asserted.

12. Neutral-Object Bridge

The neutral object is typed as one of

$$\mathcal{B}_\nu^D = \{ Y_\nu \} \quad \mathcal{B}_\nu^M = \{ M_L, M_D, M_R \} \quad \mathcal{B}_\nu^{\text{constrained}} = \text{branch-specific subset with declared constraints}$$

For the general mixed branch the neutral mass operator is the complex symmetric block

$$\mathbb{M}_\nu = \begin{pmatrix} M_L & M_D \\ M_D^T & M_R \end{pmatrix}$$

The bridge acts on the entire object:

$$\mathcal{B}_{\nu,R} = \mathcal{S}_{\nu,\star\to R}\left[\mathcal{B}_{\nu,\star}\right]$$

It may not discard M_L, M_R, sterile carriers or determinant phases because a simpler Dirac calculation would be more tractable. Dimensional reduction of the neutral sector occurs only through the threshold protocol of §26, and leaves a Schur residual (§55.8) that is published.

13. Strong-Phase Bridge

The physical invariant is

$$\bar{\theta} = \theta_{top} + \arg\det(M_u M_d) \pmod{2\pi}$$

A chiral field redefinition may shift the two terms separately but must leave $\bar{\theta}$ invariant; the invariance is checked numerically as $\varepsilon_{\bar{\theta}}$ (§55.9) under a pre-registered family of test redefinitions.

The determinant line supplies the global framework in which the determinant phase is defined. It is classified as exactly one of:

1. **trivial** — adds no third phase;
2. **globally obstructed** — prevents a single-valued determinant phase, which is itself a reportable physical result;
3. **genuinely independent residual holonomy** — admitted only with an independence proof supplied by the upstream global-measure certificate.

No unclassified θ_{line} is added to $\bar{\theta}$. Classification 3 without proof is a falsifier (F19).

14. Convention Group, Physical Quotient and Round-Trip Certificate

The strength of the closure claim depends on stating precisely what is meant by uniqueness. It is not uniqueness of a coordinate tuple; it is uniqueness of a point in a quotient.

Definition 14.1 — Convention group. Let $\mathbb{G}_{conv}$ be the group generated by

- flavour-basis unitaries: $Y_f \mapsto U_L^\dagger Y_f U_R$, with the corresponding action on $\mathbb{M}_\nu$;
- rephasings of charged and neutral fields, including the chiral rephasings that redistribute θ_{top} and arg det;
- gauge-generator basis changes preserving the charge lattice;

- admissible renormalisation-scheme changes within the declared class;
- ordering conventions of singular and Takagi values.

Theorem 14.2 — Quotient invariance. Let $\mathfrak{O}\_{phys}^{inv}$ denote the invariant output list of §60. Then $\mathfrak{O}\_{phys}^{inv}$ is constant on $\mathbb{G}\_{conv}$-orbits: for every $\gamma \in \mathbb{G}\_{conv}$,

$$\mathfrak{O}_{phys}^{inv} (\gamma \cdot p) = \mathfrak{O}_{phys}^{inv} (p) + O(\text{truncation})$$

Proof sketch. Each generator acts on the boundary vector by a transformation under which the beta functions are equivariant (§21) and the threshold maps are covariant by construction (§25). Complex poles are zeros of det Γ, which is invariant under field redefinitions of unit Jacobian and covariant under the remainder; singular values, Takagi values, rephasing-invariant quartets, Jarlskog invariants, det$[H_u, H_d]$ and θ are by definition orbit functions. Scheme changes within the declared class shift intermediate quantities at order $(16\pi^2)^{-(L+1)}$, which is precisely the retained truncation remainder and is carried in Σ_O^{scheme}. Hence the invariant list is well defined on the quotient $\mathcal{Q}$ = {boundaries} / $\mathbb{G}\_{conv}$. ■

Corollary 14.3. The composite descends to a well-defined map $\bar{F} : \mathcal{Q} \to \mathcal{O}\_{inv}$ on the quotient. "Unique renormalised Standard Model" in Theorem 60.1 therefore means: the input represents one class $[p] \in \mathcal{Q}$, and the transport assigns it one invariant package $\bar{F}([p])$ — not that the output is itself a point of $\mathcal{Q}$. A published result that is unique only in a particular basis has not closed.

Round-trip certificate. The bridge must satisfy

$$\mathcal{S}_{R\to\star} \circ \mathcal{S}_{\star\to R} = I + O((16\pi^2)^{-(L_S+1)})$$

on the supported boundary carrier. Define

$$\varepsilon_{bridge} = \| \mathcal{S}_{R\to\star} \circ \mathcal{S}_{\star\to R}[p\star] - p\star \|$$

with the norm declared in the manifest. The bridge passes when $\varepsilon\_{bridge} \le \tau\_{bridge}$, with τ_{bridge} frozen before any output is opened.

Part III — Coupled Renormalisation-Group Transport

15. Common RG State Vector

Let $t = \ln \mu$. The running state is **effective-theory dependent**: its entries change at every threshold, and it includes the Wilson coefficients generated by that threshold. Schematically,

$$p_r(t) = \{ g_s, g, g', \mu_H^2, \lambda, Y_u, Y_d, Y_e, Y_\nu, M_R, C^{(5)}, C^{(6)}, \ldots, \theta\}|_{\mathfrak{E}_r}$$

with the precise entry list fixed by the operator basis of $\mathfrak{E}_r$ and published in the ledger of §29. A state vector that omits the Wilson coefficients generated at a threshold it has already crossed is incomplete at the claimed order and falsifies P1.

Its evolution is one coupled system:

$$\mathbf{d\,p / d\,t = \boldsymbol{\beta}_{\mathfrak{S}\_R} (p, \mathfrak{T}(t))}$$

where $\mathfrak{T}(t)$ records the fields active at scale μ.

Sectors may not be evolved independently and recombined afterwards unless exact factorisation has been proved for the declared truncation. Sequential single-sector running is a known source of silent error in flavour transport, because the mixing frames run even where the singular values are stationary.

16. Gauge Running

On the full three-generation, one-doublet interval, the one-loop reference equations in conventional hypercharge normalisation are

$$\mathbf{16\pi^2\, dg_s/dt = -7\, g_s^3 \quad 16\pi^2\, dg/dt = -(19/6)\, g^3 \quad 16\pi^2\, dg'/dt = +(41/6)\, g'^3}$$

These are the minimum reference implementation, not necessarily the production truncation. The production manifest fixes:

- loop order L_g;
- threshold-dependent beta coefficients;
- finite scheme conversion between orders;
- treatment of any additional HFB-returned states charged under the gauge group;
- integration tolerances and the stiffness handling.

A threshold changes the active-field content and therefore $\boldsymbol{\beta}$. It never licenses a reset to a measured coupling.

17. Charged-Yukawa Running

Define, when Dirac-neutral Yukawas are active,

$$\mathbf{T_Y = \mathrm{Tr}(3\, Y_u^\dagger Y_u + 3\, Y_d^\dagger Y_d + Y_e^\dagger Y_e + Y_\nu^\dagger Y_\nu)}$$

In the convention that Y_f maps right carriers to left carriers, the one-loop reference equations are

$$\mathbf{16\pi^2\, \beta_{Y_u} = (3/2)(Y_u Y_u^\dagger - Y_d Y_d^\dagger)\, Y_u + Y_u\, [\, T_Y - (17/12)\, g'^2 - (9/4)\, g^2 - 8\, g_s^2\,]}$$

$$16\pi^2 \beta_{Y_d} = (3/2)(Y_d Y_d^\dagger - Y_u Y_u^\dagger) Y_d + Y_d [T_Y - (5/12) g'^2 - (9/4) g^2 - 8 g_s^2]$$

$$16\pi^2 \beta_{Y_e} = (3/2)(Y_e Y_e^\dagger - Y_\nu Y_\nu^\dagger) Y_e + Y_e [T_Y - (15/4) g'^2 - (9/4) g^2]$$

and, on a Dirac-neutral branch,

$$16\pi^2 \beta_{Y_\nu} = (3/2)(Y_\nu Y_\nu^\dagger - Y_e Y_e^\dagger) Y_\nu + Y_\nu [T_Y - (3/4) g'^2 - (9/4) g^2]$$

The production implementation may use higher-order beta functions, but must preserve **full matrix evolution**. Evolving only singular values loses the running of the mixing frames and hence of the CP invariants; this is not a small effect in the transported Jarlskog invariant and is treated as a categorical error, not an uncertainty.

18. Scalar Running

Use the convention

$$V(H) = -\mu_H^2 H^\dagger H + \lambda (H^\dagger H)^2$$

The one-loop reference equations are

$$16\pi^2 \beta_{\mu_H^2} = \mu_H^2 [12\lambda + 2 T_Y - (9/2) g^2 - (3/2) g'^2]$$

$$16\pi^2 \beta_\lambda = 24\lambda^2 - 3\lambda(3g^2 + g'^2) + (3/8)[2g^4 + (g^2 + g'^2)^2] + 4\lambda T_Y - 2 \mathrm{Tr}[3(Y_u^\dagger Y_u)^2 + 3(Y_d^\dagger Y_d)^2 + (Y_e^\dagger Y_e)^2 + (Y_\nu^\dagger Y_\nu)^2]$$

Consistency check 18.1 — quartic-vertex coherence. The coefficient of λ in $\beta_{\mu_H^2}$ and the coefficient of λ^2 in β_λ arise from the same quartic vertex and satisfy, at one loop in this convention,

$$c_{\lambda, \mu^2} = \tfrac{1}{2} c_{\lambda^2, \lambda} \Rightarrow 12 = \tfrac{1}{2} \cdot 24 \checkmark$$

This identity is checked automatically for whatever truncation the manifest selects; a mismatch indicates a convention error in the scalar sector rather than a physical result, and halts execution.

Terms involving inactive heavy-neutral fields are removed **only** through the threshold protocol.

The running quartic may become negative. RPC-1 reports that result together with the associated instability scale and the tunnelling classification implied by the declared operator basis. It may not insert higher-dimensional stabilisation unless those operators were present in the frozen HFB EFT package (P1).

19. Neutral-Sector Running

Convention 19.0 — Symmetric-phase objects. Above electroweak breaking, M_D and an active M_L are *not* gauge-invariant objects and are not transported as symmetric-phase mass matrices. The objects that run are the gauge-invariant ones: the Yukawa Y_ν, the singlet mass M_R, the Weinberg coefficient $\kappa = C^{(5)}$, and the parameters of an explicit triplet sector where the branch returns one. The broken-phase block

$$\mathbb{M}_\nu = \begin{pmatrix} M_L & M_D \\ M_D^T & M_R \end{pmatrix}$$

is assembled **after** electroweak symmetry breaking, from $M_D = (v/\sqrt{2})\, Y_\nu$ and $M_L = (v^2/2)\, \kappa$. The transport equations below are therefore to be read as the broken-phase or low-energy-effective form, applicable below the electroweak scale or on a branch whose returned objects are already of that type; above it, the equations of §17 for Y_ν and the singlet-mass and κ equations of the ledger apply.

For a mixed neutral branch in the broken-phase form, $\mathcal{B}_\nu = \{ M_L, M_D, M_R \}$ evolves covariantly:

$$dM_L/dt = \gamma_L^T M_L + M_L \gamma_L + \beta_L^{vert} \quad dM_D/dt = \gamma_L M_D + M_D \gamma_N + \beta_D^{vert} \quad dM_R/dt = \gamma_N^T M_R + M_R \gamma_N + \beta_R^{vert}$$

with anomalous dimensions and vertex terms determined by the active branch and its gauge representations, as declared in Appendix C.

For a pure Dirac branch, $M_D = (v/\sqrt{2})\, Y_\nu$ and the Yukawa equation of §17 applies.

When heavy neutral states are integrated out, the low-energy object is the exact tree-level light-block Schur complement

$$M_\nu^{light} = M_L - M_D M_R^{-1} M_D^T$$

with loop corrections and operator normalisation fixed by the threshold manifest.

Lemma 19.1 — Schur error bound. If M_R is invertible with condition number $\kappa(M_R)$ and $\|M_D\| / \sigma_{min}(M_R) = \epsilon_{mix}$, then the exact light spectrum differs from the Schur spectrum by $O(\epsilon_{mix}^4\, \sigma_{min}(M_R))$ at tree level, and the neglected mixing is bounded by ϵ_{mix}. Both ϵ_{mix} and $\kappa(M_R)$ are published with the matching, and the reduction is refused when ϵ_{mix} exceeds the declared tolerance — a near-singular M_R is an unresolved mixed branch, not an automatic seesaw.

20. Strong-Phase Transport

Within a fixed effective theory and a fixed global determinant-line trivialisation, the physical combination $\bar\theta = \theta_{top} + \arg\det(M_u M_d)$ is transported as one invariant, with

$$d\bar\theta/dt = 0$$

to the declared order inside one EFT, subject to threshold phase matching. At a chiral threshold,

$$\theta^- = \theta^+ + \Delta\theta_{thr}$$

where $\Delta\theta_{thr}$ is fixed by the determinant phase of the integrated-out operator and by the declared global section. Each threshold contributes exactly once; the ledger enforces single counting by hash, and a repeated contribution is F19.

21. Flavour-Basis Covariance

Under scale-dependent unitary basis changes $Y_f \mapsto U_L^\dagger Y_f U_R$, physical observables must be unchanged. The RG implementation must therefore satisfy the equivariance

$$\beta_{Y_f} \mapsto U_L^\dagger \beta_{Y_f} U_R + (\text{connection terms})$$

with the connection terms generated by the scale dependence of the frame convention and declared explicitly if a running frame is used.

A preferred numerical basis may be used for integration, but every published result must include basis-invariant objects:

- singular values;
- traces and determinants of Hermitian bilinears;
- commutator invariants, notably $\det[H_u, H_d]$;
- Jarlskog invariants;
- Takagi values;
- active-projector invariants;
- the determinant-line phase.

Test 21.1 — frame randomisation. The pipeline is executed on a pre-registered set of random initial frames $\gamma \in \mathbb{G}_{conv}$. The spread of the invariant list across that set is published as ε_{frame} and must lie below the numerical-conditioning budget. This is a direct empirical test of Theorem 14.2 on the actual code, and it is run before any output is opened.

22. RG Existence, Maximal Interval and Conditioning

Theorem 22.1 — Well-posedness and maximal interval. Let $\boldsymbol{\beta}$ be the declared truncation, polynomial in the components of p with manifest-fixed coefficients, on a fixed effective theory $\mathfrak{E}_r$. Then $\boldsymbol{\beta}$ is locally Lipschitz on any bounded region of parameter space, so for each admitted boundary $p(t_0) = p^\star$ there exists a unique maximal open interval $I = (t^-, t^+) \ni t_0$ and a unique solution $p(t)$ on I. If $t^+ < \infty$ then $p(t)$ **leaves every compact subset of $\mathcal{D}$** as $t \to t^+$. *Proof.* Picard–Lindelöf gives local existence and uniqueness; the standard continuation argument extends the solution to a maximal interval, and the escape criterion for a locally Lipschitz field on an open domain is escape from every compact subset. ■

Remark 22.1a — Escape is not only divergence. The physical domain $\mathcal{D}$ is an *open subset* cut out by positivity, invertibility, rank, branch-persistence and kinetic-support conditions, not all of finite-dimensional parameter space. Escape from every compact subset therefore admits two qualitatively different outcomes, and the ledger must record which occurred:

Escape mode	Signature
Norm divergence	$\|p(t)\| \to \infty$ (Landau pole)
Boundary approach at finite norm	det M_R → 0; a kinetic eigenvalue → 0; a rank change; a threshold collision; a branch boundary; exit from the declared perturbative domain

The second mode is the more common and the easier to miss, because nothing in the numerics grows. The solver therefore monitors the *domain-defining functionals* — not merely $\|p\|$ — and reports the escape mode with the escape scale.

Corollary 22.2 — Landau poles are results. A finite t^+ below the target scale is a physical statement about the transported branch under P3, reported with the escape scale and the escaping component. It is neither an implementation defect to be regularised nor a reason to alter the boundary.

The numerical solver publishes:

ε_RGE = max_t ‖ dp_num/dt − β(p_num) ‖ Δ_h O = O(h) − O(h/2) (step-size stability) **Δ_p O = O(p) − O(2p)** (precision stability)

A Landau pole, singular matrix flow, negative kinetic coefficient or uncontrolled vacuum instability terminates the corresponding transport interval and is reported as a FAIL or as a finite-domain result. It is never a reason to alter the boundary.

Part IV — Threshold Matching

23. Threshold Census

The threshold ledger is inherited from the HFB spectrum and updated self-consistently under running. Each entry is

t_i = { χ_i, M_i(μ), μ_i^dec, 𝓜_i, L_i, Σ_i, h_i }

Field	Meaning
χ_i	the field or multiplet
M_i(μ)	its running mass operator
μ_i^dec	the decoupling scale

Field	Meaning
$\mathcal{M}_i$	the matching map
L_i	the loop order of the matching
Σ_i	the threshold uncertainty
h_i	the provenance hash

No unlisted field is integrated out. No listed field is retained solely because removing it worsens agreement.

24. Self-Consistent Threshold Scale and Its Existence

The canonical threshold scale for a one-dimensional mass is the positive solution of

$$\boldsymbol{\mu_i^{dec} = M_i(\mu_i^{dec})}$$

For a matrix block, the frozen spectral rule reads

$$\boldsymbol{\mu_i^{dec} = \sigma_i [M(\mu_i^{dec})]}$$

with σ_i the declared singular or Takagi value.

Theorem 24.2 — Existence and isolation. Define $\varphi(t) = \ln M_i(e^t) - t$ on the transported interval. If M_i is C^1 and

$$\boldsymbol{d \ln M_i / d \ln \mu < 1}$$

throughout an interval on which φ changes sign, then a solution exists in that interval and is unique there. *Proof.* φ is continuous with $\varphi' = d \ln M_i/d \ln \mu - 1 < 0$, so φ is strictly decreasing; a sign change therefore yields exactly one zero by the intermediate value theorem and strict monotonicity. ■

Corollary 24.3. The anomalous dimension condition $|\gamma_i| < 1$ is the practical sufficient condition for threshold identifiability (P5). It is evaluated and published for every census entry before the threshold is used.

If no isolated solution exists, the branch returns a **threshold non-identifiability certificate**. RPC-1 may not substitute a convenient external scale, and the affected outputs are marked UNRESOLVED rather than estimated.

25. Gauge and Matter Decoupling

Across a threshold, $p^- = \mathcal{M}_i [p^+]$, with

$$g_A^- = g_A^+ \left[1 + \Sigma_{\ell=1}^{L_i} \zeta_{A,i}^{(\ell)} / (16\pi^2)^\ell \right] \quad Y_f^- = Y_f^+ + \Delta_i Y_f$$
$$\mu_H^{2-} = \mu_H^{2+} + \Delta_i \mu_H^2 \quad \lambda^- = \lambda^+ + \Delta_i \lambda$$

Every finite correction is calculated from the frozen EFT and the active spectrum, and every correction carries its own hash so that the matching history is reconstructible from the ledger alone.

26. Heavy-Neutral Matching

Partition the neutral block into light and heavy carriers:

$$\mathbb{M}_\nu = \begin{pmatrix} M_{LL} & M_{LH} \\ M_{LH}^T & M_{HH} \end{pmatrix}$$

At leading order,

$$M_{LL}^{eff} = M_{LL} - M_{LH} M_{HH}^{-1} M_{LH}^T$$

Generated operators. Integrating out heavy singlets does not merely replace the block by a light mass matrix. It generates the dimension-five Weinberg operator with coefficient

$\kappa = C^{(5)} = M_D M_R^{-1} M_D^T \cdot (2/v^2)$ at tree level, matched at μ_i^{dec}

and, beyond leading order, dimension-six coefficients (notably the kinetic-mixing operator responsible for active nonunitarity) together with threshold corrections. These Wilson coefficients enter p_r below the threshold (§15) and run with their own anomalous dimensions. Omitting them is a P1 falsifier, not an approximation.

The matching package must include:

- the complete set of generated Wilson coefficients at the declared order, with their matching scale;
- the heavy-state projector and its stability under precision refinement;
- $\kappa(M_{HH})$ and the conditioning report;
- loop corrections at the declared order;
- the effective-operator normalisation;
- active–sterile mixing retained to the declared order;
- the threshold determinant phase.

By Lemma 19.1, a near-singular M_{HH} is **not** automatically a seesaw. It is an unresolved mixed branch unless the numerical conditioning is controlled.

27. Quark Thresholds and Colour Matching

At a coloured threshold, RPC-1 updates, in one coherent step:

- g_s and the QCD beta coefficients;
- active Yukawa traces T_Y;
- the scalar beta functions;
- the QCD Λ-parameter across the flavour interval;
- determinant phases;
- the nonperturbative strong-sector matching ledger.

The same running quark mass that defines the threshold enters the Yukawa and QCD matching calculations. Different threshold masses for the same state are forbidden unless their scheme conversion is published and hashed.

28. Near-Degenerate Thresholds

If $| M_i - M_j | \lesssim \Delta_{match}$, sequential decoupling is order-sensitive. The manifest must preselect either

1. simultaneous block matching, or
2. sequential matching with an order-variation uncertainty entering $\Sigma_O^{threshold}$.

The preferred order may not be selected after seeing the final observables. Where the two prescriptions differ by more than the declared budget, the affected outputs are UNRESOLVED.

29. Effective-Theory Ledger

After each threshold, publish

$\mathfrak{E}_r$ = { active fields, gauge group, parameter vector, operator basis, beta functions, matching history, scheme, hash }

so that the entire flow is an auditable chain

$$\mathfrak{E}_0 \to \mathfrak{E}_1 \to \cdots \to \mathfrak{E}_N$$

with each arrow carrying its matching map and its uncertainty. The chain, not the endpoint, is the object under audit.

Part V — Electroweak and Flavour Reconstruction

30. Effective Electroweak Vacuum

The effective potential is

$$V_{eff}(H; \mu) = -\mu_H^2(\mu)\, H^\dagger H + \lambda(\mu)\, (H^\dagger H)^2 + \Delta V(H; \mu)$$

Writing $H = (1/\sqrt{2})\, (\, 0\, ,\, v + h\,)^T$, the tadpole equation is

$$-\mu_H^2(\mu) + \lambda(\mu)\, v^2(\mu) + (1/v(\mu))\, \partial \Delta V/\partial h\, |_{h=0} = 0$$

At tree level, $v^2(\mu) = \mu_H^2(\mu) / \lambda(\mu)$.

The solution is accepted only if, on the declared domain,

$v^2 > 0$, $\lambda_{eff} > 0$, and colour and electromagnetic directions remain unbroken

Non-isolation of the stationary point is a P6 falsifier. The gauge dependence of ΔV is controlled by the Nielsen identity; the extracted physical quantities are the poles of §41, not the value of V_{eff} at the minimum.

If HFB-1 provides an independent v_{cl}, the consistency residual is

$$\varepsilon_v = |\, v_{EWSB}(\mu\star) - v_{cl}\, | \,/\, \max(\, v_{EWSB}, v_{cl}\,)$$

published as a cross-sector residual and never used to adjust μ_H^2 or λ.

31. Gauge-Boson Running Masses

At leading order,

$$m_W^2(\mu) = \tfrac{1}{4}\, g^2(\mu)\, v^2(\mu) \quad m_Z^2(\mu) = \tfrac{1}{4}\, [\, g^2(\mu) + g'^2(\mu)\,]\, v^2(\mu) \quad m_\gamma^2(\mu) = 0$$

with neutral mass matrix

$$\mathbb{M}_0^2 = (v^2/4)\, (\, g^2\ -g\, g'\, ;\, -g\, g'\ g'^2\,)$$

whose zero eigenvalue is protected by the electromagnetic Ward identity — $\det \mathbb{M}_0^2 = 0$ identically in this convention. A nonzero photon pole mass is a **FAIL** (F11) unless an explicitly different physical branch has been returned upstream and certified as such.

32. Higgs Running Curvature

The running radial curvature is

$m^2_{H,run}(\mu) = \partial^2 V_{eff}/\partial h^2\, |_{h=0}$, with tree-level value $m^2_{H,run} = 2\, \lambda\, v^2$

The HFB scalar value and the effective-potential route must agree to the declared matching order. A discrepancy is entered in the scalar cross-sector residual (§55.1, §55.13) and is never removed by redefining λ.

33. Charged-Fermion Mass Matrices

$$M_u(\mu) = \frac{v(\mu)}{\sqrt{2}}\, Y_u(\mu),\quad M_d(\mu) = \frac{v(\mu)}{\sqrt{2}}\, Y_d(\mu),\quad M_e(\mu) = \frac{v(\mu)}{\sqrt{2}}\, Y_e(\mu)$$

For each sector, compute the singular-value decomposition

$$U_{fL}^\dagger M_f U_{fR} = D_f = \mathrm{diag}(m_{f1}, m_{f2}, m_{f3}),\quad m_{fi} \geq 0$$

The ordering convention is frozen before comparison with observed flavour labels; the labels *up, charm, top* are attached only at Stage 13, and the ordering itself is a prediction to be checked rather than an assumption to be imposed.

A singular value is set to zero only under the pre-registered numerical-rank rule, with the rank report published.

34. CKM Matrix and the Charged CP Invariant

$$V_{CKM} = U_{uL}^\dagger U_{dL}$$

Publish: the complex 3×3 matrix; all row and column unitarity residuals; its singular values; a declared angle–phase parameterisation; the rephasing-invariant quartets; and the Jarlskog invariant

$J_{CKM} = \mathrm{Im}[V_{ij} V_{kl} V_{il} V_{kj}],\ i \neq k,\ j \neq l$**

up to the associated sign convention.

Equivalently, with $H_f = M_f M_f^\dagger$ and $C_q = [H_u, H_d]$,

$$\det C_q = -2i\, J_{CKM} \times \prod_{i<j} (m_{ui}^2 - m_{uj}^2)(m_{di}^2 - m_{dj}^2)$$

for three non-degenerate generations. The two routes to the CP obstruction are computed independently and compared; agreement is the residual ε_{CP}, and disagreement is a frame or convention error rather than a physical result.

35. Neutral Mass Block

For the general branch,

$$\mathbb{M}_\nu = \begin{pmatrix} M_L & M_D \\ M_D^T & M_R \end{pmatrix} = \mathbb{M}_\nu^T$$

with dimensions determined by the HFB carrier census. No sterile row or column may be deleted because its mixing is numerically small; deletion occurs only through the threshold protocol, and leaves an auditable Schur residual.

36. Takagi Reduction

A complex symmetric matrix admits a Takagi decomposition

$$\mathbf{U_\nu^T \mathbb{M}_\nu U_\nu = D_\nu = diag(m_{\nu 1}, \dots, m_{\nu N}), \; m_{\nu i} \geq 0}$$

Publish every Takagi value; the complete unitary U_ν; the active and sterile projectors; rank and conditioning; the phase conventions; and the residual

$$\boldsymbol{\varepsilon}_{\mathbf{Takagi}} = \| \mathbf{U_\nu^T \mathbb{M}_\nu U_\nu - D_\nu} \|$$

Remark 36.1. Takagi values of a nearly degenerate pair are individually ill-conditioned even where the pair is well conditioned as a block. The conditioning report is therefore per-block, not per-value, and near-degenerate pairs are published as a block with their mixing angle.

37. PMNS Matrix and Active Nonunitarity

Let P_a project onto active left-handed neutral carriers, and define the active neutral mixing block $N_\nu = P_a U_\nu P_{light}$. Then

$$\mathbf{U_{PMNS} = U_{eL}^\dagger N_\nu}$$

In a branch with no active–sterile leakage, U_{PMNS} is unitary. In a general mixed branch the deviation is a **prediction**, and two distinct conventions for it are in circulation. RPC-1 fixes both symbols and never mixes them.

Definition 37.1 — Unitarity defect. With Θ the heavy–light mixing,

$$\boldsymbol{\Delta}_{\mathbf{NU}} = \mathbf{I_3 - U_{PMNS} U_{PMNS}^\dagger \simeq \Theta \Theta^\dagger, \; \Theta = M_D M_R^{-1}}$$

so that, for a general complex M_R,

$$\boldsymbol{\Delta}_{\mathbf{NU}} \simeq \mathbf{M_D M_R^{-1} (M_R^{-1})^\dagger M_D^\dagger}$$

Note that $(M_R^{-1})^\dagger \neq M_R^{-1}$ in general, and the frequently written $M_D M_R^{-2} M_D^\dagger$ is valid only for real M_R.

Definition 37.2 — Triangular parameter. In the alternative parameterisation $N = (I - \eta) U$ with U unitary,

$$\boldsymbol{\eta} \simeq \tfrac{1}{2} \boldsymbol{\Theta \Theta^\dagger} = \tfrac{1}{2} \boldsymbol{\Delta}_{\mathbf{NU}}$$

The factor of ½ belongs to η and **not** to Δ_{NU}. Publication uses Δ_{NU} as the primary object; η appears only where an external comparison demands that convention, and then always with Definition 37.2 cited.

Publish U_{PMNS}; Δ_{NU} (and η if used); the light and heavy masses; the active fractions; the Dirac-type invariant CP quantity; and the Majorana invariants where applicable. A published nonunitarity that does not name its convention is F15.

38. Neutral Low-Energy Invariants

For a Majorana or mixed branch, the effective neutrinoless-double-beta quantity is

$$m_{\beta\beta} = \left| \Sigma_{i \in \text{light}} (U_{PMNS})_{ei}^2 \, m_{\nu i} + \Delta_{heavy} \right|$$

with Δ_{heavy} included only when the branch and operator basis require it, and with the nuclear-matrix-element dependence held outside the RPC prediction as an explicitly separate comparison layer.

For beta decay, on the resolved light sector,

$$m_\beta^2 = \Sigma_i \left| (U_{PMNS})_{ei} \right|^2 m_{\nu i}^2$$

The cosmological mass sum is an observable comparison object,

$$\Sigma_\nu = \Sigma_{i \in \text{cosmologically active}} m_{\nu i}$$

but cosmological data do not determine which states are active in the RPC calculation. The active set is a branch output.

Part VI — Poles and Physical Observables

39. Complex-Pole Definition

For an unstable particle the physical pole is the complex zero of the inverse propagator,

$$s_p = M_p^2 - i\, M_p \Gamma_p$$

The quoted pole mass and width derive from s_p, never from a gauge-dependent off-shell mass parameter.

A valid pole must be:

- isolated on the declared Riemann sheet;
- stable under gauge-parameter variation to the retained order;
- stable under numerical precision refinement;
- connected continuously to the frozen branch.

Failure of any condition is a P7 falsifier for that observable and marks it UNRESOLVED rather than approximate.

40. W, Z and Photon Poles

The transverse charged inverse propagator is

$\boldsymbol{\Gamma_W^T(s) = s - m_W^2(\mu) - \Pi_W^T(s, \mu)}$, with the pole at $\boldsymbol{\Gamma_W^T(s_W) = 0}$

For the neutral system,

$\boldsymbol{\Gamma_0^T(s) = s\, I - \mathbb{M}_0^2 - \Pi_0^T(s)}$, with $\boldsymbol{\det \Gamma_0^T(s) = 0}$

giving the Z and photon poles. The photon solution must remain at $s_\gamma = 0$ within the Ward residual ε_{Ward}; the residual, not the assumption, is what is published.

41. Higgs Pole

$\boldsymbol{s_H - m^2_{H,run}(\mu) - \Pi_H(s_H, \mu) = 0}$, $\boldsymbol{s_H = M_H^2 - i\, M_H\, \Gamma_H}$

Theorem 41.2 — Gauge independence of the pole. If the broken-phase self-energy is computed consistently at order L with the tadpole condition of §30 imposed at the same order, the solution s_H is independent of the gauge parameter ξ up to $O(\hbar^{L+1})$, by the Nielsen identity $\partial V_{eff}/\partial\xi = -C(h, \xi)\, \partial V_{eff}/\partial h$ and its propagator analogue. *Consequence.* Residual ξ-dependence at the retained order is a diagnostic of an inconsistent order assignment between tadpole and self-energy, and is reported as such rather than absorbed into the uncertainty. The ξ-scan is run as a mandatory pre-publication test.

A running curvature mass is never silently relabelled as the pole mass (Firewall R12).

42. Charged-Lepton Poles

For mass eigenstate i, the pole follows from

$\boldsymbol{\det [\, \not{p} - D_e(\mu) - \Sigma_e(\not{p}, \mu)\,] = 0}$

Mixing self-energies are retained until the pole residues are diagonalised; diagonalising first and correcting afterwards is not equivalent at the retained order where the states are near-degenerate. The outputs are the three charged-lepton pole masses and, where relevant, widths.

43. Quark Mass Observables and Confinement

Quarks require a stricter distinction, and RPC-1 makes it explicitly rather than inheriting the loose usage common in assembly papers.

RPC-1 publishes:

- MS-bar running quark masses at declared scales;
- short-distance heavy-quark masses in declared schemes;
- the top complex pole **or** a defined short-distance replacement;
- formal perturbative pole conversions, each carried with its renormalon-ambiguity estimate of order Λ_{QCD};
- nonperturbative matching objects returned by the QCD sector.

For u, d and s, **no isolated physical pole mass is claimed**. Confinement removes an asymptotic one-quark pole from the physical spectrum, and a number produced by a perturbative pole formula in that regime is an artefact of the truncation.

For c and b, a formal pole mass may be tabulated as a perturbative conversion, but the primary precision output is a short-distance mass.

For the top quark, the field-theoretic complex pole is distinguished explicitly from any experimentally reconstructed Monte-Carlo mass; the two are different quantities and are never compared without a declared conversion and its uncertainty.

This qualification strengthens rather than weakens the closure theorem. It prevents an object with no asymptotic state from being presented as a completed observable merely because the original brief used the phrase "pole mass".

44. Neutral Poles

For stable or effectively stable neutral eigenstates, the pole masses are the real positive zeros associated with the Takagi eigenmodes after self-energy correction. For an unstable heavy neutral state,

$$\mathbf{s_{N_i} = M_{N_i}^2 - i\, M_{N_i}\, \Gamma_{N_i}}$$

The active fractions and the residues are published with each pole, since a heavy state's observability depends on the residue and not on the mass alone.

45. Couplings at Comparison Scales

At predeclared scales μ_c,

$$\alpha_s(\mu_c) = g_s^2(\mu_c) / 4\pi,\ \alpha(\mu_c) = e^2(\mu_c) / 4\pi,\ \sin^2\theta_W(\mu_c) = g'^2(\mu_c) / [\ g^2(\mu_c) + g'^2(\mu_c)\ ]$$

The scales may include conventional comparison points, but the *measured values* at those points never enter the evolution. Where a comparison scale is itself defined by a measured mass, the scale is treated as a label at Stage 13 and as a pure number during transport, with the substitution recorded.

46. QCD Scale and Strong Matching

Define the scheme-specific QCD scale by

$$\ln(\mu / \Lambda_{QCD}) = \int^{g_s(\mu)} dg / \beta_s(g) + C_{\mathfrak{S}}$$

where $C_{\mathfrak{S}}$ fixes the declared convention. At one loop,

$\boldsymbol{\Lambda_{QCD} = \mu \exp[-8\pi^2 / (b_0 g_s^2(\mu))]}$, with threshold-dependent b_0

The production value uses the frozen higher-order beta and matching functions. The QCD output package includes:

- $\Lambda_{\mathfrak{S}}^{(n_f)}$ in every active-flavour interval;
- the threshold conversion between intervals, with single-counting enforced;
- the nonperturbative scale returned by the strong-sector paper and HFB-1;
- the triality-gap and wall information B_τ;
- the string-breaking or area-law classification where returned;
- the uncertainty from nonperturbative matching, which is not merged into the perturbative budget.

The QCD completion paper distinguishes the perturbative running problem from the confinement and triality-gap problem; RPC-1 preserves that distinction rather than collapsing both into a single Λ.

47. Physical Strong Phase

At the final hadronic matching scale,

$$\bar{\theta}_{phys} = \theta_{top} + \arg\det(M_u M_d)\ (\mathrm{mod}\ 2\pi)$$

The paper reports exactly one of:

1. $\bar{\theta}_{phys} = 0$ within uncertainty;
2. $\bar{\theta}_{phys} \neq 0$;
3. a global obstruction prevents a consistent scalar phase assignment.

A positive-pushforward branch may restrict the result to $\bar{\theta} \in \{ 0, \text{global obstruction} \}$, but that restriction must follow from the HFB global-measure certificate and never from the observed smallness of strong CP violation. Outcome 2 is a falsification of the branch against experiment at Stage 13 and is reported as such; it is not a reason to revisit the determinant-line classification.

Part VII — Uncertainty and Cross-Sector Closure

48. Input Covariance

Let the HFB primary vector be represented in real coordinates as $x^\star = \mathrm{ReIm}[\mathcal{P}_{SM}^{VERSF}]$. HFB-1 supplies $\Sigma^\star = \mathrm{Cov}(x^\star)$, retaining correlations among:

- gauge responses;
- scalar parameters;
- Yukawa entries;
- neutral blocks;
- branch quantities;
- substrate scales;
- strong-phase components.

Independent error bars are insufficient where one common substrate generates correlated shifts. A diagonal $\Sigma^\star$ is accepted only with a proof of decorrelation, and otherwise blocks admission.

49. Regulator Uncertainty

For regulator levels n and n+1,

$$\Delta_{reg} O = O^{(n+1)} - \mathcal{I}_n^{n+1} O^{(n)}$$

The regulator uncertainty follows a frozen extrapolation model, typically

$$O^{(n)} = O_\infty + c\, a_n^p + O(a_n^{p+1})$$

with exponent p, fit window and acceptance criteria frozen before empirical comparison. A fitted p that drifts outside the declared window is a convergence failure (F20), not a licence to widen the window.

50. RG and Scheme Truncation

$$\Delta_{RG} O = O^{(L)} - O^{(L-1)} \quad \Delta_{scheme} O = O_{\mathfrak{S}_1} - O_{\mathfrak{S}_2}$$

using two predeclared admissible schemes. Renormalisation-scale variation and coefficient-growth diagnostics may supplement these. Schemes may not be selected after observing which agrees better; both are published whatever the outcome.

51. Threshold Uncertainty

For each threshold, vary the decoupling point by a pre-registered factor

$$\mu_i^{dec} \mapsto \xi_i \, \mu_i^{dec}, \quad \xi_i \in [\, \xi_-, \xi_+ \,]$$

with the interval frozen before the run. For near-degenerate thresholds, include the simultaneous-versus-sequential matching difference.

52. Branch Uncertainty and Degeneracy

If HFB-1 returns a set $\mathfrak{B}_{phys} = \{ \beta_1, \ldots, \beta_r \}$, RPC-1 transports **every** member.

Define the observable distance on the invariant list, normalised by the total non-branch uncertainty:

$$d(\beta_i, \beta_j) = \max_O | O(\beta_i) - O(\beta_j) | / \sigma_O^{\text{non-branch}}$$

If $d(\beta_i, \beta_j) \le \tau_{branch}$ for all pairs, the branches are observationally equivalent to the declared precision and the result is reported as a single point of Q with a branch-multiplicity note. Otherwise the Parameter-Closure result is

DEGENERATE

and no single Standard Model boundary is claimed. Concealing a degeneracy by presenting one preferred member is F22, and is the failure mode most likely to be invisible to an outside reader — which is why the branch census is published before the observables.

53. Numerical Conditioning

Every inverse, diagonalisation and pole solve carries a condition report, including

$$\kappa(M_R) = \sigma_{max}(M_R) / \sigma_{min}(M_R), \quad \kappa(Y_f) = \sigma_{max}(Y_f) / \sigma_{min}(Y_f)$$

and the eigenvector condition number for nearly degenerate pole or mixing systems. A result whose rank, ordering or phase changes under precision refinement is **UNRESOLVED**, and is published as unresolved rather than at the precision at which it happened to be stable.

54. Output Covariance

For a differentiable observable vector $O = F(x^\star)$,

$$\Sigma_O^{input} = J_F \Sigma^\star J_F^T, \quad J_F = \partial F/\partial x^\star$$

Joint nuisance formulation. The eight categories are *not* summed by default. Regulator, scheme, threshold and numerical errors share common origins — the same truncation, the same discretisation, the same conditioning — and are in general correlated. The complete covariance is therefore built from one joint nuisance vector z collecting every nuisance parameter:

$$\Sigma_O = J_z \Sigma_z J_z^T, \quad J_z = \partial O/\partial z$$

with the **cross-blocks of Σ_z retained and published**. The naive sum

$$\Sigma_O = \Sigma_O^{input} + \Sigma_O^{reg} + \Sigma_O^{RG} + \Sigma_O^{scheme} + \Sigma_O^{threshold} + \Sigma_O^{nonpert} + \Sigma_O^{numerical} + \Sigma_O^{branch}$$

is the special case in which every cross-block vanishes, and may be used **only** with an accompanying proof or numerical demonstration of decorrelation. Using it without one is F23.

Envelopes are not covariances. Several categories are not probabilistic at all. Perturbative-truncation and scheme differences are model-discrepancy statements with no sampling distribution behind them, and representing them as Gaussian blocks fabricates a likelihood the calculation does not possess. These are published as **envelopes** — interval bounds carried alongside Σ_O, not merged into it:

Category	Representation
Input $\Sigma^\star$	probabilistic covariance
Numerical conditioning	probabilistic covariance
Regulator extrapolation	covariance if the fit supports it, else envelope
RG truncation, scheme, threshold, nonperturbative	**envelope**
Branch	discrete set, never a covariance (§52)

The published uncertainty object is therefore a pair (Σ_O , $\mathcal{E}_O$) — one covariance and one envelope set — with the decomposition by category retained inside each. A single combined error bar conceals precisely the information an auditor needs, and its use is F23.

Where F is not differentiable — at a rank change, a level crossing or a threshold reordering — the linear pushforward is invalid, and the affected outputs use the declared resampling prescription or are marked UNRESOLVED.

55. Shared-Substrate Consistency Identities

The strongest part of RPC-1 is not the list of individual predictions. It is the set of identities that must hold *because every sector comes from one substrate*. A phenomenological fit can match any single observable; it cannot easily satisfy a web of over-determined identities that were fixed in advance.

55.1 Vacuum identity. $\varepsilon_v = v_{\mu,\lambda} - v_{HFB}$ **55.2 Gauge-mass identities.** $\varepsilon_W = M_W^{pole} - \mathcal{P}_W[g, v, \Pi_W]$; $\varepsilon_Z = M_Z^{pole} - \mathcal{P}_Z[g, g', v, \Pi_0]$ **55.3 Yukawa–mass identity.** $\varepsilon_{M_f} = M_f - (v/\sqrt{2})\, Y_f$ **55.4 CY3′ identity.** $\varepsilon_f^{CY3'} = \| Y_f^{mixed} - Y_f^{Hess} \|$ — the mixed-vertex and Hessian-compression routes are evaluated independently before their outputs are compared **55.5 Gauge-vertex identity.** the same g_s, g, g' normalise the gauge kinetic terms, the matter vertices, the gauge self-interactions and the ghost/BRST identities **55.6 Ward and Slavnov–Taylor identities.** $\varepsilon_{Ward} = | \mathcal{W}[\Gamma] |$; $\varepsilon_{ST} = | \mathcal{S}[\Gamma] |$ **55.7 Flavour identity.** CKM and PMNS are constructed from the same left frames that diagonalise the corresponding running mass operators **55.8 Neutral Schur identity.** $\varepsilon_{seesaw} = \| M_{light} - M_L + M_D M_R^{-1} M_D^T \|$ **55.9 Strong-phase identity.** $\varepsilon_{\bar\theta} = \mathrm{wrap}[\bar\theta - \theta_{top} - \arg\det(M_u M_d)]$ **55.10 Threshold-path identity.** $\varepsilon_{path} = | O_A - O_B |$ for two valid matching paths, required to be of higher order than the retained calculation **55.11 Scheme identity.** physical poles and invariant mixings in two predeclared schemes agree within the scheme-truncation budget **55.12 Regulator identity.** every physical output converges under the HFB/RPC regulator lift **55.13 Scalar-route identity.** $\varepsilon_H = m^2_{H,run}$(HFB route) $- m^2_{H,run}$(effective-potential route) **55.14 CP-route identity.** $\varepsilon_{CP} = J_{CKM}$(matrix route) $- J_{CKM}$(commutator route) **55.15 Frame-invariance identity.** ε_{frame} from Test 21.1

Failure of a cross-sector identity is **not** repaired by averaging the two routes. It is reported as a failure of common-substrate closure, which is the sharpest negative result the programme can produce and is more informative than a disagreement with any single measurement.

Part VIII — Blind Execution and Certificate

56. Data Quarantine

Before execution, the following are removed from the computational environment:

- measured gauge couplings;
- measured m_W, m_Z, m_H;
- measured charged-fermion masses;
- CKM and PMNS fits;
- neutrino mass splittings and ordering;
- measured Λ_{QCD};
- strong-CP limits;
- threshold scales inferred from experiment;
- any code library whose defaults encode measured Standard Model values;

- **benchmark metrics and the arrays derived from them**, in particular the unit-metric diagnostic W_prim = I and its reduced response G_red^unit = diag(24/5, 35/6, 3/2).

The last item is a live rather than hypothetical risk. A runnable G_red^unit now exists and reproduces the canonical wheel triple to precision, which means the boundary generator could complete and return numerically plausible gauge normalisations from a benchmark metric. Its route-agreement value is real and it is retained as a diagnostic; it is protected mechanically rather than editorially. **G_red^unit and the whitening identity G_red^core = I_3 are both hashed onto the quarantined-constant proximity list of Remark 4.2**, so any boundary package whose G_red lies within tolerance of it raises a provenance halt that must be resolved by derivation trace. The unit metric may validate plumbing. It may never populate a boundary certificate.

The last item is the one most often overlooked: a standard particle-physics package that silently initialises α_s(m_Z) breaches quarantine as effectively as an explicit assignment. The quarantine check therefore runs against the *resolved* dependency tree, and the tree is hashed.

Public physical constants required only for unit conversion are held in a separate immutable unit ledger $\boldsymbol{\mathcal{U}}$. No dimensionless VERSF output may depend on $\boldsymbol{\mathcal{U}}$; this is checked by dimensional-analysis assertion on every published quantity.

57. End-to-End Execution Algorithm

Stage	Action
0	Verify admission: verdict(ɧ_HFB1) = PASS; verify all hashes and the branch identifier
1	Import the HFB package into a read-only environment
2	Apply the scheme bridge p_R(μ⋆) = $\boldsymbol{\mathcal{S}}$_{⋆→R}[p⋆]; run the round-trip certificate
3	Construct the threshold ledger from the running HFB spectrum alone; check identifiability (Thm 24.2)
4	Integrate the coupled RG equations upward and downward from μ⋆, changing EFTs only through the frozen threshold maps
5	Solve electroweak breaking: v(μ), running scalar curvature, broken gauge mass matrices
6	Construct charged flavour: M_u, M_d, M_e, singular values, frames, V_CKM, J_CKM
7	Construct the neutral sector: transport $\boldsymbol{\mathcal{B}}$_ν, apply threshold reductions, Takagi-diagonalise the complete block, compute U_PMNS and Δ_NU
8	Solve the pole equations: gauge, Higgs, lepton, neutral; declared quark short-distance masses
9	Complete the strong sector: Λ_QCD, threshold matching, triality/confinement handoff, θ̄
10	Propagate uncertainty: full covariance, all eight categories separated
11	Evaluate every cross-sector identity of §55, including the frame-randomisation test
12	Freeze predictions: write the immutable output package and its hashes
13	**Only now** open experimental data and compare

Stages 0–12 are executed without any comparison to observation. The hash written at Stage 12 is what makes the ordering verifiable after the fact.

58. Publication Package

The minimum machine-readable package:

```
hfb_input_manifest.json
hfb_boundary.json
hfb_covariance.npz
branch_certificate.json
quarantine_report.json
dependency_tree_hash.json
scheme_bridge.json
scheme_bridge_code/
beta_functions.json
rge_solution.npz
rge_residuals.json
threshold_ledger.json
threshold_identifiability.json
effective_theories/
ewsb_solution.json
running_masses.npz
ckm_matrix.npy
ckm_invariants.json
neutral_block.npy
takagi_decomposition.npz
pmns_matrix.npy
neutral_nonunitarity.npy
pole_solutions.json
pole_gauge_scan.json
qcd_scale.json
strong_phase.json
frame_randomisation.json
cross_sector_residuals.json
uncertainty_ledger.json
conditioning_report.json
rpc_certificate.json
sha256_manifest.json
```

The human-readable paper must contain enough information to reproduce the package independently. Publishing only final masses and angles does not pass RPC-1.

59. Falsification Conditions

F1 — Boundary incompleteness. Any primary HFB row is missing. **F2 — Multi-branch mixing.** Parameters from different HFB branches are combined. **F3 — Scale inconsistency.** Input rows are quoted at different scales without a declared transport. **F4 — Scheme ambiguity.** The finite bridge is absent or non-invertible to the declared order. **F5 — Observational insertion.** A measured quantity enters before Stage 13. **F6 — Loop-order rescue.** A perturbative order is changed after inspecting the output. **F7 — Threshold rescue.** A threshold scale or ordering is changed to improve agreement. **F8 — Neutral typing failure.** The returned $\mathcal{B}_\nu$ is replaced by a different neutral theory. **F9 — RG breakdown.** The coupled flow develops an unhandled singularity, Landau pole or loss of positivity before the target scale. **F10 — Vacuum failure.** No acceptable electroweak vacuum exists, or colour/electromagnetism breaks unintentionally. **F11 — Photon-mass failure.** The Ward-protected photon pole is nonzero beyond uncertainty. **F12 — Gauge-pole failure.** The W or Z pole is absent, gauge-dependent or numerically unstable. **F13 — Higgs-pole failure.** The Higgs complex pole is absent or inconsistent with the scalar boundary. **F14 — Yukawa-route failure.** CY3′ or the mixed/Hessian comparison fails. **F15 — Flavour-frame failure.** The published CKM or PMNS is not constructed from the mass-diagonalising left frames; or a nonunitarity measure is published without naming its convention (Defs. 37.1, 37.2). **F16 — Neutral-rank failure.** The neutral rank or ordering is numerically unstable. **F17 — Confinement-category failure.** An isolated light-quark pole is claimed as a physical observable. **F18 — QCD matching failure.** The colour thresholds and Λ_QCD do not form one consistent running chain. **F19 — Strong-phase failure.** $\bar{\theta}$ is incomplete, double-counted or convention-dependent; or an independent determinant-line phase is used without proof. **F20 — Regulator failure.** Physical outputs do not stabilise under refinement. **F21 — Scheme failure.** Physical poles disagree between predeclared schemes beyond the truncation budget. **F22 — Branch-degeneracy concealment.** Distinct physical outputs from a degenerate branch set are collapsed into one preferred result. **F23 — Uncertainty incompleteness.** Any output lacks a decomposed uncertainty budget. **F24 — Error-bar rescue.** An uncertainty prescription is changed after comparison with data. **F25 — Common-substrate failure.** One or more cross-sector identities fail beyond the declared order. **F26 — Reproducibility failure.** The published hashes, code and data do not reproduce the tables; or any hashed input is not the latest sealed revision of its source — hashes prove integrity, not currency (§74.6, D39). **F27 — Parameter-count inflation.** The number of independent inputs increases during execution. **F28 — Frame-invariance failure.** The invariant list varies across the frame-randomisation test beyond the conditioning budget. **F29 — Benchmark or unproven proposal-metric insertion.** A boundary row is populated, directly or through G_red, by a benchmark metric rather than the history-derived physical W_prim; an edge conductance is set to κ_e = 1; a block is inserted because the downstream Hessian requires it; or the identity representation of G_op is treated as physical without a certificate that the finite-cell basis is operational-orthonormal. The conditional continuous-proposal calculation does not fire this falsifier merely because its coordinate covariance is the identity: it passes only because the identity is explicitly typed as the representation of operational Brownian heat flow in the currently declared orthonormal basis, and because its result remains conditional and quarantined pending independent provenance of G_op, A_Q and C. **F30 — Unclassified history-null enlargement.** ker(J_D† W_prim J_D + G_V) contains a direction outside the classified kinematic null space that cannot be identified as a genuine statistical redundancy. The physical quotient is then incomplete and no boundary response may be issued. **F31 — Analytic-null mismatch.** A frozen re-implementation of the same canonical finite-cell defect map returns a kinematic null space not equal within tolerance to $\mathcal{N}$_frame^{21} ⊕ $\mathcal{N}$_rec^{18}, indicating an inconsistent residual implementation, an omitted primitive variable, a changed defect content, or a previously unseen exact redundancy. **F32 — Metric–branch ordering violation.** W_prim is Doob-normalised against an operator other than the one whose component structure supplies β⋆, contrary to the declared P10 ordering. **F33 — Coverage overstatement.** A singly-derived block of W_prim is presented as cross-checked, or the doubly/singly-derived dimension counts are not published. **F34 — Gap collapse.** The spectral gap δ_n shrinks under refinement, voiding the refinement bounds while two-level agreement is nonetheless claimed. *Status: fired twice — on the explicit 8→16-cell multi-wheel candidate (δ_{16}/δ_8 = 0.2545, §66.8) and analytically on the vertex-glued diamond chain ($\lambda_2(k) = \cos^2(\pi/4k)$, §71.3). Both families are excluded as continuum regulators. The K_{N,N} antichain family (§71.3) is the sole surviving candidate, with uniform gap ½ by theorem.* **F35 — Schur monotonicity violation.** Enlarging the auxiliary census returns G_red^{(+)} ⋠ G_red, indicating a basis mismatch or a nonpositive auxiliary block. **F37 — Transport-readout failure.** Record transport is extracted from the polar part of a finite-time path-summed kernel rather than from the generator jump blocks (Thm 69.1) or an equivalent path-resolved construction that retains the record fibre until after terminal projection. *Status: fired twice — on the entry-polar Gate-7 candidate (Wilson residual 8.67×10^{-2}, §69.1), and on the Stage-A integrated run (residual 0.370538 at finite heat time, §74.2), where the already-frozen Theorem 69.1 re-graded the verdict to PASS without new mathematics.* **F36 — Proposal-provenance failure.** The continuous update-amplitude law contains a covariance, drift, radial factor or sector width not generated by G_op, E_D, a_t, A_Q and C, or the proposal is altered after any gauge, flavour, scalar or branch output is inspected. *Status: not fired by the conditional finite-cell construction — the proposal covariance, drift and normalisation are generated by one operational geometry; physical closure remains pending because that geometry and its bath compression have not been returned at two physical regulator levels.* **F39 — Factorised-refinement corroboration.** A two-level agreement obtained from a tensor-product-factorised carrier pair — or any construction whose level-independence is a theorem of its own form (Lemma 74.2) — is cited as refinement-stability evidence. *Status: fired on Stage-A Requirement 2, re-typed NOT TESTED. The requirement it protects has since been discharged honestly elsewhere: genuine non-factorising two-level passes exist in the companion corpus (SMC-1U Parts XII-bis/ter) and in §78.3's interacting cascade.* **F38 — Clock insertion.** A physical-time conversion N_TPB, record affinity, commitment density or entropy-production rate is inserted rather than returned by the master action's irreversible channel; or sector-dependent clocks are used to reproduce the relative gauge strengths, in contradiction of the universal local time-ordering premise (§73.4). *Status: not fired; the §73.3 record clock and §73.3 Role-4 grid are typed diagnostic and carry no boundary authority.*

60. The Renormalised Standard Model Parameter-Closure Theorem

Theorem 60.1 — RPC-1

Let a passing package ђ_HFB1^pass supply:

1. one complete primary boundary set 𝓟_SM^VERSF(μ⋆);
2. one physical branch, or a certified degenerate branch set;
3. one native scheme and one matching scale;
4. one complete covariance package;
5. one threshold and spectrum census;
6. the Ward, CY3′, neutral, determinant-line, triality, positivity, null and regulator certificates;

7. an immutable manifest.

Assume premises P1–P9, and in particular:

- the finite scheme bridge exists to the declared order (P4);
- the coupled RG initial-value problem has a unique solution on each required interval (Thm 22.1 under P3);
- every threshold has a well-defined frozen matching map with an isolated self-consistent scale (Thm 24.2 under P5);
- the effective electroweak vacuum has an admissible isolated branch (P6);
- every required singular, Takagi and pole problem has a stable solution (P7);
- transport occurs without observational insertion (P8, Thm 7.3);
- every uncertainty prescription is frozen before empirical comparison.

Then the composition

$$\mathfrak{O}_{phys} = \mathcal{P}_{pole} \circ \mathcal{E}_{EWSB} \circ \mathcal{M}_{thr} \circ \mathcal{U}_{RG} \circ \mathcal{S}_{bridge} [\, \mathfrak{h}_{HFB1}^{pass} \,]$$

descends to a well-defined map on the physical quotient,

$$\bar{F} : \mathcal{Q} \to \mathcal{O}_{inv}, \quad \mathcal{Q} = \{\text{boundaries}\}/\mathbb{G}_{conv}$$

assigning to each admitted boundary equivalence class $[p] \in \mathcal{Q}$ exactly one invariant observable package $\bar{F}([p]) \in \mathcal{O}_{inv}$, namely

$\mathfrak{O}_{phys}$ = { ** M_W, Γ_W, M_Z, Γ_Z, M_H, Γ_H;** ** m_e, m_μ, m_τ;** ** $m_u(\mu)$, $m_d(\mu)$, $m_s(\mu)$, $m_c(\mu)$, $m_b(\mu)$, $m_t(\mu)$;** ** declared heavy-quark short-distance masses;** ** V_{CKM}, J_{CKM};** ** $\{ m_{\nu i} \}$, U_{PMNS}, Δ_{NU}, neutral phases and invariants;** ** $g_s(\mu_c)$, $g(\mu_c)$, $g'(\mu_c)$, $\alpha_s(\mu_c)$, $\alpha(\mu_c)$, $\sin^2\theta_W(\mu_c)$;** ** Λ_{QCD}, strong matching outputs, B_τ, $\bar{\theta}$;** ** Σ_{phys}, cross-sector residuals** **}**

The result is independent of flavour basis and of the intermediate renormalisation scheme up to the declared truncation uncertainty (Thm 14.2), and independent of every quarantined observation (Thm 7.3).

If a regulator-stable degenerate branch set returns observable packages separated by more than τ_{branch} in the metric of §52, RPC-1 returns **DEGENERATE** rather than a unique Standard Model.

Proof

Existence and uniqueness of each stage. The scheme bridge is a deterministic map on the frozen physical quotient, with the round-trip certificate bounding its non-invertibility at the declared order (P4). The coupled RG equations define a unique maximal flow on each effective-theory interval by Theorem 22.1, with the escape criterion converting any breakdown into a reportable finite-domain result rather than an ambiguity. The threshold maps connect adjacent effective theories uniquely once the decoupling scales are isolated, which Theorem 24.2 guarantees under P5. The electroweak stationarity equation, together with the acceptance conditions of §30, determines the admitted broken-phase vacuum and, by isolation (P6), determines it uniquely on the declared domain.

Spectral and mixing data. Singular-value and Takagi decompositions determine the charged and neutral spectra uniquely up to the ordering and phase conventions that constitute part of $\mathbb{G}$_conv, and the published objects are the orbit functions of §21. Pole equations determine the physical complex poles wherever isolated solutions exist (P7); where they do not, the corresponding entry is UNRESOLVED and is not silently replaced by a running quantity (Firewall R12). The strong-sector and strong-phase maps are fixed by the declared matching and determinant-line certificates, with the single-counting ledger of §20 removing the residual freedom.

Composition and invariance. Composition of deterministic maps is deterministic, so the composite assigns exactly one output tuple to each admitted boundary. By Theorem 14.2 the invariant sublist is constant on $\mathbb{G}$_conv-orbits up to the retained truncation, whose remainder is carried in the scheme envelope; hence the composite is constant on orbits and descends to a well-defined map $\bar{\mathrm{F}} : \mathcal{Q} \to \mathcal{O}$_inv.

No residual freedom. No downstream stage contains a free parameter: every finite coefficient, threshold rule, ordering convention, tolerance and uncertainty prescription is fixed by the manifest prior to execution, and by Theorem 7.3 no output depends on any datum outside ($\mathfrak{h}$, $\mathscr{M}$). Therefore no mass, coupling, mixing matrix, phase or branch can be selected after the fact.

Degeneracy. If two admitted branches yield invariant lists separated by more than the non-branch uncertainty, the composite is not single-valued on $\mathfrak{B}$_phys, and uniqueness fails at the level of the branch set rather than at the level of the transport. That case is returned as DEGENERATE. ■

Remark 60.2 — What the theorem does not claim. Theorem 60.1 asserts that a complete boundary transports to one observable package. It does not assert that the package agrees with nature, that the boundary exists, or that HFB-1 will return one. The empirical content is entirely in R4 and is deliberately withheld from the theorem, so that a disagreement at Stage 13 falsifies the branch and not the protocol.

61. Structural Certificate

A structural PASS is issued only where the component is complete as a *definition of the transport map*. Several components are schemas whose defining data — bridge coefficients, production beta functions, matching functions — are themselves open in Appendix H. Those are not merely missing numbers; they are part of the map. They are graded accordingly.

Component	Verdict
Frozen input contract	**PASS**

Component	Verdict
Non-insertion architecture and measurability theorem	**PASS**
Convention group and quotient invariance	**PASS**
Scheme-bridge schema	**DEFINED; COEFFICIENTS OPEN** (D3)
Coupled RG reference system	**PASS**
Production RG system	**OPEN** (D2)
Threshold schema and identifiability criterion	**DEFINED; MATCHING FUNCTIONS OPEN**
Electroweak reconstruction	**DEFINED**
Neutral transport	**PARTIAL** — symmetric-phase objects fixed (Conv. 19.0); Wilson-coefficient ledger open
Pole definitions and confinement typing	**DEFINED**
Uncertainty architecture	**PARTIAL** — joint-nuisance form fixed; envelope models open (D5, D7, D8)
Cross-sector identity set	**DEFINED**
Numerical closure	**NOT ADMITTED**

The downstream calculation is therefore fully specified in schema and not yet fully specified in coefficient. The distinction matters: a schema cannot be gamed after the boundary arrives, because its shape is frozen and hashed; but a coefficient that does not yet exist is a place where the map is still open, and every such place is listed in Appendix H. Claiming a blanket structural PASS while the open-debt ledger lists constitutive elements of the map would be exactly the kind of overstatement the rest of this paper is built to prevent.

62. Numerical Certificate

Object	Value	Uncertainty	Scheme	Scale	Branch	Hash	Status
$g_s(\mu\star)$	—	—	—	$\mu\star$	—	—	awaiting HFB-1
$g(\mu\star)$	—	—	—	$\mu\star$	—	—	awaiting HFB-1
$g'(\mu\star)$	—	—	—	$\mu\star$	—	—	awaiting HFB-1
$\mu_H^2(\mu\star)$	—	—	—	$\mu\star$	—	—	awaiting HFB-1
$\lambda(\mu\star)$	—	—	—	$\mu\star$	—	—	awaiting HFB-1
$Y_u(\mu\star)$	—	—	—	$\mu\star$	—	—	awaiting HFB-1
$Y_d(\mu\star)$	—	—	—	$\mu\star$	—	—	awaiting HFB-1
$Y_e(\mu\star)$	—	—	—	$\mu\star$	—	—	awaiting HFB-1
$\mathcal{B}_\nu(\mu\star)$	—	—	—	$\mu\star$	—	—	awaiting HFB-1
$\bar{\theta}(\mu\star)$	—	—	—	$\mu\star$	—	—	awaiting HFB-1

Verdicts:

HFB-1 physical boundary: NOT SUPPLIED RPC-1 numerical execution: NOT ADMITTED Renormalised Standard Model Parameter Closure: NOT ISSUED

No candidate scalar values, wheel values, CFB outputs or measured Standard Model values may populate this table. The upstream HMGBC construction preserves the same lock pending a passing HFB return.

63. Conclusion of the Structural Theorem

The purpose of a final assembly theorem is not to make an unfinished derivation look complete. It is to determine whether a complete microscopic boundary, once supplied, actually becomes one coherent low-energy Standard Model — and to fix that determination in advance, so that the answer cannot be arranged.

RPC-1 freezes the final chain:

$\mathcal{P}$_SM^VERSF(μ⋆) → scheme bridge → coupled RG flow → threshold matching → electroweak breaking → running spectra → physical poles and invariants

Every sector uses the same branch, matching scale, field normalisation, gauge convention, threshold ledger, perturbative-order ledger, determinant-line convention, uncertainty model and source manifest. That shared discipline is what makes §55 an over-determined test rather than a checklist: a substrate that is merely flexible enough to fit observables one at a time will not satisfy fifteen identities that were written down before it spoke.

The paper also corrects an overstatement common to final-assembly programmes. Not every Lagrangian mass parameter corresponds to an isolated physical pole. Light quarks are confined. Unstable gauge bosons and the Higgs are defined by complex poles. Mixed neutral states require a full Takagi analysis and predict a unitarity defect Δ_NU that a Dirac-only reading does not possess. A strong-phase result is one global invariant, not a sum of loosely typed phases. These distinctions are part of closure, not complications appended to it.

One upstream freedom is removed conditionally. The continuous history proposal is no longer an unspecified distribution over update amplitudes: given the operational geometry, the complete defect differential and the history step, the reference fluctuations are operational heat flow and the defect deformation is the unique minimum-operational-norm drift, whose Cameron–Martin curvature fixes the full core metric W_core = E_D† G_op E_D. This does not produce the physical Standard Model boundary; it relocates the remaining uncertainty into three concrete geometric operators — **G_op, A_Q, C** — and the final history metric is whatever one physical master history generator returns through W_prim = E_D† G_op E_D − C† A_Q⁺ C, subject to positivity, null classification, branch consistency and regulator convergence. No later stage has authority to change that result.

The final outcome may be:

PASS — one frozen HFB boundary transports into a complete, regulator-stable, internally consistent physical Standard Model; **DEGENERATE** — several history-selected branches survive and produce physically distinct low-energy worlds; **FAIL** — the vacuum, RG flow, thresholds, poles, flavour structure, strong sector or cross-sector identities do not close; **UNRESOLVED** — the transport is admissible but the numerics do not determine the disputed entries; **NOT ADMITTED** — HFB-1 does not return the complete frozen boundary.

The result cannot be rescued downstream. That is the core theorem of this paper:

A VERSF Standard Model boundary becomes a physical prediction only when the entire renormalised transport from substrate scale to observable scale has been completed without introducing any value that the substrate did not itself return.

This concludes the structural theorem as frozen. Part IX (§§64–80) records what followed: the numerical admission audits, the executed derivations and their repairs, the fired falsifiers, and the exact non-closure and pre-temporal certificates. The status statements above are superseded where Part IX sharpens them; the transport rules themselves are not.

Part IX — Numerical Admission Audit and First Corpus Execution

The numerical closure condition is not discharged by defining the transport map. It requires a complete HFB-1 boundary package and one successful end-to-end run. This Part performs the admission audit against the corpus as it stands, executes the physical-input preflight, and reports the first genuinely numerical corpus-level result: a conditional diagnostic branch that **fails** RG transport. The failure is a derivation output, and it is published under the same rules as a pass would be.

64. Numerical Input Ledger and Physical Preflight

64.1 Input ledger

Boundary object	Corpus return	Grade	RPC status
Z_H	1	Route-A conditional	Quarantined
v_cl	243.722807638 GeV	Route-A conditional	Ancillary only
λ	0.128999748047	Route-A conditional	Quarantined
μ_H²	7662.689132 GeV²	Route-A conditional	Quarantined
m_H^leading	123.795711816 GeV	Route-A conditional	Diagnostic
g_s	not returned	—	**OPEN**
g	not returned	—	**OPEN**

Boundary object	Corpus return	Grade	RPC status
g′	not returned	—	**OPEN**
Y_u	not returned physically	—	**OPEN**
Y_d	not returned physically	—	**OPEN**
Y_e	not returned physically	—	**OPEN**
ℬ_ν type	full-rank type-I-dominant Majorana	Conditional	Form only
M_D	not returned numerically	—	**OPEN**
M_R	not returned numerically	—	**OPEN**
θ̄	not returned	—	**OPEN**
μ⋆	not returned	—	**OPEN**
branch label β⋆	not returned	—	**OPEN**
covariance ledger Σ⋆	not returned	—	**OPEN**
regulator levels	not declared	—	**OPEN**

"Quarantined" marks a genuinely numerical return from a conditional predecessor branch that Admission Rule 4.1 excludes from the physical boundary: it may enter a clearly typed diagnostic (§65) but may not populate a primary row. The scalar return graded Route-A conditional is such an object — a conditional numerical pass on its frozen Route-A premise stack, not unconditional one-master-action closure.

The provisional scalar input file is frozen as:


```
{
  "schema": "VERSF-SCALAR-BOUNDARY-1.0",
  "status": "CONDITIONAL_ROUTE_A",
  "Z_H": 1.0,
  "v_cl_GeV": 243.722807638,
  "lambda": 0.128999748047,
  "mu_H2_GeV2": 7662.689132,
  "m_H_leading_GeV": 123.795711816,
  "matching_scale": null,
  "physical_hfb_branch": null,
  "rpc_admissible": false,
  "reason_not_admissible": "Awaiting HFB-1 branch, common matching scale and
history-derived physical certificate"
}
```


64.2 Physical-direct preflight

The physical HFB boundary generator requires the arrays

G_red; E_3, E_2, E_q; V_H, X_H, *∂{φ_H}V_H,* ∂{φ_H}X_H; A_{uL}, A_{uR}, A_{dL}, A_{dR}, A_{eL}, A_{eR}, A_{νL}, A_{νR}

Resolution 64.0 — Neutral completion route. The neutral sector is generated through the **same address-compression route** as the charged sectors, so A_{νL} and A_{νR} are mandatory and the required-array count is **sixteen**, not fourteen. This yields Y_ν and hence M_D; it does **not** yield M_R, which is a singlet mass carrying no electroweak address and arrives from the separate neutral-sector construction as `M_R_direct.npy` together with the carrier census fixing its rank. The full neutral boundary is therefore $\{ A_{\nu L}, A_{\nu R} \} \to Y_\nu$, plus M_R_direct → M_R, assembled per Convention 19.0.

together with the scalar boundary, neutral boundary, strong-phase, branch, uncertainty, regulator and source manifests. From these it computes the gauge normalisations

$$\mathbf{Z_3 = \tfrac{1}{8}\,\mathrm{Tr}(E_3^\dagger\, G_{red}\, E_3),\ Z_2 = \tfrac{1}{3}\,\mathrm{Tr}(E_2^\dagger\, G_{red}\, E_2),\ Z_q = E_q^\dagger\, G_{red}\, E_q}$$

and hence $\mathbf{g_s = Z_3^{-1/2},\ g = Z_2^{-1/2},\ g' = 6\, Z_q^{-1/2}}$, and the common left–right completion and Yukawa operators

$$\mathbf{C_{LR} = V_H^\dagger X_H\ \ Y_{LR} = \Lambda\star\,[\,(\partial_{\varphi_H} V_H^\dagger)\, X_H + V_H^\dagger\,(\partial_{\varphi_H} X_H)\,]}$$

followed by the typed sector compressions with A_{fL}, A_{fR}.

The preflight return is:

```
{
  "status": "blocked_missing_physical_inputs",
  "missing_required_files": [
    "G_red.npy", "E3_direct.npy", "E2_direct.npy", "Eq_direct.npy",
    "V_H.npy", "X_H.npy", "dV_H_dphi.npy", "dX_H_dphi.npy",
    "A_uL.npy", "A_uR.npy", "A_dL.npy", "A_dR.npy", "A_eL.npy", "A_eR.npy",
    "A_nuL.npy", "A_nuR.npy", "M_R_direct.npy"
  ]
}
```

Remark 64.1. This is an admissible numerical result, and an important one: it proves mechanically that the physical calculation has not silently fallen through to benchmark inputs. A boundary generator that *refuses to run* on an incomplete corpus is the non-insertion protocol (Thm 7.3) operating as designed. A generator that ran would be evidence of a quarantine breach.

64.3 Upstream status of G_red: evaluated differential, conditionally derived core metric and unevaluated physical bath relaxation

Stage N2 is no longer blocked on machinery. The finite master-vacuum calculation on the normalised canonical $K = 7$ cell has evaluated the metric-independent six-defect differential analytically, and G_red is now assembled from frozen arrays rather than rebuilt.

Factorisation. The parent Hessian at a common defect zero is

$$\mathbf{\mathbb{G}\star = G_V + J_D^\dagger\, W_{prim}\, J_D,\ J_D = DD\star}$$

with the two factors exported independently. The differential is further linear in the two undetermined primitive scales,

$$J_D(\kappa, \alpha_H) = J_0 + \kappa J_\kappa + \alpha_H J_H, \quad \alpha_H = \Lambda_\star^{-1}$$

so κ_e and $\Lambda_\star$ enter frozen arrays without redefining or redifferentiating the primitive defects. The potential Hessian is exported as $G_V = 2\lambda_{sub} \rho_c^2 P_\rho + 2\lambda_H v_{cl}^2 P_h$.

Rank and null ledger. On the executed cell, with 226 configuration variables, 243 primitive defect coordinates and 22 potential residual coordinates:

Object	Value
rank J_D	183
dim ker J_D	43
moduli lifted by the potential residuals	4
rank J_{full}	187
dim ker J_{full}	39
endpoint-frame directions $\mathcal{N}_{frame}$	21
positive-stretch record-coboundary directions $\mathcal{N}_{rec}$	18

The kernel decomposes exactly as ker $J_{full} = \mathcal{N}_{frame} \oplus \mathcal{N}_{rec}$, giving the exact kinematic quotient projector

$$P_{phys} = I - N_{null} N_{null}^\dagger, \quad \mathbb{G}_\star^{phys} = P_{phys}^\dagger \mathbb{G}_\star P_{phys}$$

Verification status. The residuals must be read for what each one tests. $\|J_{full} N_{null}\|_F = 1.14\times10^{-15}$ compares two analytic objects built from one implementation and is a **self-consistency** figure, not an independent verification. The independent checks are: the analytic-versus-numerical projector agreement, 1.28×10^{-14} on the normalised cell and 1.36×10^{-13} on the transported CFB-1 background (maximum principal angle $\approx 2.3\times10^{-6}$ degrees), since the numerical projector is built from singular vectors rather than from the analytic basis; and the central-difference audit of the analytic Jacobian at two step sizes, agreeing to maximum column-relative discrepancies of 1.67×10^{-11} and 2.68×10^{-11}. The Jacobian is therefore independently verified at the 10^{-11} level and the null classification at the 10^{-13} level; no claim rests on the 10^{-15} figure.

Consequence for Stage N2. The parent-Hessian machinery is no longer blocked on either the primitive differential or the existence of a continuous-amplitude proposal law. The calculation supplies

$$J_D, \; G_V, \; P_{phys}, \; E_D, \; W_{core} = E_D^\dagger G_{op} E_D$$

The physical result remains blocked on five returns: the physical provenance and regulator-level evaluation of G_{op}; the unresolved-bath operator A_Q and defect–bath coupling C; the physical scales κ_e and $\Lambda_\star$; the refinement-compatible multi-cell auxiliary census; and the history-selected branch. The final metric entering the parent Hessian is

$$W\_prim = W\_core - C^\dagger A\_Q^+ C$$

not W_core alone. The differential, quotient, core proposal metric and assembler are frozen constructions; the bath correction and physical regulator provenance remain upstream outputs.

Kernel enlargement. P_phys removes the *kinematic* kernel. A positive-semidefinite W_prim may carry an information kernel larger than ker J_full, and such directions are not automatically gauge. The physical execution publishes ker J_full, ker(J_D† W_prim J_D + G_V), their overlap, and any additional history-null basis. An unclassified enlargement blocks the boundary (F30).

Two distinct kernels. The conditional core metric has rank W_core = 183 and dim ker W_core = 60 on the 243-dimensional primitive residual carrier. These 60 residual-coordinate null directions are **not** the 39 kinematic configuration-space null directions: they are combinations of primitive defect coordinates outside the rank-183 realizable image of J_D at the executed vacuum. The physical bath-relaxed metric may enlarge this information kernel further. The execution therefore publishes separately

ker J_full, ker W_core, ker W_prim, ker(G_V + J_D† W_prim J_D)

together with the inclusions, intersections and classifications among them.

64.4 Upstream physical-return ladder: W_prim, the scale tuple and the branch

Stage N1 is not a single computation. The returns that unblock G_red (§64.3) decompose into seven obligations whose *order is itself load-bearing*: the two regulator levels are frozen first, not appended as a convergence check afterwards. RPC-1 records the ladder because the admission test at Stage 0 verifies that it was executed in this order, not merely that its outputs exist.

freeze two physical regulators → one master history operator per level → { branch, W_prim, κ_e, C_Ω, U_Ω } → { Λ⋆, S_scale, G_red } → two-level stability → boundary execution

64.4.1 The typed history metric and the conditional continuous-amplitude proposal theorem

The typed physical metric acts on

$$\mathcal{R}\_prim^{(n)} = \mathcal{R}\_C \oplus \mathcal{R}\_J \oplus \mathcal{R}\_T \oplus \mathcal{R}\_R \oplus \mathcal{R}\_B \oplus \mathcal{R}\_H$$

whose sector dimensions on the evaluated canonical cell are

Sector	C	J	T	R	B	H	total
dim	18	72	42	36	72	3	**243**

so that $\mathbf{W\_prim^{(n)} \in Herm_+(243)}$, with a 6×6 *operator*-block structure in which an entry such as $W_{BH} : \mathcal{R}_H \to \mathcal{R}_B$ is a 72×3 map, not a scalar coefficient.

64.4.1A The support-only rank obstruction

A history kernel on a finite state catalogue can carry no more independent score directions than the dimension of its admissible stochastic tangent space. The canonical seven-state wheel has 31 supported directed transitions and seven row-sum constraints, hence

$$\mathbf{\dim \mathcal{T}_{hist}^{K=7} = 31 - 7 = 24}$$

The complete evaluated physical defect differential has rank $J_D = 183$. Therefore

$$\mathbf{24 < 183}$$

and no deformation of transition probabilities on the support-only seven-state catalogue can faithfully represent the complete physical defect image. For a chain of m persistence-preserving wheel cells with nearest-cell bridges, the supported stochastic tangent dimension grows as $26m - 2$, while a regulator-replicated MASD carrier grows its independent defect image as $183m$, leaving the asymptotic deficit

$$\mathbf{183m - (26m - 2) = 157m + 2}$$

The physical history carrier must therefore contain continuous update amplitudes, or an equivalently rich microscopic move variable, rather than merely more copies of the same seven discrete state labels. This converts the choice of a continuous law from an option into an obligation.

64.4.1B The operational minimum-norm defect lift

Let $J_n = D\mathbf{D}\_n|_{\{\mathfrak{X}\star,n\}}$ be the complete primitive defect differential and Q_{kin} an orthonormal basis of the physical tangent carrier after quotienting the exact kinematic null directions. With $J_p = J_n Q_{kin}$ and $G_p = Q_{kin}^\dagger G_{op} Q_{kin}$, where G_{op} is the inherited operational tangent metric, the canonical lift of a primitive defect amplitude D is

$$\mathbf{E_D = Q_{kin} G_p^{-1} J_p^\dagger (J_p G_p^{-1} J_p^\dagger)^+}$$

This is the unique physical tangent displacement satisfying $J_n E_D D = P_{\{\mathrm{im}\, J_n\}} D$ and minimising $\|\delta\mathfrak{X}\|^2_{\{G_{op}\}}$. The Moore–Penrose inverse does not insert a dynamical coefficient; it removes the non-uniqueness caused by configuration directions that produce the same realizable defect change and selects the displacement of least operational distinguishability.

On the executed finite cell, rank J_p = rank E_D = 183, with minimum-norm right-inverse residual 6.86×10^{-15}.

64.4.1C The measure-valued continuous proposal kernel

The global proposal is the drifted heat-kernel measure of the operational Dirichlet geometry. In a rank-stable normal chart around the frozen vacuum, its declared quadratic-order form is

$$\xi \mid (\mathfrak{X}, D) \sim \mathcal{N}(a_t E_D D, a_t G_{op}^{-1}), \text{ followed by } \mathfrak{X}' = \mathrm{Exp}_{\mathfrak{X}}^{op}(\xi)$$

so the continuous update-amplitude covariance is

$$\mathrm{Cov}(\xi) = a_t G_{op}^{-1}$$

It is not separately chosen for ρ, U, J, Φ or for the six defect sectors: their relative geometry is inherited through the common operational carrier and the single metric G_{op}. Locally, $\rho_i' = \rho_i + \xi_{\rho,i}$ and $U_e' = U_e \exp(\xi_{U,e})$ with $\xi_{U,e}^\dagger = -\xi_{U,e}$, current and record variables updating through their inherited covariant linear and polar charts. No factorwise proposal width is introduced.

64.4.1D Exponential tilt and rate curvature

At the frozen linearized vacuum, the Radon–Nikodym derivative of the drifted proposal relative to the defect-free proposal is

$$\log dQ_{n,D}/dQ_{n,0} = \langle E_D D, \xi \rangle_{G_{op}} - (a_t/2) \|E_D D\|^2_{G_{op}}$$

The linear score and quadratic normalisation are fixed *together*; a defect-dependent normalisation inserted independently of this formula defines a different history law and is F29. The one-step information-rate curvature is

$$\mathcal{I}_n^{core}(D) = ½ D^\dagger W_{core}^{(n)} D, \quad W_{core}^{(n)} = E_D^\dagger G_{op} E_D$$

The construction is coordinate invariant: under a non-orthogonal physical-tangent reparameterisation, the evaluated W_{core} changed by relative residual 2.65×10^{-14}. A direct score-covariance simulation reproduced the analytic Fisher matrix with finite-sampling relative discrepancy 8.69×10^{-3}, and the KL-rate Hessian agrees analytically to floating-point precision. The three residuals verify three different things — coordinate invariance, the stochastic representation, and the analytic identity — and are read as such, not pooled.

64.4.1E Finite-cell core return

In the current operational-orthonormal coordinate representation, $W_{core} \in \mathrm{Herm}_+(243)$ has

$$\mathrm{rank}\, W_{core} = 183, \quad \dim\ker W_{core} = 60$$

with smallest eigenvalue -4.8×10^{-16} (numerical zero). The parent core Hessian $\mathbb{G}_{core} = G_V + J_D^\dagger W_{core} J_D$ annihilates the classified kinematic null space with residual 9.91×10^{-16}. The normalized, no-bath diagnostic Schur reduction gives

$$G_{red}^{core} = I_3 \text{ to order } 10^{-15}$$

This is a **whitening identity** in the operationally normalized basis. It is not a physical gauge response and may not enter the HFB boundary; it joins G_{red}^{unit} on the quarantined-constant proximity list.

64.4.1F Unresolved-bath proposal and physical metric

Let A_Q be the positive generator of the unresolved bath. Its exact continuous one-step proposal is the Ornstein–Uhlenbeck kernel

$$q' \mid q \sim \mathcal{N}\left(e^{-a_t A_Q} q,\ A_Q^{+} \left[I - e^{-2 a_t A_Q} \right] \right)$$

verified on the diagnostic canonical nonpersistent rates by two half-steps reproducing one full step with covariance-semigroup residual 1.57×10^{-16}. If C is the physical defect–bath coupling returned by the same master history generator, integrating out the Gaussian bath gives

$$W_{prim} = W_{core} - C^\dagger A_Q^{+} C$$

admissible only if $\operatorname{ran} C \subseteq \operatorname{ran} A_Q$ and $W_{core} - C^\dagger A_Q^{+} C \succeq 0$. The physical bath correction therefore **softens** the core metric; it cannot add stiffness by hand. Positivity carries a sharp corollary: any coupling column of C reaching a direction in $\ker W_{core}$ violates positivity immediately, so the bath may couple only to realizable defect directions — a checkable constraint on the eventual C, published with the return.

64.4.1G Refinement status

For a canonical isometric product refinement, the proposal covariance and defect drift push forward exactly: $\|C_n \Sigma_{n+1} C_n^\dagger - \Sigma_n\| = 3.04\times10^{-15}$ and $\|C_n E_D^{(n+1)} D - E_D^{(n)} D\| = 2.13\times10^{-15}$. This proves refinement compatibility for the canonical product test only; it does not certify the actual MASD ordered-holonomy and Karcher-mean coarse maps, which remain subject to §64.4.7.

64.4.1H Conditional verdict

continuous-amplitude proposal form: CONDITIONAL DERIVATION PASS

Fixed, conditional on the inherited operational heat geometry: the probability family; the continuous amplitude covariance; the minimum-norm defect drift; the exponential tilt; the radial normalisation; the core Fisher metric W_{core}; and the exact unresolved-bath OU proposal form.

The final physical metric is not issued because the calculation has not independently returned: (1) the uniquely forced physical $G_{op}^{(n)}$; (2) the physical $A_Q^{(n)}$ and C_n; (3) the selected component supplying the P10 Doob normalisation; (4) the actual multi-cell regulator geometry; (5) the fermionic positivity certificate; (6) the two-level physical refinement return.

The open history-metric problem is therefore no longer "choose a continuous amplitude law." It is

evaluate G_op, A_Q, C from one physical master history operator

64.4.1I Coverage ledger

Object	Derivation status	Physical authority
Continuous proposal family	derived conditional on operational heat flow	conditional
E_D	evaluated on the canonical finite cell	conditional
W_core	full 243×243 matrix evaluated; rank 183	conditional
OU bath proposal form	exact for supplied A_Q	structural
Physical A_Q	not evaluated	none
Physical C	not evaluated	none
Bath correction $C^\dagger A\_Q^+ C$	formula fixed, matrix absent	none
Physical W_prim	not issued	none
Fisher/bath-Schur route agreement	not executable until physical A_Q, C exist	open

A statement that the physical W_prim has been derived from the conditional W_core alone is F33. Hermiticity, positivity, cross-block traceability and null-space publication remain pass conditions on the eventual W_prim (F30, F36), unchanged by the conditional advance.

64.4.2 Edge conductances κ_e

The constitutive-current defect is $\mathcal{D}$_J(e) = J_e − κ_e (ρ_{t(e)} − U_e ρ_{s(e)}), and κ_e is derived, never set to unity. With Δ_e ρ = ρ_{t(e)} − U_e ρ_{s(e)}, the weighted least-squares return is

κ_e = Re⟨ Δ_e ρ, J_e ⟩*{W_J} / ⟨ Δ_e ρ, Δ_e ρ ⟩*{W_J}

On a homogeneous vacuum both J_e and Δ_e ρ vanish and this is indeterminate. Two escapes exist — the directional-derivative ratio on the canonical current-response direction, and extraction from the quadratic current block of W_prim. **They are not alternatives.** Both are computed and their difference is published as the residual

ε_κ = | κ_e^{deriv} − κ_e^{block} | / max(κ_e^{deriv}, κ_e^{block})

The canonical response direction used by the derivative route is pre-registered in the manifest; selecting it after inspecting the geometry is F5.

Pass conditions: κ_e > 0 on an admitted transport edge; invariance under edge reversal in the transformed basis; equality on symmetry-equivalent edges; cylindrical compatibility under refinement; and independence of colour, weak and hypercharge labels unless the common history operator itself breaks that equivalence. Values enter the frozen decomposition $J_D = J_0 + \Sigma_e \kappa_e J_{\kappa_e} + \Lambda\star^{-1} J_H$; no Jacobian is rebuilt.

64.4.3 Λ⋆ and the primitive scale tuple

$$\mathbf{S_{scale}^{(n)} = (\ell_n, a_t, \rho_c, \lambda_{sub}, \{ \kappa_e \}, \Lambda\star)}$$

with ℓ_n the spatial regulator geometry and a_t the common history-transfer step; neither is resettable per sector. The radial potential $V_\rho = (\lambda_{sub}/4)(\rho^\dagger\rho - \rho_c^2)^2$ gives $K_\rho = 2 \lambda_{sub} \rho_c^2$, and the quartic vertex returns λ_{sub} independently, so ρ_c is recovered rather than only the product.

The completion scale is defined by $Z_{comp} = \partial K_{comp}(p^2)/\partial p^2|_{p^2=0}$ and $\ell_{comp}^{-2} = K_{comp} / Z_{comp}$, giving $\Lambda\star = \ell_{comp}^{-1} Z_{comp}^{-1/2}$. **The composite form is published explicitly**, because the two-step definition invites applying the normalisation once:

$\mathbf{\Lambda\star = \sqrt{K_{comp}} / Z_{comp}}$ (not $\sqrt{(K_{comp} / Z_{comp})}$)

$\Lambda\star$ is therefore a result of the common reduced Hessian, not a fitted mass scale. A single misapplied factor of $\sqrt{Z_{comp}}$ rescales every absolute fermion mass, so this line carries its own implementation assertion.

64.4.4 Multi-cell auxiliary census

After the exact null quotient, $\mathcal{T}_{phys}^{(n)} = \mathcal{T}_{retained} \oplus \mathcal{T}_\eta$, with the retained block containing the Higgs radial and scalar-compatible modes, the twelve physical gauge tangent directions, completion-strain modes, terminal matter-source directions, light neutral completion modes, and every mode required to define $A_{fL/R}$, V_H, X_H and the scalar response. The auxiliary block contains every same-order positive mode coupling to a retained direction. Then $G_{red}^{(n)} = H_{rr} - H_{r\eta} (H_{\eta\eta})^{-1} H_{\eta r}$.

Completeness test. Enlarging $\mathcal{T}_\eta \subset \mathcal{T}_{\eta,+}$ must leave

$$\mathbf{\Delta_{aux} G_{red} = \| G_{red}^{(+)} - G_{red} \| / \| G_{red} \|}$$

below the frozen tolerance. Schur relaxation can only soften the retained response, so

$$\mathbf{G_{red}^{(+)} \preceq G_{red}}$$

is a genuine *one-sided* constraint: a violation is unambiguous evidence of a basis mismatch or a nonpositive auxiliary block, never a tuning opportunity (F35). It requires $H_{\eta\eta} \succ 0$ for the enlarged block as well as the original, and both positivity checks are published.

64.4.5 Terminal transport and holonomy descent

The terminal conductance and transport are pushforwards of the stationary history flow, not independently assigned:

$$\mathbf{C_\Omega(a,b) = \Sigma_{x: r_n(x)=a} \Sigma_{y: r_n(y)=b} c_n(x,y)\ M_{ba}^\Omega = \Sigma_{x,y} c_n(x,y) S_b^\dagger U_{yx}^{rec} S_a,\ U_{ba}^\Omega = Pol(M_{ba}^\Omega)}$$

with generation Laplacian $\Delta_\Omega = B_\Omega^\dagger C_\Omega B_\Omega$. The physical test is the Wilson product around the terminal generation cycle, $W_\Omega = U_{AC}^\Omega U_{CB}^\Omega U_{BA}^\Omega$, required to satisfy $\mathrm{spec}(W_\Omega) \subset \{ e^{2\pi ik/7} \}$ with $k \neq 0$ on the occupied branch. The covering relation $k_\Omega = 4 k_{vac} \pmod 7$ is *expected* and must be **returned** by the pushforward, not imposed; imposing it is F5. Only after this passes may the holonomy-split generation spectra be treated as physical.

64.4.6 Branch selection

Every candidate branch must arise as a component of one operator T_n^{hist} on one history space with one reference measure. A post-hoc direct sum of separately constructed branch operators does not qualify. With P_β the invariant projectors of the observable-algebra decomposition, $T_{n,\beta} = P_\beta T_n^{hist} P_\beta$, and the raw Perron root $\lambda_{0,\beta}^{(n)}$ taken **before** any branchwise normalisation,

$$\mathbf{f_\beta^{(n)} = -(1/a_t) \log \lambda_{0,\beta}^{(n)},\ \mathfrak{B}_{phys}^{(n)} = \mathrm{argmin}_\beta f_\beta^{(n)}}$$

The comparison is meaningful only because all branches are components of one operator with one action unit and one measure. Returns are PASS (isolated minimum), DEGENERATE (tied components) or FAIL (no comparable component structure). A degeneracy may not be broken using measured Standard Model data (F5), and a DEGENERATE return propagates to §52. For a unique branch the selection gap

$$\mathbf{\Delta_{sel}^{(n)} = \min_{\beta \neq \beta\star} (f_\beta^{(n)} - f_{\beta\star}^{(n)}) > 0}$$

must remain positive under refinement.

64.4.7 Two genuine regulator levels

A profile enlargement is a software test, not a physical refinement. Two actual regulator complexes $\mathcal{S}_n \to \mathcal{S}_{n+1}$ are required, with explicit lift and coarse maps for configurations, defect carriers, bath carriers, terminal records, gauge generators, retained and auxiliary tangent spaces, and branch components. The persistence/self-transition support must be preserved, or the H defect collapses into the current sector.

At both levels, $W_{prim}^{(n)}$, $\kappa_e^{(n)}$, $S_{scale}^{(n)}$, $G_{red}^{(n)}$, $C_\Omega^{(n)}$, $\Delta_\Omega^{(n)}$, $R_\Omega^{(n)}$ and $\beta\star^{(n)}$ are computed independently. The core refinement residual is

$$\mathbf{\varepsilon_n = \| T_{n+1} V_n - V_n T_n \|}$$

and, with a uniform spectral gap δ,

$\| P_{n+1}^{Perron} V_n - V_n P_n^{Perron} \| = O(\varepsilon_n / \delta)$ $\| W_{prim}^{(n+1)} - V_n W_{prim}^{(n)} V_n^\dagger \| = O(\varepsilon_n / \delta^2)$

The gap is a precondition, not a diagnostic. Both bounds are vacuous without a uniform δ, and the W_prim bound degrades quadratically as δ shrinks — which is precisely the near-null Perron mode that F28 concerns. δ_n is therefore published at every level alongside ε_n, and a δ that collapses under refinement voids the two-level agreement (F34).

Two levels are necessary and not sufficient. Agreement at two levels is consistent with convergence to something other than the continuum limit. A convergence certificate additionally requires an analytic bound, a monotonicity theorem or a controlled Cauchy estimate (D24).

64.5 Numerical execution ladder

The pass attempt proceeds in this immutable order:

HMGBC transfer execution → G_red → physical embeddings → gauge and Yukawa boundary → neutral block → strong phase → HFB certificate → RPC transport

Stage	Output
N1	Physical history return at two regulator levels per the ladder of §64.4: first the operational metric G_op and continuous proposal kernel, then the physical bath operator A_Q, coupling C, $W_{prim} = W_{core} - C^\dagger A_Q^+ C$, κ_e, S_scale, C_Ω, U_Ω, R_Ω, β⋆ and Δ_sel, with ε_n and δ_n
N2	Assemble $\mathbb{G}^\star = G_V + J_D^\dagger W_{prim} J_D$, remove the classified kinematic and any additional history-null directions, and form the physical $G_{red} = H_{rr} - H_{r\eta} H_{\eta\eta}^{-1} H_{\eta r}$ on the complete multi-cell census
N3	Direct gauge embeddings E_3, E_2, E_q from the frozen representation ledger
N4	Completion differential V_H, X_H, *∂{φ_H}V_H,* ∂{φ_H}X_H
N5	Sector address embeddings A_{fL}, A_{fR}, f ∈ {u, d, e, ν}, plus the singlet mass operator M_R from the neutral carrier census (Resolution 64.0)
N6	Complete microscopic boundary $\mathcal{P}$_SM^HFB1(μ⋆) = { g_s, g, g′, μ_H^2, λ, Y_u, Y_d, Y_e, $\mathcal{B}$_ν, ϑ̄ }
N7	RPC-1 execution (Stages 0–13 of §57) — begins only on an N6 PASS

64.6 Numerical pass rule

RPC-1 receives a numerical PASS only when: all ten primary boundary objects are populated; every object belongs to one HFB-selected branch; μ⋆ and the native scheme are supplied; at least two regulator levels agree within the frozen error model; the gauge factor blocks are isotropic and cross-factor clean to tolerance; all charged Yukawa matrices are full-rank where claimed; CY3′ passes independently; the complete neutral block has stable Takagi rank; ϑ̄ is evaluated or globally obstructed; the triality and determinant-line certificates pass; every input and output is hash-covered; and no benchmark or measured value fills a missing slot.

65. First Conditional Corpus RG Stress Test

65.1 The question and the premise

Whether the strongest currently numerical predecessor returns can already form one common boundary is a question the transport machinery can answer *now*, without waiting for HFB-1 — provided the diagnostic character of the inputs is typed and frozen. Assemble the conditional diagnostic package

$\boldsymbol{\mathcal{P}_{diag} = \{ \mathcal{P}_{HR1}^{A}, \mathcal{P}_{EW}^{\gamma}, \mathcal{P}_{MCHY}^{C}, \mathcal{P}_{colour}^{r=1} \}}$

This package is not an HFB-1 physical certificate. Its components originate in distinct conditional predecessor branches, and their equality of matching scale has not been derived. The test therefore rests on one visible, falsifiable premise:

Premise DCS-1 — Diagnostic common-scale identification. The Route-A scalar and MCHY-1C charged coefficients are interpreted as boundary values at

$\boldsymbol{\mu_0 = v_{cl} = 243.722807638\ \mathrm{GeV}}$

with the colour reference value transported from 5.8 TeV to μ_0. *Falsifier:* failure of the frozen RG transport applied to $\mathcal{P}_{diag}$ on the interval $[\mu_0, 5.8\ \mathrm{TeV}]$.

The logic of the test is modus tollens. The transport map is frozen (Parts II–IV); the inputs are frozen; if the composite fails, DCS-1 fails — not the transport, and not the substrate. That is precisely the asymmetry the protocol is built to preserve: a diagnostic identification is disposable, the machinery is not.

65.2 The diagnostic boundary

Scalar (Route-A conditional). $v_{cl} = 243.722807638$ GeV, $\lambda = 0.128999748047$, $\mu_H^2 = 7662.689132\ \mathrm{GeV}^2$, $m_H^{(0)} = 123.795711816$ GeV, $Z_H = 1$.

Electroweak couplings (γ-persistence branch). With $\alpha_{int} = 7/960$ and $e = \sqrt{4\pi\, \alpha_{int}} = 0.3027041224$, the conditional closure relation

$\boldsymbol{m_H^2 = (15/14)(m_W^2 + m_Z^2)}$, together with $\boldsymbol{m_H / v_{cl} = 32/63}$

yields the quadratic

$\boldsymbol{(32/63)^2\, s_W^2(1 - s_W^2) = (15\, e^2/56)(2 - s_W^2)}$

with roots $\boldsymbol{s_W^2 = 0.2165573823}$ and $\boldsymbol{s_W^2 = 0.8785733950}$. The photon-persistence tie-breaker conditionally selects the first branch; that selection principle is stated in the corpus rather than fully derived, and is carried here as part of DCS-1. Then

$g = 0.6504768409$, $g' = 0.3419910489$ $m_W = 79.26802099$ GeV, $m_Z = 89.55594468$ GeV (leading, running convention)

The closure relation is verified internally: $(15/14)(m_W^2 + m_Z^2) = 15325.378264\ \mathrm{GeV}^2 = m_H^2$ to ten digits. The conditional branch is *internally coherent*; what §65.4 tests is whether it is *transportable*.

Charged Yukawa (MCHY-1C grid coefficients, quarantined).

$Y_e = \mathrm{diag}(2.9918\times10^{-6}, 6.197\times10^{-4}, 1.0696\times10^{-2})$ $D_d = \mathrm{diag}(2.6926\times10^{-5}, 5.385\times10^{-4}, 2.7886\times10^{-2})$ $D_u = \mathrm{diag}(1.243\times10^{-5}, 6.379\times10^{-3}, 1.67356)$

The source paper is explicit that these are pre-RG grid coefficients, related to the physical common-scale singular values by an unevaluated matching operator, $D_u(\mu\star) = R_u[D_u^{grid}]$. It also supplies a conditional Hermitian representative $Y_u^C = (V_{CKM}^C)^\dagger D_u V_{CKM}^C$ with $|J_q| \simeq 3.00\times10^{-5}$; neither the frame nor $R_{u,d}$ is claimed as a blind physical output. With $M_f = (v_{cl}/\sqrt{2}) Y_f$ and $v_{cl}/\sqrt{2} = 172.3380500$ GeV, the unmatched tree-level ledger is:

State	Conditional matching-point mass
e	0.51560 MeV
μ	106.798 MeV
τ	1.84333 GeV
d	4.6404 MeV
s	92.804 MeV
b	4.80582 GeV
u	2.1422 MeV
c	1.09934 GeV
t	288.418 GeV

These are not pole masses and are compared with nothing (Stage 13 has not been reached; the labels are attached per §33 only diagnostically).

Colour (unit unscreened reference). $Z_3 = 6$ gives $g_s(5.8\ \mathrm{TeV}) = 6^{-1/2} = 0.4082482905$. One-loop transport to μ_0 gives **$g_s(v_{cl}) = 0.41816$**. The source paper itself classifies the unscreened branch as unphysical: with its provisional thresholds it generates **$\Lambda_3^{VBF} = 2.01\times10^{-20}$ GeV**, an exponentially inadequate QCD scale.

Neutral and strong phase. The neutral branch is conditionally typed as full-rank type-I-dominant, $\mathcal{B}_\nu = (0, M_D ; M_D^T, M_R)$, rank M_D = rank M_R = 3, three light and three heavy Majorana modes, normal ordering, eτ attachment, $\theta_{23} > 45°$, negative leptonic CP invariant — with the absolute entries open. For this charged-sector test the heavy states are taken decoupled above the interval; no numerical neutrino prediction is made. The conditional

Hermitian charged branch has arg det(Y_u Y_d) = 0, so the positive-real trivialisation would give $\bar{\theta} = 0$, but the substrate character χ_sub remains unevaluated and $\bar{\theta}$ stays OPEN.

65.3 The RG system and initial derivatives

Gauge transport uses the exact one-loop solution

$$1/g_A^2(\mu) = 1/g_A^2(\mu_0) - (b_A / 8\pi^2) \ln(\mu/\mu_0), \quad (b_Y, b_2, b_3) = (41/6, -19/6, -7)$$

The scalar/flavour test retains the dominant top contribution in the frozen convention of §§17–18:

$$16\pi^2\, dy_t/d\ln\mu = y_t [(9/2) y_t^2 - (17/12) g'^2 - (9/4) g^2 - 8 g_s^2] \quad 16\pi^2\, d\lambda/d\ln\mu = 24\lambda^2 - 3\lambda(3g^2 + g'^2) + (3/8)[2g^4 + (g^2 + g'^2)^2] + 12\lambda y_t^2 - 6 y_t^4 \quad 16\pi^2\, d\ln\mu_H^2 /d\ln\mu = 12\lambda + 6 y_t^2 - (9/2) g^2 - (3/2) g'^2$$

This is a one-loop diagnostic, not the production RPC truncation; the vertex-coherence check 18.1 is satisfied by construction.

At μ_0, with $y_t = 1.67356$ and $\lambda = 0.128999748$:

$$dy_t/d\ln\mu |_0 = +0.10690 \quad d\lambda/d\ln\mu |_0 = -0.26992 \quad d\ln\mu_H^2 /d\ln\mu |_0 = +0.10305$$

The decisive term is $-6y_t^4 \approx -47.07$ inside $16\pi^2 \beta_\lambda$; the positive scalar and gauge terms, +0.399 + 0.244, are two orders of magnitude too small to balance it, and $+12\lambda y_t^2 = +4.34$ does not close the gap.

65.4 Results of the transport

Gauge flow (perturbative throughout the interval):

μ	g′	g	g_s
89.56 GeV	0.34027	0.65607	0.42144
243.72 GeV	0.34199	0.65048	0.41816
374.5 GeV	0.34274	0.64812	0.41677
1 TeV	0.34446	0.64282	0.41366
5.8 TeV	0.34761	0.63366	0.40825

Quartic flow. Integrating the coupled system, λ crosses zero after

$$\Delta \ln\mu = 0.4296, \text{ i.e. } \mu_{\lambda=0} = 374.5 \text{ GeV}$$

with $y_t(\mu_{\lambda=0}) = 1.722$ and the gauge couplings still weak. The diagnostic branch loses positive quartic stability at ≈ 375 GeV, far below the 5.8 TeV record-coherence scale. Per §18 this is reported as an instability scale, and no stabilising operator is inserted (P1).

Top-Yukawa flow. $y_t(1\text{ TeV}) = 1.854$, $y_t(5.8\text{ TeV}) = 2.212$, with a perturbative breakdown at

$$\mu_{y_t\text{ pole}} \sim 1\times10^5 – 3\times10^5\text{ GeV}$$

(the coupled system reaches $y_t = 10$ near 2.2×10^5 GeV; the pure-y_t analytic pole sits at 1.3×10^5 GeV). The existence of a low breakdown scale is robust for any initial value near 1.67; only its precise location is truncation-sensitive.

Colour. Independently, the unit unscreened branch's $\Lambda_3^{VBF} = 2.01\times10^{-20}$ GeV stands as a blind failure of the $r = 1$ colour normalisation, already so classified by its source paper.

65.5 What the run proves

The central conclusion is a rejection, and its scope must be stated precisely:

Under DCS-1, the stated one-loop minimal operator content, and the requirement $\lambda > 0$ through 5.8 TeV, the direct identification $D_u^{grid} = D_u(\mu_0)$ fails.

It does **not** establish that $D_u^{grid} \neq D_u(\mu_0)$ on any physical branch whatever. A physical branch could alter the conclusion through derived thresholds, additional HFB-returned operators, a different scalar boundary, or the production bridge and truncation — each of which the diagnostic holds fixed by assumption rather than by derivation.

The MCHY paper warned that the identification requires the unevaluated matching operator R_u; the transport now *quantifies* that operator, conditionally. Requiring $\lambda(\mu) > 0$ on the full interval $[\mu_0, 5.8\text{ TeV}]$ under the coupled one-loop flow gives the critical value

$$y_t(\mu_0) \leq 1.0292$$

(the cruder analytic estimate $y_t \lesssim 1.09$ overstates the allowance, because y_t itself grows along the flow). Against the grid value $y_t^{grid} = 1.67356$ this is the derived constraint

$$\sigma_{max}[\, R_u D_u^{grid} \,] \leq 0.615\, \sigma_{max}[\, D_u^{grid} \,]$$

— a suppression of at least ≈ 38.5% in the top singular value. **This bound is conditional on DCS-1 and the stated one-loop operator content, and must be recomputed with the HFB-derived bridge, the derived thresholds and the production RG system.** *(Recomputed on the colour-completed branch in §72.2: $r_{u,crit} = 0.666093460291$ — stronger QCD running relaxes the requirement, and the value cross-checks the independent FRGM-1C ceiling to eight figures.)* It is not a parameter fit, and it is not a target: it is a consistency constraint on a VERSF-internal operator, derived by transport, before any comparison with observation.

Remark 65.1 — The failure is load-bearing. A programme whose machinery can only return PASS has no machinery. The value of §65 is that the frozen transport, applied blind to the strongest available conditional inputs, returned FAIL with a specific, quantified culprit —

exactly the behaviour Theorem 60.1 requires of the composite when a premise (here DCS-1) is false. The same pipeline, unmodified, is what the physical HFB-1 boundary will face.

65.6 Diagnostic verdicts

Conditional cross-paper RG branch: FAIL Failure 1 — scalar/flavour: $\lambda(\mu) = 0$ at $\mu \approx 375$ GeV under the direct grid identification **Failure 2 — colour:** Λ_3^VBF = 2.01×10^{-20} GeV on the unit unscreened branch **Physical VERSF/HFB-1 boundary: NOT TESTED RPC-1 numerical pass: NOT ACHIEVED**

The failure attaches to the provisional assembly $\mathcal{P}$_diag under DCS-1, not to the unevaluated HFB-1 physical branch. It converts two open items into mandatory, quantified substrate requirements:

1. a nontrivial R_u matching in the top sector, with σ_max suppression ≤ 0.615 at one loop;
2. a substantial colour-adjoint bath relaxation lowering Z_3 from the unit unscreened value.

Neither remedy is established as unique. The colour result rejects the **unit unscreened r = 1 normalisation**; it does not by itself prove that colour-adjoint bath relaxation is the only route, since a modified finite bridge, a different physical embedding, a changed threshold structure or a revised nonperturbative normalisation could equally alter Λ_3. Both entries are therefore recorded as *requirements on the eventual return*, not as identified mechanisms. Either arising from fit rather than from the substrate is F5.

66. Integrated Eight-Gate Conditional Execution

The eight obligations of §64.4 have been executed as far as the frozen corpus and numerical arrays permit. The result is a substantial integrated conditional execution — not a physical HFB-1 certificate — and, more importantly, an exact identification of *why* the final promotion cannot honestly be made.

66.1 Gate ledger

Gate	Result	Verdict
1. Typed history metric	Full rank-183 W_core evaluated; exact bath-relaxation family constructed	Conditional core pass; **physical metric non-unique**
2. κ_e, Λ⋆, scales	κ_e = 1/31 on the canonical wheel; Λ⋆^id = v_cl/√2 = 172.3380500 GeV on the identity-completion branch	Conditional return
3. Terminal transport and holonomy	Exact terminal Wilson phases, generation Laplacians and completion spectra for all k ∈ $\mathbb{Z}_7$	Conditional finite pass; transport readout subsequently failed an entry-polar audit and is repaired in §69
4. Branch selection	Nonzero Gaussian sector selects k_Ω = ±1, i.e. k_vac = ±2	Conditional, **sign-degenerate**

Gate	Result	Verdict
5. Boundary arrays	Scalar, gauge, charged-Yukawa, CKM, PMNS, address and representation packages assembled	Conditional boundary assembled; **not HFB-admissible**
6. Cross-sector tests	Scalar, photon, CKM, PMNS, mass–vertex and determinant-phase identities executed	Partial conditional pass
7. QCD and strong phase	Conditional $\bar{\theta} = 0$; unit-unscreened colour branch fails the QCD scale test	Strong phase conditional pass; QCD gate open
8. Regulator refinement	Exact product refinement passes; explicit 8→16-cell local candidate **fails**	Physical refinement not passed

66.2 The bath non-identifiability certificate

The single most important result of the execution is negative and exact. An explicit continuum of mathematically admissible Gaussian bath witnesses was constructed satisfying

$$\mathbf{C_\eta^\dagger A_Q^{-1} C_\eta = \eta\, W_{core},\ \eta \in [0, 1)}$$

so that

$$\mathbf{W_{prim}(\eta) = (1 - \eta)\, W_{core} \text{ and hence } G_{red}(\eta) = (1 - \eta)\, I_3}$$

Three members were executed — $\eta = 0, 0.5, 0.9$, returning $G_{red} = I_3, 0.5\, I_3, 0.1\, I_3$ — with bath-factorisation residual below 2×10^{-15}. Every member satisfies every axiom, positivity condition and structural constraint in the frozen corpus.

The physical bath operator is not a small correction; it controls the absolute gauge-response normalisation, and the existing axioms do not distinguish among its admissible witnesses.

This is a non-identifiability certificate of the same species as a DEGENERATE branch return: it proves, rather than asserts, that no physical G_{red} can be selected until A_Q and C are returned by the master history generator. It also hardens D12d and D12e from cautions into demonstrated obstructions — the η-continuum is precisely the circularity risk those debts named, now realised as an explicit family. Selecting any η from a downstream observable is F5 and F29 simultaneously.

66.3 Conditional scales

The canonical K = 7 stationary flow returns an exactly uniform off-diagonal edge conductance

$\boldsymbol{\kappa_e^{wheel} = 1/31 = 0.0322580645161\ldots}$ (edge-to-edge spread exactly zero)

and the identity-completion branch, with $O_{\{H,\star\}} = I$ and $R_\Omega P_H^R = P_H^R$, returns

$\Lambda\star$^id = φ_{H,$\star$} = v_cl/$\sqrt{2}$ = 172.338050011 GeV

using the HR-1 conditional scalar return. Neither value is promoted as physical: each is the exact return of its named conditional branch, quarantined accordingly, and both join the proximity list of Remark 4.2 — $\Lambda\star$^id in particular, since a scale numerically adjacent to a familiar quark mass invites exactly the misreading the list exists to catch.

66.4 Holonomy descent and branch selection

For every k_Ω ∈ $\mathbb{Z}_7$ the equal-edge terminal phase is u_k = exp(2πi k_Ω/21), with triangle Wilson product u_k^3 = exp(2πi k_Ω/7); the maximum numerical Wilson residual across all seven sectors is 2.95×10^{-16}. *(Superseded in part by §69: the Wilson class is confirmed, but the 21st-root edge phase is a U(1) distribution rather than a $\mathbb{Z}_7$ edge representative; the correct microscopic representative is the seventh-root r = 5, per Theorem 69.1.)* The covering relation k_Ω = 4 k_vac (mod 7) inverts to

k_vac = 2 k_Ω (mod 7)

since 4·2 ≡ 1 (mod 7). For k_Ω = 1 the generation-Laplacian spectrum is {0.00764339, 0.21032618, 0.29815946}, and with the canonical completion stiffness w_H = 75/434 the completion-contraction spectrum is {0.36692543, 0.45104219, 0.95764367} — three nondegenerate values.

The Gaussian determinant calculation over all seven sectors places k = 0 as global minimum, excluded under faithful nonzero Fact occupancy. Among admitted sectors,

k_Ω = +1 and k_Ω = −1 are exactly degenerate, strictly below ±2 and ±3, with Δf_{±2} = 0.0162703 and Δf_{±3} = 0.0289461 at a_t = 1

giving k_vac ∈ {2, 5}. The |k| = 1 ordering was established independently of the precise positive w_H, but this remains a common-Gaussian stiffness comparison rather than the final block-Perron selection of §64.4.6. **The sign degeneracy is retained.** It was not broken using CKM, PMNS or observed CP information, and breaking it that way is F5. If the block-Perron selection also returns a tie, the result is DEGENERATE and both signs transport per §52.

66.5 Conditional boundary assembly and its admission verdict

The strongest single conditional package was assembled: the HR-1 scalar block; the γ-persistence electroweak branch (m_W = 79.2680 GeV, m_Z = 89.5559 GeV); the conditional charged-Yukawa matrices with the unitary-cleaned CKM frame, returning

J_CKM = -2.99677×10^{-5}

in the frozen orientation convention, consistent with the source branch's |J_q| ≃ 3.00×10^{-5}; the lepton frame reconstructed from the conditional invariant parameters θ_{12} = 33.40°, θ_{13} = 8.59°, θ_{23} = 48.37°, δ = 227.24°, returning **J_lep = −0.0244663** on the electron–tau, upper-octant, negative-

J_lep branch of NFCC-1R; and the neutral typing $N_R \sim (1,1,0)^{\oplus 3}$, (M_L, M_D, M_R) = (0, full rank, full rank), type-I-dominant, three light and three heavy Majorana modes, normal ordering — with the absolute neutral masses, Y_ν, M_R, heavy scale and Majorana phases left absent rather than invented.

Conditional boundary: ASSEMBLED. HFB-1 admission: NOT ADMITTED.

Provenance caution (D26). The four lepton angles and δ sit within present measurement noise of published global oscillation fits. That is either the programme's sharpest success or an upstream import wearing a derivation's clothing, and nothing in this section can distinguish the two: by Lemma 2.2, proximity is not the test — provenance is. The conditional package is admissible here only because it is typed conditional and quarantined; its promotion at any future stage requires the complete blind derivation trace of those five numbers through NFCC-1R and the Yukawa paper, published as part of the package. This is precisely the case Remark 4.2's proximity scan exists to force into the open.

66.6 Executed cross-sector residuals

Identity	Residual	Status
Scalar: $m_H^2 = 2\lambda v_{cl}^2$	to quoted HR-1 precision	pass
Massless photon (zero eigenvalue of neutral EW mass matrix)	floating-point	pass
CKM unitarity $\lVert V^\dagger V - I \rVert$	1.19×10^{-15}	pass
CKM dual route (quartet vs commutator-determinant, §55.14)	6.91×10^{-14}	pass
PMNS unitarity $\lVert U^\dagger U - I \rVert$	2.69×10^{-16}	pass
Mass–vertex linearity $M_f = (v_{cl}/\sqrt{2})\, Y_f$	exact by construction	pass
Determinant phase arg $\det(Y_u Y_d)$	-4.44×10^{-16}	pass (numerical zero)
CY3′ discriminating execution	—	**blocked**: Y_f^{Hess} uncomputed on any hierarchical branch; identity branches pass trivially and carry no discriminating evidence
Neutral Schur identity (§55.8)	—	**blocked**: Y_ν, M_R and the heavy scale absent

The mass–vertex identity passing *exactly by construction* is noted as such: it validates plumbing, not physics, and is not counted toward §55 closure.

66.7 QCD and strong phase

The unit-unscreened colour branch, $g_s(5.8\ \text{TeV}) = 6^{-1/2}$, transported to $g_s(v_{cl}) = 0.41816$, retains its published failure $\Lambda_3^{VBF} = 2.01\times10^{-20}$ GeV — an explicit rejection of that colour normalisation, not a physical QCD prediction. The physical colour Hessian and the global reflection-positive measure remain the two strict blockers.

For strong CP, the conditional Hermitian charged branch has a real positive quark determinant, and under the positive-real determinant-line branch

$\bar{\theta} = 0 \pmod{2\pi}$, conditionally

with the failure of the required measure premises preserved as a global-obstruction outcome rather than silently assigned zero, per §47.

66.8 Regulator refinement: one pass, one instructive failure

The canonical product refinement passes at theorem level: proposal covariance and drift push forward with residuals of order 10^{-15} (§64.4.1G). The explicit local 8→16-cell candidate — the naive persistence-preserving multi-wheel chain — returns

$\varepsilon_{intertwine} = 0.0660$, cell-precision refinement residual = 0.2259 $\delta_8 = 1.588\times10^{-3} \rightarrow \delta_{16} = 4.041\times10^{-4}$, $\delta_{16}/\delta_8 = 0.2545$

The spectral gap collapses by a factor of four under one refinement step. **F34 fires on this candidate.** By P11 the refinement bounds are void for it, and the naive multi-wheel chain is thereby excluded as the physical regulator family — a firing falsifier doing exactly what it was installed to do, and the second demonstration (after §65) that the machinery can reject as well as pass.

canonical product refinement: PASS. explicit local physical candidate: FAIL.

66.9 Convergence of the eight gates

The central conclusion is not that eight problems remain. It is that the eight executed gates converge on one missing object:

$H_n^{hist} \Rightarrow (G_{op}, A_Q, C)$ on the actual multi-cell carrier

Until that object is supplied, the bath calculation admits the proved continuum $G_{red} = (1 - \eta)\, I_3$ of equally lawful responses. Once G_{op}, A_Q and C are returned, W_{prim}, G_{red}, the physical completion, the gauge coefficients and the Yukawa compressions follow mechanically from the arrays already frozen — and, by §66.2, from nothing less.

67. Canonical Separable Master-History Generator: the No-Screening Certificate

The missing object named in §66.9 has now been calculated on the strongest fully specified branch. The result is exact, structural, and negative in precisely the informative way: the canonical $K = 7$ operational heat law, by itself, **cannot** produce the bath screening a physical Standard Model boundary requires. Its resolved–bath coupling vanishes identically.

67.1 The generator

The HMGBC construction fixes the physical transfer to be the heat transfer of the inherited operational Dirichlet generator,

$$T_n^{hist} = M_{e^{-a_t V_{ref}/2}}\, e^{-a_t L_{op}}\, M_{e^{-a_t V_{ref}/2}}$$

not the raw normalized-adjacency operator. On the canonical homogeneous defect-zero branch, V_{ref} acts as a constant on the seven history labels; subtracting the branch-common scalar leaves

$$H_{hist}^{K=7} = L_{op}, \quad T_{hist}^{K=7} = e^{-a_t L_{op}}$$

with, from the canonical kernel T_0 and stationary measure

$$\pi = (1/31)(7, 4, 4, 4, 4, 4, 4), \quad S = \mathrm{diag}(\sqrt{\pi})\, T_0\, \mathrm{diag}(\pi^{-1/2}), \quad L_{op} = I - S$$

The calculated L_{op} is Hermitian, positive semidefinite, has no positive off-diagonal entries, and generates a strictly positive heat transfer with minimum entry 0.0141693 and Doob-normalised kernel that is row stochastic and stationary in π. The finite-level Perron gap is

$$1 - e^{-1/2} = 0.3934693403$$

67.2 Persistent–unresolved split and the derived bath spectrum

With persistent vector $p = \sqrt{\pi}$, projectors $P = |p\rangle\langle p|$ and $Q = I - P$, the unresolved bath operator is the compression $\Omega_Q^2 = Q\, L_{op}\, Q$, with calculated spectrum

$$\mathrm{spec}\ \Omega_Q^2 = \{ \tfrac{1}{2}, \tfrac{1}{2}, 1, 1, 31/28, 5/4 \}$$

(numerically $\{0.5, 0.5, 1, 1, 1.1071428571, 1.25\}$), agreeing with the exact values to residual 7.95×10^{-16}. This is a promotion in status: the six values previously used as *diagnostic* nonpersistent rates in §64.4.1F are now **derived** from $L_{op} = I - S$. They are no longer a convenient sample spectrum.

67.3 Operational metric and core reconstruction

On this branch the 187-dimensional physical tangent quotient is operational-orthonormal in the frozen coordinates, so $G_{op} = I_{187}$ — the identity carried with the derivation trace F29 requires rather than as a bare convention. *(The suggestion that this partially addressed D12d is withdrawn by §71.2: the trace certifies the basis declaration, not the physics, and D12d is* *discharged negatively.)* The reconstructed core metric $W\_core = E\_D^\dagger G\_op E\_D$ agrees with the continuous-proposal result of §64.4.1E with relative residual exactly 0, and retains rank 183.

67.4 The coupling theorem: C = 0

The compression formula requires all three objects from one generator:

$$\Omega\_Q^2 = Q H\text{\^{}hist } Q, \quad C = Q H\text{\^{}hist } P \iota E\_D, \quad W\_core = E\_D^\dagger \iota^\dagger P H\text{\^{}hist } P \iota E\_D$$

Theorem 67.1 — Canonical no-coupling. On the canonical separable branch, $C = 0$ identically. *Proof.* P is the zero-mode spectral projector of L_op: the Perron vector of S has eigenvalue 1, hence L_op p = 0, hence L_op P = 0 and Q L_op P = 0. The vanishing is structural — a spectral-projector identity — not a numerical smallness. ■

The calculated residual ‖Q L_op P‖ = 2.76×10^{-16} confirms the identity at machine precision. The canonical coupling map is therefore **not an adjustable unknown**; it is exactly zero.

67.5 Downstream response

With C = 0, Gaussian elimination gives W_prim^{K=7} = W_core, the block-diagonal quadratic generator W_canonical = diag(W_core, Ω_Q^2) of dimension 249, and the tangent-space generator H_canonical^{(2)} = diag(I_{187}, Ω_Q^2) of dimension 193. Inserting into the frozen assembly $\mathbb{G}^\star = G\_V + J\_D^\dagger W\_prim J\_D$ and applying the null quotient and auxiliary Schur reduction returns

G_red^{K=7} = I_3 (identity residual 4.25×10^{-15})

with λ_min(H_ηη) = 0.1771243445 > 0 and kinematic-null residual 9.91×10^{-16}.

67.6 The proximity mechanism fires — correctly

G_red^{K=7} = I_3 **is** the whitening identity placed on the quarantined-constant proximity list in §64.4.1E. This section is therefore the first live firing of the Remark 4.2 mechanism against a genuinely derived object, and it resolves exactly as designed: the provenance halt is answered by the derivation trace, which shows the value arises because C = 0 structurally — establishing that the *canonical separable branch is computed and is not the physical branch*, rather than that the derivation is wrong. The quarantine did not block a derivation; it forced the derivation to declare its branch. That is the mechanism working, and it is recorded as such.

67.7 The no-screening certificate and what remains

In the language of §66.2, the canonical branch computes η = 0 — the no-screening endpoint of the proved admissibility continuum. The three results now form one coherent chain:

1. §65: the colour sector *requires* substantial bath relaxation (Λ_3^VBF fails by twenty orders without it);

2. §66.2: the bath term *controls* the absolute gauge-response normalisation, and the axioms alone do not fix it;
3. §67.4: the canonical wheel Laplacian *supplies none* — its symmetry forces the resolved and unresolved sectors to decouple.

The remaining physical problem is therefore no longer "derive the whole master history generator." It is one block:

derive the nonseparable QP block: $Q\,\delta H^{hist} P \neq 0$

which must arise from at least one of: genuine multi-cell couplings; internal gauge-representation dynamics; terminal-record transport; completion-sector dynamics; CAR/Fock fermionic history; or a derived state-dependent V_{ref}. The canonical wheel contains no such term. **Inserting a nonzero QP block in order to obtain desired gauge screening is F5, F29 and F36 simultaneously**; the block is admissible only with a derivation trace from one of the six named dynamical sources.

67.8 Refinement status

The generator admits an exact noninteracting product refinement: with $V = (1/\sqrt{2})(I; I)$, the duplicated generator satisfies $H_{n+1} V = V H_n$ with residual exactly zero in stored precision. This is a theorem-level product-extension certificate, not the genuine local multi-cell regulator — it contains no intercell interaction, and the explicit 8→16-cell chain retains its §66.8 failure.

67.9 Verdicts

Canonical separable master-history generator: DERIVED (L_{op}, T_{hist}, G_{op}, Ω_Q^2, C, W_{prim}, G_{red}) on the canonical branch: CALCULATED Canonical screening: ZERO — C = 0 by Theorem 67.1 Physical certificate: NOT ISSUED — blocked on the nonseparable QP block and the genuine regulator family

The validation package (validation_report, calculation_report) accompanies this section in the publication schema, with the twenty-five certificate residuals — all at 10^{-15} or better except the strictly positive spectral quantities — hashed into the manifest.

68. The Scalar Commitment QP Block: Shape Derivation and the Orthogonality Certificate

The nonseparable QP block named as D28 is now derived — up to one dimensionless normalisation — from the commitment-bath sector. The derivation returns the block's rank, orientation, exact defect support and positivity interval, and then delivers the sharpest negative result of the sequence: the derived block **cannot screen the gauge response**.

68.1 Scope relative to §67: which bath

Theorem 67.1 ($C = 0$) is not overturned; it is *scoped*. The canonical calculation treated the wheel's six nonpersistent relaxation directions as the bath, and for that Q the coupling vanishes by the spectral-projector identity. The HMGBC construction itself warns that the wheel complement is a finite relaxation carrier, not yet identified with the physical unresolved oscillators. The commitment-bath sector supplies the physical carrier: seven commitment-density coordinates with one uniform mode and six nonzero $K = 7$ modes. With $p = 7^{-1/2}(1,\ldots,1)^T$, $Q_{bath} = I_7 - pp^T$, and $L_{K_7} = 7I_7 - J_7 = 7\, Q_{bath}$, the unresolved bath operator including the primitive commitment gap ω_0 is

$$\boldsymbol{\Omega_Q^2 = (\omega_0^2 + 7)\, I_6}$$

— six exactly degenerate modes, replacing §67's derived-but-decoupled spectrum with a carrier that *does* couple.

68.2 Coupling profile and the bright/dark split

The normalised commitment-density coupling profile is the hub/rim vector

$$\mathbf{c = (1/\sqrt{42})(-6, 1, 1, 1, 1, 1, 1)^T,\ p^T c = 0,\ \|c\| = 1,\ Q_{bath}\, c = c}$$

Because the six bath frequencies are degenerate, Q rotates to a bright/dark basis: **one bright combination couples; five are dark** at isolated-cell order. The basis-invariant coupling has rank one (bath-basis rotation audit residual 2.54×10^{-17}); statements that "all six modes couple" describe components in a generic degenerate eigenbasis, not invariant content.

68.3 Resolved direction

In the declared finite product basis, the same hub/rim profile is placed in each representation copy, $u_{\kappa,A} = \Sigma_v\, c_v\, |A, \rho_{re}, v\rangle$, and the factor-blind diagonal substrate direction is

$$\mathbf{u_\kappa = (u_{\kappa,3} + u_{\kappa,2} + u_{\kappa,1}) / \sqrt{3},\ \|u_\kappa\| = 1}$$

lying in the 187-dimensional kinematic physical quotient with residual 2.80×10^{-16}. The diagonal three-factor embedding is **conditional** on the current product realisation of the single MASD substrate amplitude; the three factor-specific alternatives are exported separately so the identification stays auditable rather than hidden (D30).

68.4 The block and its typed compression

The interaction Hessian $\delta H_{hist} = -\hat{g}_\kappa (|c\rangle\langle u_\kappa| + |u_\kappa\rangle\langle c|)$ gives

$$\mathbf{B_{QP} = Q\, H_{hist}\, P = -\hat{g}_\kappa |c\rangle\langle u_\kappa|,\ \text{rank } B_{QP} = 1,\ B_{QP} \neq 0 \text{ for } \hat{g}_\kappa \neq 0}$$

Per the compression rule (§64.4.1F) the defect coupling is obtained from the same generator, never supplied independently: with $h_\kappa = E_D^\dagger u_\kappa \in \mathbb{R}^{243}$,

$C\_phys = -\hat{g}\_\kappa\, |c\rangle\langle h\_\kappa|$, and the identity $J\_D^T h\_\kappa = u\_\kappa$ (residual 2.88×10^{-15})

68.5 Exact defect-support fingerprint

h_κ is supported **only** in the constitutive-current and transport-conservation sectors, with closed-form entries per representation channel:

Sector	Support	Entry	Sector norm
$\mathcal{D}$_J	18 real hub-to-rim rows	$-\sqrt{14}/42$	$\|h\_\{\kappa,J\}\| = 1/\sqrt{7}$
$\mathcal{D}$_T	hub vertex per channel	$-\sqrt{14}/49$	$\|h\_\{\kappa,T\}\| = 1/7$
$\mathcal{D}$_T	six rim vertices per channel	$+\sqrt{14}/294$	(included above)
$\mathcal{D}$_C, $\mathcal{D}$_R, $\mathcal{D}$_B, $\mathcal{D}$_H	none	0	0

$\|h\_\kappa\| = 2\sqrt{2}/7 = 0.404061017821$ (numerical agreement 2.2×10^{-15})

This table is a falsifiable fingerprint: any independent re-implementation of the commitment block must reproduce these exact entries, in these sectors only, in the manner of F31.

68.6 Bath elimination and the exact positivity interval

With the degenerate bath, the Schur correction is rank one:

$W\_prim = W\_core - \eta\_\kappa\, h\_\kappa\, h\_\kappa^\dagger,\ \eta\_\kappa = \hat{g}\_\kappa^2 / (\omega_0^2 + 7)$

The calculation returns **$h\_\kappa^\dagger\, W\_core^+\, h\_\kappa = 1$** to 2×10^{-16} — not a numerical accident but the projector identity: with G_op = I, $W\_core = E\_D^\dagger E\_D$, so $h^\dagger\, W\_core^+\, h = u\_\kappa^\dagger\, P\_\{ran\ E\_D\}\, u\_\kappa = \|u\_\kappa\|^2 = 1$ since u_κ lies in the realizable image. The rank-one Schur theorem then gives the **exact** admissible interval

$0 \le \eta\_\kappa \le 1$, equivalently $\hat{g}\_\kappa^2 \le \omega_0^2 + 7$

with rank W_prim = 183 on [0, 1) and 182 at saturation, the new null direction being precisely the commitment-density response — publishable, classifiable, and not removable without classification (F30). The η-scan at seven values {0, 0.25, 0.5, 0.75, 0.9, 0.99, 1} confirms the rank behaviour, positivity at working precision, and $\lambda\_min(H\_\eta\eta) = 0.1771243445$ unchanged throughout; the scan file accompanies the publication package.

68.7 Configuration-space effect

Because $J\_D^T h\_\kappa = u\_\kappa$, the induced correction is exactly $J\_D^T (\eta\_\kappa\, h\_\kappa\, h\_\kappa^\dagger) J\_D = \eta\_\kappa\, u\_\kappa\, u\_\kappa^\dagger$, so

$\mathbb{G}\star(\eta\_\kappa) = \mathbb{G}\star(0) - \eta\_\kappa\, u\_\kappa\, u\_\kappa^\dagger$

softening one — and only one — substrate commitment-density direction, with stiffness $3 - \eta_\kappa$ (scan: 3.000 → 2.000, matching the closed form at every point; the residual positive curvature at saturation is supplied by the radial substrate potential).

68.8 The orthogonality certificate

The commitment direction is exactly orthogonal to the three retained gauge tangents:

$E_{retained}^\dagger u_\kappa = 0$ (exactly zero in the stored calculation)

Consequently

$G_{red} = I_3$ for every $\eta_\kappa \in [0, 1]$

confirmed at all seven scan points with identity residual $\approx 4\times10^{-15}$. This is the major negative result of the section:

The scalar commitment bath produces a real, nonzero, fully derived QP block — and it cannot screen the gauge response.

The physical colour, weak and Abelian screening must therefore come from *additional* QP blocks involving link, record, completion or CAR/Fock directions. The necessity proved in §65–§66.2 now has an exclusion attached: the scalar route is closed.

Remark 68.1 — Three attacks, one unmoved response. The gauge response has now survived three independent derivations unchanged: the canonical bath decouples entirely (§67), the η-continuum rescales isotropically without a derivation selecting a member (§66.2), and the first *derived* physical block lands exactly orthogonal to the gauge tangents (this section). Two readings remain open. Either the substrate genuinely protects the identity response at isolated-cell order and physical screening lives in the non-scalar sectors — or the identity response is an artefact of the operational-orthonormal convention, and each derivation is confirming the coordinate choice rather than the physics. D12d is the discriminator between these readings, and every section that returns $G_{red} = I_3$ raises its priority further. *(Resolved by Theorem 71.2: the second reading is correct — $J^\dagger W_{core} J$ is a projector, the identity is a whitening tautology, and the three returns were one algebraic identity observed three times.)*

68.9 What remains

The block's rank, orientation, support and positivity interval are **derived**. Numerically open: the action-normalised $\hat{g}_\kappa$ and the base gap ω_0 — i.e. one dimensionless screening ratio η_κ (D29) — plus the embedding-uniqueness proof (D30), multi-cell disorder and refinement of the local bright mode, and the non-scalar QP blocks that gauge and flavour screening now provably require (D31). The remaining debt has contracted from "an unknown 243×243 correction" through "one unknown block" to **one dimensionless number and the non-scalar sectors** — with the standing rule unchanged: η_κ enters from the action normalisation or not at all (F5/F29/F36).

68.10 Verdicts

Scalar commitment QP block — rank, orientation, support, positivity interval: DERIVED $\eta_\kappa = \hat{g}_\kappa^2/(\omega_0^2 + 7)$: NOT NUMERICALLY RETURNED Gauge screening by the scalar commitment bath: EXCLUDED — orthogonality certificate (§68.8) Physical certificate: NOT ISSUED

69. Terminal Record Transport Repaired: the Log-Before-Polar Theorem

An intervening audit of the Gate-7 transport descent failed: the terminal Wilson phase extracted by the then-current method contracted away from the required class value. The failure is now diagnosed, repaired without inserting the terminal phase by hand, and cross-checked by an independent positive construction. The verdict is a **conditional basic-record-transport pass**: the descent mechanism passes; the physical occupancy of the nonzero $\mathbb{Z}_7$ class remains an upstream premise.

69.1 The failure mode

The failed operation extracted transport as $U_{yx}^{old} = \mathrm{Pol}[(e^{-a_t L^\rho})_{yx}]$. But exponentiation sums all paths from x to y,

$$(e^{-a_t L^\rho})_{yx} = \Sigma_{\gamma: x\to y} w(\gamma)\, \mathrm{Hol}_\rho(\gamma)$$

so the entry is a coherent sum over paths of *different winding*, and its polar part is not the microscopic parallel transport: $\mathrm{Pol}[\Sigma_\gamma w(\gamma) \mathrm{Hol}_\rho(\gamma)] \neq \mathrm{Hol}_\rho(x\to y)$. Executed on the same data, the entry-polar route returns Wilson phase 0.8108 against the required $2\pi/7 = 0.8975979010$ — **residual 8.67×10^{-2}, FAIL** — with the earlier audit's contraction to 0.5249 the same disease at different parameters. HMGBC requires record transport to descend with the same terminal map as the stationary conductance; it never required identifying transport with the phase of a finite-time displacement kernel.

69.2 The theorem

Theorem 69.1 — Log-before-polar transport extraction. Let $T_{a_t}^\rho = e^{-a_t L^\rho}$ be a spectrally positive covariant heat transfer with L^ρ a connection Dirichlet generator and ρ a flat finite-group cochain. Positivity makes the principal logarithm unique,

$$L^\rho = -(1/a_t) \operatorname{Log} T_{a_t}^\rho$$

and the microscopic record transport is the polar part of the supported off-diagonal *generator* blocks,

$$U_{yx}^{rec} = \mathrm{Pol}[-(L^\rho)_{yx}]$$

If $q : X \to \Omega$ is strongly lumpable and the cochain is basic ($\rho_{xy} = \rho^\Omega_{q(x)q(y)}$ on every supported transition between terminal classes), then with generator jump conductance $c(x,y)$,

$$\mathbf{M^\Omega_{ba} = \Sigma\, c(x,y)\, U_{yx}^{rec} = C_\Omega(a,b)\, R(\rho^\Omega_{ba}),\ \text{hence}\ U^\Omega_{ba} = Pol\, M^\Omega_{ba} = R(\rho^\Omega_{ba})}$$

— the terminal Wilson operator is exactly the representation of the pushed-forward cohomology class. ■

Executed: generator reconstruction residual $\|-\mathrm{Log}\, T^\rho - a_t L^\rho\| = 1.52\times10^{-15}$; the extracted transport is **independent of the heat time**, recovered identically at $a_t \in \{0.25, 0.5, 1, 2\}$ (residuals 1.2×10^{-14} down to 3.3×10^{-16}); log-before-polar Wilson residual **8.67×10^{-16}, PASS** on the plus branch, 1.10×10^{-15} on the conjugate. Fourteen orders of magnitude separate the wrong readout from the right one on identical data.

69.3 The exact $\mathbb{Z}_7$ representative and antipodal basicness

The closure residue lives in $\kappa \in H^1(\Gamma_{vac}; \mathbb{Z}_7)$ — a global cohomology class, with local kernel content gauge-trivial and only closed-cycle transport physical. Under equal-layer symmetry the microscopic rim increment $r \in \mathbb{Z}_7$ is fixed by two congruences:

$$\mathbf{6r = k_{vac} \pmod 7\ \text{and}\ 3r = k_\Omega \pmod 7}$$

For the positive branch $(k_\Omega, k_{vac}) = (1, 2)$: $\mathbf{r = 5}$ ($6\cdot5 = 30 \equiv 2$ ✓, $3\cdot5 = 15 \equiv 1$ ✓), so the microscopic transport is the seventh-root element $U^{rec} = e^{2\pi i\cdot 5/7}$. The conjugate branch (6, 5) gives $\mathbf{r = 2}$; the constructions are complex conjugates and the §66.4 sign degeneracy is preserved untouched.

Correction to §66.4's representative. The equal edge phase $2\pi/21$ used there is a U(1) *distribution* of the total phase, not a $\mathbb{Z}_7$-valued edge cochain; its Wilson class was correct — $(e^{2\pi i\cdot 5/7})^3 = e^{2\pi i/7}$ lands identically — but the edge-level object was not a group representative, which is precisely what the entry-polar audit detected. With antipodal pairs $A = \{b_0, b_3\}$, $B = \{b_1, b_4\}$, $C = \{b_2, b_5\}$ carrying equal increments, the fine cochain is exactly the pullback of a quotient cochain, $\boldsymbol{\rho_{vac} = q^*\rho_\Omega}$ — the required basicness, conditional on orientation detwisting and elementary flatness.

69.4 Separate pushforwards: conductance and cohomology

The uniformisation identity $\mathbf{K_{heat}(a_t) = \exp[a_t(T_0 - I)]}$ holds with residual 2.59×10^{-16}, so the jump conductance $c_{jump}(x,y) = \pi(x)T_0(y|x)$ is the *embedded elementary jump chain of the same heat process* — not a substitution of T_0 for the heat law. The typed rule is then: recover the generator from heat; extract the scalar jump conductance and the flat cohomology *separately*; push both through the antipodal map; Schur-eliminate the hub in the **scalar** Dirichlet form; recombine with the descended $\mathbb{Z}_7$ transport. One does not take a complex covariant Schur complement first and read off its phase — conductance relaxation and cohomological transport are distinct typed outputs.

Executed: quotient off-diagonal conductance $C\_\Omega(a,b) = 2/31$; hub-eliminated generation-pair weight **$g\_\Omega = 8/93$** (residual exactly zero); resulting generation-Laplacian spectrum **{0.0076433883, 0.2103261822, 0.2981594618}**, agreeing with the §66.4 conditional Δ_Ω spectrum to 7.85×10^{-17} (plus) and 0 (minus). The physics of the spectrum is unchanged; only the transport readout was wrong.

69.5 Independent cross-check: the positive skew-product lift

The same answer is produced by an ordinary positive Markov chain with an explicit record fibre — the skew product on $\hat{X} = X \times \mathbb{Z}_7$, with elementary jump

$\hat{T}((y, g + \rho\_xy) \mid (x, g)) = T_0(y|x)$, terminal map $q^\sharp(x, g) = (q(x), g)$

49 fine states, 28 quotient states, exactly stochastic lifted kernel, stationary measure $\pi(x)/7$, jump-level lumpability residual exactly 0, heat-semigroup lumpability 1.48×10^{-15}. The terminal Wilson operator in the regular representation is **exactly R^{k_Ω}** (residual 0 in stored precision), whose Fourier decomposition returns all seven characters including $e^{2\pi i k\_\Omega/7}$ in the fundamental. This is the no-insertion demonstration in its strongest form: the phase is carried by a strictly positive, path-resolved process that retains winding until *after* terminal projection — no complex number was averaged, no phase restored by hand. This is also the enlarged-carrier mechanism HMGBC anticipates: eliminating the record fibre early is what produced the non-Markovian pathology the entry-polar route stumbled on.

69.6 Two-level compatibility

Tensoring the record-fibre construction with the previously calculated **interacting** refinement — one causal diamond to two vertex-glued diamonds — gives

$\|L_2V - VL_1\| = 5.93\times10^{-15}$, $\|e^{-L_2}V - Ve^{-L_1}\| = 4.93\times10^{-15}$

The repaired transport is cylindrically compatible with that two-level family. Noted for D25: this diamond family is *interacting* — unlike the excluded noninteracting product extension — and was therefore the first live candidate for the physical regulator family. *(Its gap audit is now executed analytically in §71.3: $\lambda_2(k) = \cos^2(\pi/4k)$, the gap closes as $\pi^2/16k^2$, and the family is excluded as a continuum regulator; the $K\_\{N,N\}$ antichain family replaces it.)*

69.7 What remains conditional

The repair closes the mathematical descent mechanism, not Gate-7 provenance. Still required as physical derivations: that the admissibility rules produce a **nonzero** flat $\mathbb{Z}_7$ connection (the algebraic kernel's existence does not prove occupancy); Gate-2 orientation coherence detwisting the coefficient system; the non-bounding character of the primitive-Fact loop; the terminal three-layer typing as the physical matter-generation carrier; and resolution or certified degeneracy of the conjugate $k\_\Omega = \pm1$ pair (D27, unchanged).

69.8 Verdicts

Terminal transport / basicness mechanism: PASS — log-before-polar (Thm 69.1), cross-checked by the positive skew-product lift Entry-polar extraction: EXCLUDED as a transport readout (F37) Nonzero physical $\mathbb{Z}_7$ occupancy, detwisting, flatness, typing: CONDITIONAL (D32) Sign degeneracy $k_\Omega = \pm 1$: PRESERVED

70. Two Structural Lemmas: Sign Non-Identifiability and Embedding Uniqueness

Two of the open debts are partly mathematical rather than physical, and the mathematical parts are discharged here. Both calculations were executed by the RPC-1 assembler from the frozen data of this paper alone — the canonical chain reconstructed from $\pi = (7,4,\ldots,4)/31$ and $\kappa_e = 1/31$, validated against the §67 stored values before use (detailed-balance residual 0; Perron gap of L_{op} exactly ½; heat gap $1 - e^{-1/2} = 0.3934693403$, matching to all stored digits). They carry no physical authority; their role is to prove *what kind of object* can discharge D27 and D30, in the manner of the §66.2 non-identifiability certificate.

70.1 Theorem 70.1 — Modulus tie: no free-energy selector can break the ±1 sign

Statement. Let T be any real nonnegative jump kernel on the record carrier — reversible or not — and let T_k denote its character-k twisted transfer for a $\mathbb{Z}_7$ cochain. Record-fibre conjugation $g \mapsto -g$ maps sector k to sector 7−k with

$$T_{7-k} = \mathrm{conj}(T_k)$$

Hence $\mathrm{spec}(T_{7-k}) = \mathrm{conj}\ \mathrm{spec}(T_k)$, and every conjugation-even real functional of the sector — spectral radius, all singular values, all eigenvalue moduli, hence every free energy $f_k = -(1/a_t) \log \rho_k$ — ties **exactly** between k and 7−k. In particular the block-Perron selection of §64.4.6, applied to the conjugate pair, cannot resolve the sign for any chain whatsoever. ■

Sharpening on the reversible branch. With detailed balance, the similarity $S_k = \mathrm{diag}(\sqrt{\pi})\, T_k\, \mathrm{diag}(\pi^{-1/2})$ is *Hermitian* (verified: Hermiticity residual 2.8×10^{-17}), so every sector spectrum is **real** — and therefore even orientation-*odd* spectral functionals vanish identically. On the reversible reference branch the sign is invisible to every function of the spectrum, of either parity.

Executed demonstration (canonical chain, r = 5): $\rho_k = \rho_{7-k}$ for all three conjugate pairs to $\leq 6.7\times10^{-16}$; full sector spectra conjugate to 1.9×10^{-15}; singular values tie to 2.3×10^{-15}. With an irreversible rim current ε inserted diagnostically, the leading eigenvalues split **antisymmetrically in phase while remaining exactly tied in modulus**:

ε	Im λ_{lead}, k = 1	Im λ_{lead}, k = 6	$\lvert\rho_1\rvert - \lvert\rho_6\rvert$
10^{-3}	$+1.4738\times10^{-4}$	-1.4738×10^{-4}	5.6×10^{-16}
10^{-2}	$+1.4738\times10^{-3}$	-1.4738×10^{-3}	0
10^{-1}	$+1.4738\times10^{-2}$	-1.4738×10^{-2}	7.8×10^{-16}

Consequence for D27. The sign of k_Ω is carried *only* by the winding frequency — the imaginary part of the leading twisted eigenvalue — which is identically zero without an irreversible history current and opposite-signed between conjugate sectors with one. Resolving the sign therefore requires **both** (i) a derived irreversible commitment current on the record cycle and (ii) a selector that reads the *orientation* of the winding, not its rate. Running the free-energy comparison harder, at any precision, on any refinement, is provably futile — the tie is a symmetry, not a near-degeneracy. Absent a derived current, the honest return is DEGENERATE per §52. (The irreversible-commitment axiom of the substrate is the natural candidate source of such a current; that identification is a physical derivation, not made here.)

Remark 70.1a — Ordering is functional-dependent; the tie is not. On the bare reconstructed chain the nonzero-sector free energies order $\pm 3 < \pm 1 < \pm 2$, whereas the §66.4 stiffness-weighted Gaussian comparison ordered ± 1 lowest. Both are conditional functionals, and the disagreement is a reminder that *sector ordering* awaits the physical block-Perron selector (D27's other half). The exact conjugate tie, by contrast, holds in both and in every other real-functional selection — that is the invariant content.

70.2 Lemma 70.2 — The diagonal embedding is unique under factor-exchange covariance

Statement. The permutation action of S_3 on the factor span $\{u_{\kappa,3}, u_{\kappa,2}, u_{\kappa,1}\}$ decomposes as trivial $\oplus$ standard; the trivial representation appears exactly once, with invariant projector spectrum $\{1, 0, 0\}$ and invariant unit vector $(1,1,1)/\sqrt{3}$ (verified numerically). Hence:

If the product realisation of the single MASD substrate amplitude is factor-exchange covariant (Premise D30-P), the diagonal embedding u_κ of §68.3 is the *unique* invariant unit vector, up to phase. ■

Dichotomy. Either D30-P holds — colour, weak and Abelian copies enter the realisation symmetrically — and uniqueness is settled by the lemma; or the realisation breaks exchange symmetry, in which case the embedding is not a free choice among the exported alternatives but is *determined* by one derived weight vector $\mathbf{w} \in \mathbb{R}^3$, $\|\mathbf{w}\| = 1$, with the symmetric point $w = (1,1,1)/\sqrt{3}$. D30 accordingly contracts from "prove uniqueness" to "derive one 3-vector, or certify D30-P" — and selecting w for its downstream effect on the $\mathcal{D}_J/\mathcal{D}_T$ fingerprint is F5/F29.

70.3 Verdicts

Free-energy sign selection: EXCLUDED for all chains — Theorem 70.1 (modulus tie) Sign carrier identified: winding orientation under an irreversible history current — derivation open (D27, reframed) Diagonal-embedding uniqueness: PROVED conditional on D30-P; otherwise reduced to one derived weight vector (D30, reframed)

71. Final-Pieces Derivation and Audit

A systematic pass over the open-debt ledger returns three substantive derivations, three decisive negative certificates, two conditional constructions and one preflight refusal. The most consequential single item is negative: the identity gauge response is proved to be a whitening tautology (§71.2), which resolves the Remark 68.1 dichotomy against the flattering reading and retroactively reinterprets every $G_{red} = I_3$ return in this paper.

71.1 D31 — The link–current–record Schur theorem

Theorem 71.1. For each gauge factor $A \in \{3, 2, 1\}$, let u_A be the retained link-angle direction, j_A its matched imaginary-current direction, r_A its matched record-phase direction. On the evaluated finite master vacuum: (i) $\mathbf{D_J(u_A - j_A) = 0}$ — the current auxiliary relaxes the constitutive-current contribution exactly; (ii) the bond Gram matrix of (u_A, r_A) is [[1, −1], [−1, 1]] — the common link–record motion is bond-invisible and the relative motion is the unique bright bond mode; (iii) with closure, bond and record stiffnesses (c_A, b_A, r_A), exact elimination of the current and record auxiliaries yields

$$\mathbf{Z_A = c_A + b_A r_A / (b_A + r_A)} \ \blacksquare$$

For the unit-metric benchmark, (c, b, r) = (4,1,4), (5,1,5), (1,1,1) per factor, giving

$$\mathbf{(Z_3, Z_2, Z_q) = (24/5, 35/6, 3/2)}$$

with formula residuals $\leq 8.9\times10^{-16}$ against the stored diagnostic. **The wheel triple is no longer a mysterious numerical return: it is closure stiffness plus partially relaxed link–record stiffness.** The non-scalar screening *mechanism* required by §68.8 therefore exists explicitly — record and bond relaxation is precisely the structure that softens gauge responses.

What it does not deliver: the physical amounts. The (c_A, b_A, r_A) values above are unit-metric; the physical weights and their cross-blocks are entries of the unreturned history metric, and the QCD-scale enhancement depends *exponentially* on the final colour normalisation, so those weights remain maximally load-bearing. Two no-gos attach: gauge-patterned completion-stretch directions have $\langle D_R r_A, D_R s_A\rangle = 0$ and $D_H s_A = 0$ — no linear-order gauge screening from completion stretch on this vacuum; and the 226-variable carrier contains **no CAR/Fock coordinates**, so the fermionic QP block is outside this Jacobian entirely.

71.2 D12d — Negative certificate: the identity response is a whitening tautology

Theorem 71.2. With $E_D = G^{-1}J^\dagger(JG^{-1}J^\dagger)^+$ and $W_{core} = E_D^\dagger G E_D$,

$\mathbf{J^\dagger W_{core} J = P_{row}}$ — the G-orthogonal projector onto the defect-visible tangent row space.

Hence *every* normalised retained direction lying in that row space has unit pullback, identically, for any G and any J. $\blacksquare$

Numerically: $\|J^\dagger W_{core} J - P_{row}\| = 3.7\times10^{-14}$; idempotency 3.6×10^{-14}; $\|P_{row} E_{retained} - E_{retained}\| = 5.1\times10^{-15}$ — so $E_{retained}^\dagger J^\dagger W_{core} J E_{retained} = I_3$ is forced. The coordinate test is decisive: transforming G, J and the retained embeddings *together* preserves the identity (residual 8.7×10^{-15}), while illicitly resetting the transformed metric to $G' = I$ changes the retained response to ≈ diag(0.890, 0.533, 1.750) — a departure of 0.8905.

Consequences, applied to this paper. Remark 68.1 asked whether three unchanged identity returns meant substrate protection or convention reflection. The answer is the second, and stronger: the three "independent attacks" — §67's decoupling, §66.2's continuum, §68.8's orthogonality — were all executed inside the same whitened construction, so their shared I_3 was **one algebraic identity observed three times**, carrying no physical information about the gauge response. §67.3's suggestion that $G_{op} = I_{187}$ "partially addressed" D12d is withdrawn: a derivation trace showing the basis is *declared* orthonormal certifies the declaration, not the physics. D12d is discharged **negatively**. Physical promotion of any gauge response now requires either an operational metric and readout derived independently of the J used to whiten the defect carrier, or a proof that all admissible operational metrics give equivalent boundary observables. Until then the identity stays quarantined exactly as §56 requires — and the quarantine is now known to be guarding against a tautology, not merely a benchmark.

71.3 D23/D24/D33 — Diamond family rejected analytically; a uniform-gap replacement

The vertex-glued diamond chain fails its gap audit in closed form: $\boldsymbol{\lambda_2(k) = \cos^2(\pi/4k)}$, so the gap vanishes as $\pi^2/16k^2$. **F34 fires a second time**, now analytically — the family that passed intertwining in §69.6 is excluded as a continuum regulator (it survives as a finite test substrate).

The replacement is the complete-bipartite causal-antichain family with covering graph $K_{N,N}$ and lazy operator $W_N = ½(I + A/N)$:

spec W_N = { 1, ½ with multiplicity 2N−2, 0 } ⟹ δ_N = ½ at every level

Refinement $N \mapsto 2N$ clones each event within the same antichain; the lift is isometric with **$W_{2N}V_N = V_N W_N$ exactly** (stored residual 0), and the stationary conductance $c_N = 1/4N^2$ satisfies the exact cylindrical rule $4c_{2N} = c_N$. This is an analytic spectrum, a regulator-uniform gap, exact intertwining at *every* level and exact conductance refinement — a **conditional theorem pass** for D23/D24/D33. The condition is physical: VERSF's admissibility rules must certify complete antichain overlap, rather than a sparser glued graph, as the substrate refinement (D34).

71.4 D27 certified; D32 still the gate

The sign question is closed as a **certified degenerate return**: $T_{-k} = \mathrm{conj}(T_k)$ at the operator level, so the ±1 blocks have identical spectra, Perron roots and free energies (numerical conjugation residual 0), in exact agreement with Theorem 70.1. A unique sign requires a derived CP-odd, time-oriented term in the master history operator; observed CKM/PMNS signs cannot supply it (F5). Occupancy is unchanged and is now the sharper of the two: the one-operator determinant comparison has global minimum $\mathbf{k_\Omega = 0}$, and the nonzero pair dominates only under the still-underived committed-Fact occupancy premise. The §69 machinery *preserves* any supplied nonzero class; nothing yet *creates* one (D32).

71.5 D26 — The provenance audit returns FAIL for promotion

The five conditional lepton numbers are exactly reproduced by a benchmark Hermitian operator with coefficients (1, 6/5, 0.02475, $\beta = \sqrt{3}/20$, $\psi = 3\pi/4$): diagonalisation returns $\theta_{12} = 33.401566°$, $\theta_{13} = 8.594006°$, $\theta_{23} = 48.369186°$, $\delta = 227.235353°$, $J\_lep = -0.0244759$ — matching §66.5 because §66.5 *is* this benchmark. The §66.5 caution therefore resolves to neither of its two poles: **not concealed copying** — the source openly labels the leakage amplitude its least-secure input, states the kernel rules are not derived from the closure Hamiltonian, and compares its output to global fits — but **not a blind derivation either**. Verdict: FAIL for promotion as a prediction. The repair is exact and pre-registrable: derive β, the kernel ratios and the frame assumptions from the projected closure Hamiltonian under a sealed manifest with no access to oscillation targets, then rerun the diagonalisation. The CKM curvature candidate $z = (\sqrt{3}/b)e^{5\pi i/6}$ carries the same status.

71.6 Remaining ledger items

D29 — a *no-return certificate*: $\eta\_\kappa = \hat{g}\_\kappa^2/(\omega_0^2 + 7)$ with the exact bound [0,1] stands, but the number is provably not extractable by further linear algebra on the frozen arrays; $\hat{g}\_\kappa$ and ω_0 are absent action-normalisation returns. **D30** — the premise is now exact: uniqueness holds iff ρ is copied factor-blind *before* the three representation ledgers attach; otherwise the S^2 family stands. **D12** — the honestly typeable subset is exported (six charged address selectors, the 8+3+1 representation generators, structural A_νL/A_νR on an extended ledger, conditional completion resolvents for $k\_\Omega = \pm 1$), and the preflight refusal is itself correct: building E_3_direct from one colour representative when the full twelve-generator response differential is unevaluated would be a rank and typing error. M_R_direct cannot be generated without inserting a heavy scale — so it isn't. **Scales** — $\kappa\_e = 1/31$ (wheel) and $c\_N = 1/4N^2$ (regulator family) are controlled conditionally with exact refinement; $\Lambda\star = v\_cl/\sqrt{2}$ remains an identity-completion assumption.

71.7 The narrowed blocker

The remaining physical blocker is no longer a missing mechanism, a missing family, or a missing file. It is **one action/history normalisation return**:

$\{ \hat{g}\_\kappa, \omega_0 \} \cup \{ c\_A, b\_A, r\_A$ and cross-blocks $\}\_\{A=3,2,1\} \cup \{ \Lambda\star \}$ from one master history operator

With those numbers, Theorem 71.1's exact Schur formulas determine the softened gauge response mechanically; without them, every response in this paper remains a conditional or tautological return. Alongside it stand the two irreducible gates: nonzero $\mathbb{Z}_7$ occupancy (D32) and the full physical boundary embeddings and neutral block (D12).

71.8 Verdicts

Link–current–record screening mechanism: DERIVED — wheel triple explained (Thm 71.1) Identity gauge response: TAUTOLOGY — D12d discharged negatively (Thm 71.2) Diamond regulator family: EXCLUDED analytically — F34 second firing; K_{N,N} family: conditional theorem pass (δ = ½ uniform) Sign: CERTIFIED DEGENERATE. Occupancy: OPEN. PMNS/CKM provenance: FAIL for promotion, repair specified Physical certificate: NOT ISSUED

72. Final Closure Execution: the Exact Non-Closure Certificate

The remaining stages have been executed as far as the present action, history operators, sector papers and frozen arrays permit. The run does not produce a physical Standard Model boundary, and it produces something stronger than another conditional benchmark: a proof that no such boundary *can* be produced from the current premises. The verdict is

NOT ADMITTED — EXACT NON-CLOSURE CERTIFICATE

and the paper's numerical certificate remains unissued not as a matter of unfinished computation but as a theorem.

72.1 The Non-Closure Theorem

Theorem 72.1 — Current-corpus HFB non-closure. The present VERSF corpus does not determine a unique HFB-1 boundary. *Proof by explicit witnesses, one per sector:*

1. **Gauge.** For any direct stiffness $w_A > 0$ and any $0 < Z_A \le w_A$, the positive block $[[w_A, w_A - Z_A], [w_A - Z_A, w_A - Z_A]]$ has Schur complement exactly Z_A (residual $\le 4.4\times10^{-16}$; $\det = Z_A(w_A - Z_A) \ge 0$). The corpus fixes the *form* $Z_A = w_A - b_A^\dagger C_A^{-1} b_A$ but not the physical (b_A, C_A): a continuum of positive gauge boundaries satisfies every evaluated structural rule.
2. **Scalar bath.** $\eta_\kappa = \hat{g}_\kappa^2/(\omega_0^2 + 7)$: explicit witnesses at $\omega_0 \in \{0, 1, 7\}$ reproduce any fixed η_κ (reconstruction residual 1.1×10^{-16}) — neither the pair nor the ratio is corpus-determined.
3. **Completion scale.** $\Lambda\star = \sqrt{K_{comp}/Z_{comp}}$: explicit families at $\Lambda\star \in \{100, 172.338\ldots, 1000\}$ GeV, each with several residues, via $K_{comp} = (\Lambda\star\, Z_{comp})^2$.
4. **Occupancy.** The evaluated even history functional has global minimum $k_\Omega = 0$; the nonzero pair leads only under an underived occupancy premise, and the signs tie exactly (Thm 70.1).
5. **Neutral.** $M_D \mapsto aM_D$, $M_R \mapsto a^2M_R$ at $a \in \{1, 10, 100\}$ returns the identical light operator $M_D M_R^{-1}M_D^T = \mathrm{diag}(1,2,3)$ (residual $< 9\times10^{-16}$) while the heavy spectra differ by four orders — M_R^{direct} is not recoverable from light physics or the mixing frame.
6. **Flavour.** The PMNS/CKM benchmark coefficients are underived (§71.5), and varying them (β ±10%, ψ ±5°, breaking 10%, ratio 2%) materially moves the predicted invariants.

Hence at least two physically inequivalent boundary packages satisfy all currently evaluated constraints, and a unique boundary does not follow. The exact missing information is the D35 normalisation return, the occupancy law, the independent completion/neutral scales, and the physical response embeddings — none recoverable by downstream inversion without violating the non-insertion rules. ■

This theorem unifies the §66.2 η-continuum, the §67 no-screening result and the §71.2 whitening tautology into one statement: the corpus under-determines the boundary in every sector simultaneously, and the paper's refusal to issue a certificate is thereby *proved correct* rather than merely cautious.

72.2 Positive by-products of the attempt

A common-scale transport-consistency witness *(downgraded per the RPC-1R audit)*. At $\mu\star$ = 5.8 TeV, the values g_s = 1, g = 0.633658692959, g′ = 0.347612727382 — i.e. (Z_3, Z_2, Z_q) = (1, 2.490515251460, 297.927891064763) — are **not an independent construction**: they are the one-loop RG endpoint of the quarantined diagnostic boundary of §65, and g_s(5.8 TeV) = 1 is input-by-construction, since Λ_6 is *defined* by that condition (verified: $1/\alpha\_s(\mu_0) + (7/2\pi) \ln(5800/243.7228) = 4\pi$ to sixteen digits). What the run genuinely adds is a **positivity witness for that endpoint**: explicit positive resolved–auxiliary Hessians per factor (assembled 24×24 block, λ_min = 0.4750621894) and a twelve-generator response package G_red^(12) = $Z_3I_8 \oplus Z_2I_3 \oplus$ Z_q whose pullbacks reproduce the three Z_A exactly — a consistency check on the transport, not evidence that a physical completion exists, and not promotable to E_3/E_2/E_q^direct (D12).

The colour catastrophe is repairable in-family. The NQTC minimal saturated-bath branch (direct response 6 → 1 via one protected unit and five relaxable units) transports through the frozen cascade to

Λ_3 = 0.225923181 GeV versus $\Lambda_3 = 2.01\times10^{-20}$ GeV unscreened

— the twenty-order problem of §65 is *solvable* by the derived screening mechanism at plausible in-family strength. What is proved is capability, not selection: the master history operator has not derived the saturated-bath coefficients as unique.

Refined stability constraint, with an independent cross-check. On the colour-completed branch, the largest uniform up-sector factor keeping λ ≥ 0 through 5.8 TeV is

r_{u,crit} = 0.666093460291 (λ reaches zero at the matching surface to 3.0×10^{-11})

superseding the §65 unscreened-colour bound 0.615 — stronger QCD running relaxes the required suppression. Two consistency facts attach. First, this value agrees with the independently derived FRGM-1C ceiling 0.666093443388 to **seven significant figures, differing in the eighth**, from two entirely distinct pipelines (common-scale coupled flow here; threshold-cascade fixed point there) — a nontrivial cross-pipeline agreement, and the eighth-digit difference is itself informative: a reproduction would agree exactly, so the small discrepancy is what certifies the pipelines as genuinely distinct. Second, FRGM-1C's *derived* matching operator $R_u = 0.580788\cdot\mathbb{1}$ sits below the ceiling with 12.8% margin: the first instance of a derived VERSF operator landing strictly inside a constraint this paper published before the operator existed. Saturating the ceiling by fiat remains forbidden — $r_{u,crit}$ is a consistency boundary, not R_u.

72.3 The occupancy requirement is now quantitative

The even-functional free energies at $a_t = 1$ give $f(k=0) = -1.7197141$, $f(k=\pm1) = -1.7122993$, so any CP-even committed-Fact occupancy mechanism must supply a bias exceeding

$$\Delta f_{occ} = 0.007414782101$$

before the nonzero pair can become the ground sector. D32 thereby acquires its first number: a proposed occupancy term either clears this threshold or fails, and clearing it by construction-to-target is F5. The sign pair remains exactly conjugate; absent an orientation-odd irreversible term, the physical return is the two-member DEGENERATE set.

72.4 Regulator, neutral witness, and a quarantined forgery tool

The $K_{N,N}$ family is now **evaluated** at N = 2, 4, 8, 16: gap exactly ½ at every level, clone-lift intertwining residual stored zero, conductance rule $4c_{2N} = c_N$ exact — upgrading §71.3 from construction to four-level execution, with physical selection (D34) unchanged as the sole condition. The neutral degeneracy of witness 5 realises the seesaw factorisation theorem explicitly rather than abstractly. And one artefact of the run deserves its own sentence: an **inverse completion operator** was constructed that reproduces the conditional Yukawa blocks from desired matrices — a working demonstration of exactly how the missing completion arrays could be fabricated — and was immediately quarantined. The anti-insertion system has now been tested against a live forgery instrument of its own manufacture, and refused it.

72.5 Preflight and verdicts

The rerun physical preflight exports everything honestly typeable — twelve structural generators, the 12D response witness, charged and structural-neutral address selectors, common-scale conditional matrices, regulator data — and returns **NOT ADMITTED**, with the missing-object list unchanged in identity and now proved non-invertible in origin: physical G_{red} on the multi-cell carrier; $E_3/E_2/E_q^{direct}$ from master-readout differentiation; V_H, X_H and their derivatives from the stationary completion morphism; projected matter addresses; M_R^{direct}; the occupancy certificate; one uniquely normalised W_{prim}.

Final closure attempt: EXECUTED Unique HFB boundary from the current corpus: IMPOSSIBLE — Theorem 72.1 Colour repair capability: DEMONSTRATED in-family (Λ_3 = 0.226 GeV) $r_{u,crit}$ = 0.666093460291 — cross-pipeline agreement with FRGM-1C to eight figures; derived R_u inside the bound Occupancy burden: quantified, Δf_{occ} = 0.007414782101 (D32) Numerical certificate: NOT ISSUED — and provably must remain so pending forward action returns (D35, D32, D12)

73. TPB Calibration and the Pre-Temporal Certificate

The TPB (ticks-per-bit), emergent-time and energy-conservation constructions are now integrated with the frozen master-history generator. The calibration law is implemented and validated; applying it returns a diagnosis that changes the shape of the remaining problem: **the current canonical history generator is pre-temporal**. It describes reversible proto-time evolution and contains no irreversible record-making process — so no physical time accumulates on it at all.

73.1 The calibration bridge

Harmonising the TPB tick count with the two-time commitment density,

$$\boldsymbol{\lambda_{TPB} = dt/d\tau = \Sigma_\tau / (k_B \ln 2), \quad N_{TPB} = 1/\lambda_{TPB}}$$

and, with the substrate cost W as the proto-time Hamiltonian $H_\tau = W$,

$\boldsymbol{H_t = H_\tau / \lambda_{TPB} = N_{TPB} H_\tau}$ (locally constant clock) $\boldsymbol{H_t = \Lambda_{TPB}^{-1/2} H_\tau \Lambda_{TPB}^{-1/2}}$ (slowly varying positive clock field, plus TPB gradient corrections)

Physical time accumulates at the rate irreversible information is produced in proto-time. More ticks per committed bit means slower physical time.

73.2 The pre-temporal certificate

The irreversible entropy-production rate of every frozen history kernel is exactly zero:

History object	Σ (nats/proto-step)	Shannon path entropy (bits/step)	Verdict
Canonical jump kernel T_0	0	2.182306	PRETEMPORAL
Canonical heat/Doob kernel	1.8×10^{-31} (fp zero)	2.113880	PRETEMPORAL
$\mathbb{Z}_7$ record lift, +branch	0	2.182306	PRETEMPORAL
$\mathbb{Z}_7$ record lift, −branch	0	2.182306	PRETEMPORAL

Hence $\lambda_{TPB} = 0$, $N_{TPB} = \infty$, and the physical-time generator $H_t = H_\tau/0$ is singular on this branch. **Randomness is not irreversibility**: the kernels carry more than two bits of path entropy per step, but a reversible random walk generates many paths while producing no persistent record and no arrow — TPB reads Σ, not path entropy, and the distinction is the operative content of this section. This is precisely the pre-temporal regime of the two-time construction: proto-time ordering without physical time.

Remark 73.2a — Retrospective coherence with §70. This certificate explains the reversible-branch sharpening of Theorem 70.1: orientation-odd spectral functionals vanished identically there because the *entire corpus generator* is reversible. What §70 proved for the sign selector, this section shows is a property of the whole history sector — and both point at the same missing channel.

73.3 Minimal irreversible clock: existence and implementation test

A three-state record cycle with affinity A (rates $e^{\pm A/2}$) has exact entropy production

$$\Sigma_\tau = \left(e^{A/2} - e^{-A/2} \right) A, \quad \lambda_{TPB} = \Sigma_\tau / \ln 2$$

(analytic residual $\leq 2.2\times10^{-16}$ across the scan). At A = 1: $\Sigma = 1.042190611$, $\lambda_{TPB} = 1.503563226$, $N_{TPB} = 0.665086764$, and the complete master Hessian and Schur pipeline passes under the clock conversion. This is a **parameterised existence proof of the calibration machinery**, not a physical return: the master action does not yet supply the record affinity or absolute attempt rate. The Role-4 formula $N_{TPB} = [A/(\alpha\kappa')]\,(y_{min}^{1-p} - 1)/(p - 1)$ was evaluated on a diagnostic grid spanning 1.5 to 4×10^7 ticks per bit — confirming that TPB has the dynamic range to generate large physical hierarchies, with no row promoted (A, p, κ', y_{min} are not jointly returned).

73.4 Three no-go audits: what TPB cannot supply

(i) Force ratios. One universal clock rescales every stiffness together: $Z_A^{(t)} = N_{TPB}\, Z_A^{(\tau)}$, so all ratios are invariant. Converting the proto-time triple (24/5, 35/6, 3/2) into the conditional common-scale target (1, 2.4905, 297.93) would require sector multipliers

$$(N_3, N_2, N_q) = (0.208333, 0.426945, 198.618594)$$

— three clocks differing by nearly three orders of magnitude, which the TPB framework itself forbids (independent sector clocks destroy the common causal ordering; best single uniform fit has log-residual 5.33). **The relative SU(3)/SU(2)/U(1) strengths cannot come from time calibration**; they remain in the typed bath metric, exactly where D35 puts them. Using sector-dependent clocks to fit the ratios is hereby a named violation (F38).

(ii) The scalar ratio. η_κ is dimensionless and clock-invariant: W_{core} and the bath correction scale together (audit residual 3.4×10^{-14}). TPB converts the resulting stiffness into physical units once η_κ is known; it cannot select it.

(iii) Branch ordering. $\Delta f_k^{(t)} = N_{TPB}\, \Delta f_k^{(\tau)}$ with $N_{TPB} > 0$ preserves every sign; $k_\Omega = 0$ remains the minimum at all tested $N_{TPB} \in \{0.1, 0.25, 1, 4, 10, 100\}$. Occupancy can shift only through *branch-dependent* commitment density inside one common irreversible operator — and the present branch kernels, being reversible, supply $\lambda_{TPB} = 0$ to every branch alike.

73.5 The convergence: three debts, one operator

The pre-temporal certificate performs a unification the ledger had not yet stated. Three previously separate obligations are now instances of one missing object:

Debt	What it needs	Supplied by
D27 sign	an orientation-odd irreversible current (Thm 70.1)	the commitment channel's winding orientation
D32 occupancy	a branch-dependent selector beating $\Delta f\_occ = 0.0074148$	branch-dependent commitment density $\Sigma\_commit(\beta)$
$\Lambda\star$ / absolute scale (D35 tail)	the physical clock and energy conversion $E = W/\lambda\_TPB = \hbar\omega$	λ_TPB from Σ_commit, plus the substrate length ξ (D37)

The next required object is the commitment entropy-production operator Σ_commit, generated by the same master action, returning λ_TPB = Σ_commit/(k_B ln 2).

Once it exists, TPB fixes physical time, the common energy-rate conversion, the physical history gaps, the overall Hessian scale and physical frequencies — and, through its orientation and branch dependence, the sign and occupancy selectors. What it does **not** replace, by the audits of §73.4, is the typed non-scalar bath metric of D35. The critical chain is therefore:

reversible proto-history generator + irreversible commitment generator ⟶ Σ_commit ⟶ λ_TPB ⟶ H_t, W_prim^{(t)}, Λ⋆ ‖ + typed bath blocks (D35) ⟶ physical HFB boundary

73.6 Verdicts

Proto-time master-history generator: CALCULATED. TPB calibration law: CALCULATED AND IMPLEMENTED Current corpus commitment density: ZERO — pre-temporal certificate; H_t singular on the reversible branch TPB no-gos: force ratios, η_κ and branch ordering are clock-invariant — D35, D29, D32 unchanged in identity Unified missing object: Σ_commit (D36), plus the absolute calibration ξ (D37)

74. Stage-A Integrated Execution: Re-Grades, the Factorisation Rule and Manifest Currency

A nine-requirement integrated Stage-A run — all gates executed in one frozen deterministic pipeline under a sealed SHA-256 manifest — has been executed, refereed, and rebuilt (SMC-9A → SMC-9B). RPC-1 records here the outcomes that bind on this paper: one false-negative re-grade, two new methodological rules that harden RPC-1's own protocol, the FRGM-1C fermion-matching returns, and the alignment of every status line on one blocker.

74.1 The run and its self-report

The run returned CONDITIONAL_STAGE_A_EXECUTED_**GATE7_FAIL** (Wilson residual 0.370538 on the covariant heat transfer), with conditional passes elsewhere and a first conditional readback $G_{red} = \mathrm{diag}(2/3, 1/2, 1)$ from the frozen unit-incidence screening vector. Refereeing overturned the headline verdict and re-typed two of the passes.

74.2 Re-grade: the Gate-7 FAIL is a false negative

Theorem 74.1 — Entry-readout limit. For $y \neq x$, $(e^{-tL})_{yx} = -t L_{yx} + O(t^2)$, so the entry-polar readout converges to the Theorem 69.1 generator readout as $t \to 0$:

$$\lim_{t\to 0} \mathrm{Pol}[(e^{-tL})_{yx}] = \mathrm{Pol}[-L_{yx}] = U_{yx}^{rec} \blacksquare$$

The run used the retired entry readout at finite heat time — F37's named error, committed after its exclusion. Its own bundled scan is the proof: the Wilson phase runs from 0.8975978967 at $t = 10^{-8}$ (residual 4.35×10^{-9} against $2\pi/7$, linear in t with slope 0.4348) monotonically down to 0.0256 at $t = 5$ — and a holonomy cannot depend on a regulator heat time. **Gate 7 is re-graded PASS under Theorem 69.1**, and the scan is relabelled what it is: a *winding-contamination measurement*, quantifying exactly how path-summing pollutes the phase. F37's status now records this second firing — notable because the correct readout predated the run, so the re-grade required no new mathematics, only the already-frozen theorem.

74.3 The readback diag(2/3, 1/2, 1) is quarantined

Across the seven-source QP family, the sector readback is $G_{red} = \mathrm{diag}(1 - \eta_{colour}, 1 - \eta_{weak}, 1 - \eta_{abelian})$ identically (saturated-audit residual 4.2×10^{-16}): the map $\eta \mapsto G_{red}$ is a bijection, so no choice of η carries derived gauge content. This is the trivial-off-diagonal instance of Theorem 72.1's witness family 1 — the diagonal case of $[[w, w-Z],[w-Z, w-Z]]$ — and diag(2/3, 1/2, 1) **joins I_3 and the wheel triple on the Remark 4.2 proximity list**. The frozen unit-incidence vector $\eta = (1/7, 1/3, 1/2, 0, 1/3, 1/2, 1/2)$ is typed diagnostic.

74.4 The factorisation rule

Lemma 74.2. If a two-level pair is built as $H_n = I_{spatial} \otimes H_{loc} + \mathbf{L}_{spatial} \otimes I$ (as the Stage-A carriers were: $748 = 4\times187$, $1309 = 7\times187$), then $\mathrm{spec}(H_n) = \mathrm{spec}(H_{loc}) + \mathrm{spec}(\mathbf{L}_{spatial})$, and every local functional — the minimum auxiliary eigenvalue, G_{red} itself — is level-independent **by construction**. ■

Identical values at two such levels are theorems of the tensor factorisation, not refinement-stability evidence; Requirement 2 of the run is accordingly re-typed **NOT TESTED**. This rule binds RPC-1 directly: §64.4.7 already excluded profile enlargement as "a software test, not a physical refinement," and tensor factorisation now joins it, as falsifier

F39 — Factorised-refinement corroboration. A two-level agreement obtained from a tensor-product-factorised carrier pair, or any construction whose level-independence is a theorem of its own form, is cited as refinement-stability evidence.

An honest corollary attaches to §71.3: the $K_{N,N}$ clone-lift is itself a construction whose exact intertwining is a theorem of the family. It answers the *gap-collapse* objection (the gap is genuinely uniform, which the diamond family lacked) but not the *independent-refinement* objection — physical refinement evidence still requires an interacting, non-factorised two-level return (annotated at D34).

74.5 Determinant sign is not OS positivity

The Gate-8 pass is re-titled a **determinant-sign audit only**. Two of its own numbers show why: the 45-dimensional one-particle transfer has minimum eigenvalue −0.146 (not a contraction), while the 6-mode Fock audit reports minimum transfer eigenvalue exactly 1.0 — different spectra under one "positivity" heading. A real nonnegative determinant certifies the sign of the fermionic measure; it does not certify reflection/OS positivity, and D12f is annotated with this discrepancy as its open content.

74.6 Manifest currency

The sealed Stage-A manifest hashed a **superseded** copy of FRGM-1C — the pre-correction text still carrying the four-flavour-window error. The hashes verified perfectly, over stale input. The lesson is a protocol gap in RPC-1 itself: F26 proves *integrity*, not *currency*. F26 is accordingly extended: reproducibility failure now includes **any hashed input that is not the latest sealed revision of its source**, and the publication package gains a revision-registry check (D39). The corrected FRGM constraint is restated here as current: the readout scale must satisfy $\mu_R < 4.390909$ GeV; the four-flavour window terminates at $M_b = 4.805819$ GeV, and the sub-interval between them genuinely fails.

74.7 FRGM-1C returns, entered into this paper's ledger

The fermion RG matching theorem resolves the §65 top-sector instability as a **scale-typing error, not a hierarchy failure**: the QCMP-1 grid lives at $\mu_R = 2$ GeV, not at μ_0. Its coupled threshold fixed point — existence and uniqueness by Banach contraction, $\|J\|_\infty \leq 0.649795$ on the admissible box — returns

$R_u = R_d = 0.580788332942 \cdot \mathbb{1}_3$, $(m_t, m_b, m_c) = (171.7837, 4.2132, 1.2283)$ GeV $(\Lambda_5, \Lambda_4, \Lambda_3) = (143.828, 188.445, 216.517)$ MeV, $\sigma_{max}(Y_u)(\mu_0) = 0.971984$, $\lambda(5.8\ \text{TeV}) = 0.068066 > 0$

with the ceiling cross-check already recorded in §72.2 (seven figures, 12.807% margin). One free cross-check forestalls the "which top?" objection: the diagnostic running top at μ_0, 167.509848 GeV, divided by the six-flavour matching leg $U_6(\mu_0 \leftarrow m_t) = 0.975118217$, returns 171.784 GeV — exactly the FRGM threshold m_t; the two tops differ by precisely the declared matching factor. One further proximity is noted at the correct strength: the NQTC in-family repair $\Lambda_3 = 0.225923$ GeV sits 4.34% from FRGM's cascade $\Lambda_3 = 0.216517$ GeV — *suggestive, not certifying*: different branches, different schemes, no shared intermediate. And one identity: $\Delta f_{occ} = 0.007414782101$ equals the selected branch free energy — the occupancy burden and the branch gap are two readings of one quantity.

74.8 Status alignment and verdicts

Every status line across RPC-1, SMC-9B and the Stage-A package now reads the same way:

Gate 7: PASS (re-graded under Thm 69.1); the FAIL was a readout error, not a physics failure Requirement 2: NOT TESTED (Lemma 74.2); diag(2/3, 1/2, 1): QUARANTINED (§74.3) Gate 8: determinant-sign audit only; OS positivity open (D12f) F26 extended to manifest currency (D39); F39 added Overall: NON-CLOSURE PROVED — BLOCKED ON D35 ‖ D36, with D32 and D12 alongside

75. The One-Bit Irreversible Score Branch: First Executed Commitment Channel

The operator that §73.5 named as the unified missing object now has its first executed instance. A driven, genuinely irreversible history law has been constructed on the canonical carrier, its complete score geometry computed, and the resulting bath package — W_defect, the coupling C, the precision A_Q, and the reduced metric — delivered as arrays and **independently verified by this paper's assembler** before entry. The status is conditional (ISG-1 branch, physical certificate false), and the section types every conditionality; but the structural news is unambiguous: **irreversibility mechanically generates the nonseparable coupling, real sector-differentiated screening, and the orientation imprint** — the three things the reversible corpus provably could not produce.

75.1 The branch and its clock

The ISG-1 branch drives the record cycle with affinity **α = 0.9590011097**, fixed not by choice but by the one-bit normalisation: the stationary entropy production is

Σ = ln 2 = 0.6931471806 nats per common step — exactly one committed bit per step

so that λ_TPB = Σ/(k_B ln 2) = 1 and **N_TPB = 1**: on this branch, ticks equal bits and H_t = H_τ — the §73 calibration is activated and trivialised simultaneously. The stationary measure departs from the reversible π (hub depleted to 0.189424 from 7/31 = 0.225806, rim exactly uniform at 0.135096 — the drive respects the cyclic symmetry), and the Perron modulus gap is 0.368270. The pre-temporal certificate of §73.2 is thereby answered *at diagnostic level*: physical time runs on this branch. Typing under F38: the one-bit condition is a **declared step convention** — a principled calibration of the common step to the commitment unit — not yet the action-derived Σ_commit; D36 retains its physical-authority content.

75.2 The verified score-bath package

With defect scores S_A(x,y) = F_A(x,y) − Σ_z K(x,z)F_A(x,z), the six D_6 symmetry-adapted bath modes φ_a, bath scores B_a = φ_a(y) − (Kφ_a)(x), and stationary-path expectations,

(A_Q)_ab = E[B_a B_b], C_aA = E[B_a S_A], W_score = W_defect − C^T A_Q^{−1} C

Assembler verification of the delivered arrays: the Schur identity holds to **6.9×10^{-18}**; the reduced spectrum {0.040591, 0.041078, 0.121772, 0.155865, 0.255523, 0.324726} reproduces to all published digits and is strictly positive (admissible); A_Q is **exactly diagonal** in the symmetry basis (off-diagonal $\leq 2.5\times10^{-16}$) with the first genuinely non-unit, non-degenerate derived precisions {0.9967, 0.6009, 0.6009, 0.8410, 0.8410, 0.8407}; and the "important separation" is honoured — these are static Fisher/Onsager precisions, published apart from the conductance relaxation rates, not silently identified with oscillator masses.

75.3 The coupling: rank four, two dark modes, six sectors reached

rank C = 4, with the m2 pair **exactly dark** (entries $\leq 9.1\times10^{-17}$) — a symmetry-forced fingerprint in the style of §68.5: any faithful re-derivation must reproduce the dark pair, and a nonzero m2 coupling falsifies the implementation (F31-style).

The bright structure maps bath modes to defect sectors: radial → (C, J, H); the m1 pair → (T, B); m3 → R. **Every defect sector is reached**, including the record sector R that the scalar block of §68 could not touch. The resulting screening is real and, for the first time, *sector-differentiated*:

Sector	W_defect	W_score	screening
C	0.3247	0.2905	10.5%
J	0.1530	0.0787	**48.6%**
T	0.1461	0.0812	44.4%
R	0.3247	0.2555	21.3%
B	0.1461	0.0812	44.4%
H	0.1530	0.1525	0.4%

(trace screening 24.7%). The current sector screens hardest under a driven current, and the Higgs-persistence sector is almost untouched — a physically coherent pattern that no one selected.

75.4 The orientation imprint

The m1_cos and m1_sin coupling rows are **not** exchange-symmetric (asymmetry 0.2433): the drive's orientation is imprinted in the derived coupling matrix, and the branch carries the label orientation = +1 accordingly. This is precisely the orientation-odd structure that Theorem 70.1 proved necessary and the reversible corpus provably lacked — now present in a derived object. The conditionality is typed exactly: the drive *direction* is an input of the diagnostic branch; the physical sign selection still requires the action-derived orientation of Σ_commit (D27's residue inside D36).

75.5 What is honestly not claimed

Four typings keep this section from overreach. **(i)** The gauge readback (1.2127, 1.4982, 0.3460 → g′ = 10.2) is graded DIAGNOSTIC_ONLY by its own report — a six-scalar wheel compression, transparently non-physical, with the faithful 243-dimensional defect lift open; the run *resisted* promoting it, which is the discipline working. **(ii)** The refinement residuals (0, 0, 9.5×10^{-17}, isometry 4.4×10^{-16}) are exact-zero in the pattern Lemma 74.2 warns about; they are not cited as refinement evidence pending an interacting non-factorised audit (F39). **(iii)** This is the compressed 6×6 score geometry, not the faithful 243-carrier block. *(Executed in §76: the faithful typed lift, unique under Premise FB, verified to 10^{-17}.)* **(iv)** An assembler audit finding: an independent rebuild of the driven kernel from the narrative alone (frozen reversible conductances with e^{±α/2} rim tilts) returned $\Sigma = 0.185 \neq \ln 2$ and a different stationary measure — the internal package is exact, but the kernel convention (attempt rates, step definition) is under-published. Publishing it to independent-rebuild standard is a new documentation debt (**D40**), in the spirit of F31.

75.6 Ledger effects and verdicts

First irreversible commitment channel: EXECUTED at one-bit normalisation — Σ = ln 2, λ_TPB = 1, physical time on (diagnostic level) Nonseparable coupling: DERIVED — rank 4, all six sectors reached, m2 pair exactly dark, package Schur-verified to 10^{-18} Screening: REAL and sector-differentiated (J 48.6% … H 0.4%); reduced metric strictly positive Orientation: IMPRINTED in the derived coupling — Thm 70.1's required structure exists; physical direction still an action return Not claimed: gauge readback (DIAGNOSTIC_ONLY), refinement evidence (F39), the 243 lift, the action-derived Σ_commit (D36 open)

76. The Faithful Typed Score Lift

The open item that §75 typed as its largest — "this is the compressed 6×6 score geometry, not the faithful 243-carrier block" — is now executed. The six irreversible wheel score modes are lifted through the complete continuous-amplitude score map onto the full typed carrier, faithfully in rank, range and type, under one named premise. The assembler verified the entire package at machine precision, including a full independent rebuild from the theorem's formula alone.

76.1 The uniqueness theorem

Theorem 76.1 — Minimal faithful typed lift. Let $S : \mathcal{R}\_\mathrm{prim} \to \mathcal{H}\_\mathrm{score}$ be the minimum-operational-norm score map, $W\_\mathrm{core} = S^\dagger S$, and $R = S^+S$ the projector onto the realizable defect image. Among lifts invariant under every independent orthogonal coordinate change inside each typed sector $\mathcal{R}\_A$, the mode-weight operator is uniquely

$D\_a = \Sigma\_A\ c\_aA\ P\_A$

(Schur's lemma on the sector decomposition), and the minimal realizability-preserving typed coupling and precision are

$C\_a\text{^typed} = S\ D\_a\ R$, $A\_a\text{^typed} = a\_a\ I_{187}$, $W\_\mathrm{prim} = W\_\mathrm{core} - \Sigma\_a\ (C\_a\text{^typed})^\dagger\ C\_a\text{^typed} / a\_a$ ■

Premise FB (factor-blind internal multiplicity): within each typed sector, the scalar irreversible score coefficient acts identically on all operational score directions. Under FB the lift is *forced*, not chosen — the same logical shape as Premise D30-P. The full typed bath has dimension $6 \times 187 = 1122$, and the stacked coupling has rank 183.

76.2 Assembler verification, including independent rebuild

From the delivered arrays: W_core = S†S to residual **0**; the bath response B = Σ C_a†C_a/a_a to **0**; W_prim = W_core − B to **0**. Decisively, the assembler **rebuilt the entire 1122×243 typed coupling independently** — from nothing but the six scalar coefficients of §75, the sector projectors, S and R — and reproduced the uploaded bath response to **1.4×10^{-17}**. This layer therefore meets the independent-rebuild standard that D40 demands of the kernel layer: the construction is completely specified by its published formula.

76.3 The realizability projection is load-bearing — a prediction confirmed

Omitting R, the candidate metric has minimum eigenvalue **−0.035463** (reproduced exactly by the assembler): the unprojected lift lets the bath couple into ker W_core and positivity fails at once. With R, the minimum eigenvalue is -3.8×10^{-16} — positive semidefinite at machine precision. This is the §64.4.1F corollary, written before any bath existed ("any coupling column reaching a direction in ker W_core violates positivity immediately"), now demonstrated on a real derived object. The frozen rule did not merely survive contact with the calculation; it predicted the calculation's one failure mode.

76.4 Faithfulness certificates

rank W_prim = rank W_core = rank R = 183; smallest positive eigenvalue 0.081385 null-projector agreement to 1.4×10^{-15} — no new information null (F30 clean) master 226-Hessian: kinematic-null residual 9.1×10^{-16}; physical minimum eigenvalue 0.177055 > 0 within-sector coordinate covariance: 4.5×10^{-16} (the FB-invariance of Thm 76.1, tested)

76.5 Screening structure and the diagnostic gauge response

Screening on the realizable core support runs **0.0569% to 28.23%** by direction (assembler Rayleigh check on core eigendirections: 0.0569–23.05%, consistent — the published maximum is over all support directions). The per-source audit:

Source direction	screening
completion	6.92%
scalar commitment	5.86%
terminal record	4.15%
weak transport	2.73%
colour transport	2.65%
abelian transport	2.27%

Source direction	screening
CAR/Fock	0.057%

Two facts deserve emphasis. First, **the gauge transport directions are now screened** — 2.3–2.7% — where §68.8's scalar block was *exactly* orthogonal to them: the typed lift reaches the gauge tangents through the 𝓓_J/𝓓_T/𝓓_B carriers the scalar direction could not touch. Second, the diagnostic reduced response is

G_red^diag = diag(0.773030, 0.769270, 0.789449) (off-diagonal $\leq 1.5\times10^{-16}$)

— off the identity, and *sector-split* by ≈ 2.6%. The typing is strict and inherited from Theorem 71.2: the core score map is still operationally whitened, so the **magnitudes are not force predictions**; but the *departure from equality* among the three blocks is derived structure — the first non-tautological differentiation ever to appear in a gauge response in this programme, conditional on Premise FB.

76.6 Refinement and residue

All intertwining residuals under the inherited 187 → 374 product refinement are $\leq 3.5\times10^{-15}$ — and are typed as product-form per F39; the package's own grade lists the physical multi-cell regulator OPEN, exactly as it must. The remaining physical debt is now precisely the sector-*internal* structure that Premise FB averages away: the representation-dependent, terminal-record, completion and CAR/Fock score generators (**D41**), the genuine spatial multi-cell regulator (D34), and the ISG-1 kernel specification (D40, unchanged — the lift layer passes the rebuild standard; the kernel layer still owes it).

76.7 Verdicts

Faithful typed lift: EXECUTED — rank 183, range-exact, sector-typed, FB-unique (Thm 76.1) Independent rebuild from the published formula: PASS at 1.4×10^{-17} Realizability-positivity prediction of §64.4.1F: CONFIRMED live (−0.0355 unprojected → PSD projected) Gauge sectors screened for the first time (2.3–2.7%); response split 2.6% — derived, non-predictive under whitening Open: sector-internal score generators (D41), physical multi-cell regulator (D34), ISG kernel spec (D40)

Interpretation. The typed lift solves the *plumbing* problem, not yet the *force-strength* problem. It proves the six irreversible score modes can be carried consistently through all 183 realizable defect directions while maintaining rank W_prim = 183, positivity, ran C ⊆ ran W_core, null preservation and typed coordinate covariance. But Premise FB necessarily treats every internal direction within one defect sector identically, so it cannot generate the detailed colour, weak and hypercharge representation structure that the very large physical separation of the three stiffnesses likely requires — which is exactly D41's content. The accurate present conclusion is:

Irreversible score mechanism: EXECUTED Full-rank typed lift: EXECUTED CONDITIONALLY (Premise FB) Representation-dependent physical history metric: OPEN (D41) Physical HFB boundary: NOT ADMITTED

77. The Six-Input Reduction

The blocker ledger has, until now, been a list: the typed weights, the commitment operator, occupancy, the absolute scale, the boundary arrays, the regulator and branch. The reduction executed here shows this list is not six independent unknowns. Under two named premises it collapses to **two primitive forward returns** — and every number in the collapse was verified by the assembler against the paper's own frozen formulas before entry.

77.1 The reduction theorem (candidate grade)

Theorem 77.1. Under Premise PF (a primitive Fact is a *nonidentity* closure transition) and Premise FP (the $\mathbb{Z}_7$ phase representation is faithful):

1. **Occupancy is not an independent input.** A primitive commitment carries nonzero $\mathbb{Z}_7$ winding by PF + FP; the $k_\Omega = 0$ sector lies *outside the primitive-Fact domain* and requires no finite free-energy penalty. Under the unit-step reading, $|k_\Omega| = 1$; only the sign remains, tied as always to orientation.
2. **Inputs 1, 2, 5 and the dynamical half of 6** — internal bath structure, commitment dynamics, boundary operators, regulator law — are derivatives, compressions or spectral data of **one representation-resolved commitment-maintenance action H_CMR**: its stationary path law returns the entropy current, score covariance, bath precision, defect–bath coupling, maintenance response, completion law, chiral addresses and branch components. The boundary arrays are its compressions; the regulator maps are its discretisation law.
3. **Input 4** is the dimensional conversion supplied by one absolute coherence/action unit ξ.

Hence the closure problem reduces to the pair **{ H_CMR, ξ }**. ■ *(Candidate grade: the reduction is proved for the executed candidate structures; that the candidate H_CMR is uniquely forced by the substrate, and that Route-A is the unique coherence branch, are not proved — D44, D45.)*

Effect on D32. The occupancy debt is *reframed*: from "supply a mechanism beating $\Delta f_{occ} = 0.0074148$" to "certify Premises PF and FP." The quantitative threshold survives as the fallback test should either premise be contested — but on this reading the zero sector is not a competitor to be outbid; it is outside the domain.

77.2 The κ pair, conditionally returned

Matching the scalar score susceptibility to the κ-field Schur block returns

$\boldsymbol{\omega_0^2 = 4/3}$ **(ξ units),** $\boldsymbol{\hat{g}_\kappa = 0.698840195786}$**,** $\boldsymbol{\eta_\kappa = 0.058605314310}$

Assembler checks: the frozen §68.6 formula $\eta\_\kappa = \hat{g}\_\kappa^2/(\omega_0^2 + 7)$ reproduces the claimed value to machine precision; and η_κ **equals the derived scalar-commitment screening of §§75–76 (5.86%)** — which is the entire content of "score matching": the κ ratio is read from the executed irreversible score law, not chosen. Status of D29: **conditionally returned** by score matching; the unconditional master-action derivation remains open. One consequence chains cleanly: $m\_\kappa = \omega_0 E\_\xi = (2/\sqrt{3})\, E\_\xi$ (verified exactly, §77.4).

77.3 The no-fit gauge candidate — published as a fail

Combining the representation-current metric **K_current = diag(1, 13/8, 189)** with the *derived* typed screening fractions of §76 (2.649%, 2.725%, 2.275%) gives, with no fitted quantity anywhere,

G_red = diag(0.973506, 1.580714, 184.700451), (g_s, g, g′) = (1.013516, 0.795378, 0.441486)

(all reproduced exactly by the assembler from $G\_A = K\_A(1 - \eta\_A)$ and $g' = 6\, Z\_q^{-1/2}$). Its electroweak ratio Z_q/Z_2 = **116.846** fails the programme's internal threshold (> 140): the candidate is **informative and not physical**, and it is published as such rather than adjusted. Two typings attach: K_current is a *current-score factorisation candidate* whose uniqueness is precisely D44's content; and unlike the whitening-family readbacks, G_red here is not a bijective image of an undetermined input — K_current carries structure — but structure whose provenance is the open question. A failed no-fit candidate, kept, is worth more than a passed fitted one.

77.4 Route-A absolute scale

On the named Route-A coherence branch:

ξ = 88 μm, $E\_\xi = \hbar c/\xi$ = 0.00224235205 eV, m_κ = 0.00258924512 eV, $c/\xi = 3.40673248\times10^{12}$ Hz, v_cl = 243.722807638 GeV (residual 3.7×10^{-10} GeV)

Assembler checks: $E\_\xi = \hbar c/88$ μm to all digits; $m\_\kappa/E\_\xi = 2/\sqrt{3}$ exactly — i.e. $m\_\kappa = \omega_0 E\_\xi$ with the §77.2 gap, closing the loop between the bath gap and the coherence scale. D37 thereby acquires its first **named conditional candidate**; the unconditional selection of ξ, the independent completion residue Z_comp, and the identity-completion status of $\Lambda\star = v/\sqrt{2}$ remain open (D45).

77.5 Hierarchy capability

The RCMO fixed-point maintenance operator with the dyadic $\mathbb{Z}_7$ accessibility ladder — verified exactly $(196^{-2}, 196^{-1}, 1)$, $196 = 14^2$ — produces a positive 9×9 common Yukawa readout C_Y whose F_Y singular values span 1.6294 down to 4.888×10^{-4}: **condition number 3333.3, generated without any fermion mass entering**. This is a capability certificate against the shallow-spectrum obstruction diagnosed in the companion corpus (SMC-1U, Part XII-bis / D42): a steep common hierarchy *can* arise from maintenance-record structure alone. The physical chiral embeddings, direct gauge maps and M_R remain open (D12), and the RCMO convergence order p = 1.99670 with choice-free polar blocking carries the regulator half.

77.6 Ledger effects and verdicts

The blocker restatement: **D35's typed weights are reclassified as spectral data of H_CMR** — not withdrawn, relocated; D36 and the dynamical content of D34 likewise fold into H_CMR's return; D37 gains the Route-A candidate; D32 is reframed onto Premises PF/FP with Δf_occ as fallback. Two new debts: **D44** — proof that the current-score factorisation and the RCMO metric-graph action are uniquely forced by the substrate; **D45** — unconditional selection of ξ and the independent Z_comp.

Six-input reduction: EXECUTED (candidate grade) — the closure problem is { H_CMR, ξ } Occupancy: k_Ω ≠ 0 by premise-level theorem (PF + FP); |k_Ω| = 1 unit-step; sign unchanged κ pair: CONDITIONALLY RETURNED by score matching — $\omega_0^2 = 4/3$, ĝ_κ = 0.6988, η_κ = 5.8605% No-fit gauge candidate: FAILS its own threshold ($Z_q/Z_2 = 116.8 < 140$) — published, not adjusted Route-A ξ = 88 µm: named conditional candidate; m_κ = (2/√3)E_ξ = 2.589 meV Hierarchy: condition-3333 common spectrum without fermion-mass input — capability, not physics Physical certificate: NOT ISSUED — uniqueness of H_CMR (D44) and of ξ (D45) open

78. The H_CMR and ξ Forward-Closure Attempt

Theorem 77.1 named two primitive returns. Both have now been constructed forward — without any measured Standard Model mass, coupling, mixing angle or phase entering — and the attempt returns one repaired obstruction, one physical failure published as such, and the first **two-route consistency on the absolute scale**. The grade throughout is conditional: closure inside a declared premise class, with the class's own uniqueness as the named residue.

78.1 The H_CMR contract

Theorem 78.1 (conditional uniqueness). Under six premises — one binary commitment per primitive Fold; additive independent channels in the negative log history weight; the six matter slots (Q, u, d, L, e, N); gauge-admissible completion plus shared colour/weak/singlet channels as the only declared-order edges; the quadratic Casimirs, integer-hypercharge square, chirality square and completion-route square as the only on-site invariants; Hilbert–Schmidt orthogonality of distinct gauge factors — the leading local representation/maintenance action is fixed by channel counting up to the one-Fold action unit, the driven K = 7 closure kernel is fixed by Σ = ln 2, and eliminating every zero-mean state-function score returns the factor-separated CMR metric

$H_{CMR} = W_{score} - C_{fn}^T A_{fn}^+ C_{fn}$ ■

The theorem's own boundary is stated with it: this is uniqueness *inside the declared local, quadratic, independent-channel class* — not a proof that the substrate path measure belongs to that class. That proof is D44's sharpened content.

78.2 The floor was scaffolding

The maintenance action is constructed **floorless** — the K^{-3} positivity floor of the RCMO construction removed entirely — and positivity survives on its own: $\lambda_{min}(H_{\Omega^o}) = 0.174278 > 0$. The floorless fixed point differs from the original RCMO fixed point by only **0.00293**, and second-order convergence persists ($p = 1.99644$, residual ratios approaching 4). The floor was scaffolding, not load-bearing structure — a robustness certificate for the RCMO family that also answers the natural referee objection that its convergence was floor-induced.

78.3 Six-level factor convergence: the hierarchy test repaired, the physical test failed

The blocking cascade runs six genuine levels of growing carriers (42 → 112 → 252 → 532 → 1092 → 2212 states), blocking unitarity $\leq 1.7\times10^{-15}$, minimum overlap singular values → 1, and the **address gap stable at ≈ 0.108 with no collapse across the family** — the strongest gap-stable multi-level convergence in the corpus, of the interacting-subdivision type graded genuine in the companion record (not the F39 factorised form). The factor metric converges:

Level	states	Z_q/Z_2
0	42	184.486
1	112	156.299
2	252	153.784
5	2212	153.172
Richardson	—	**153.1629**

with exact factor-trace orthogonality (cross norms $\leq 1.7\times10^{-16}$; generator norms 6/6/10 clean). **Z_q/Z_2 = 153.16 passes the internal > 140 hierarchy test that the §77.3 candidate failed at 116.8** — the electroweak hierarchy *direction* is repaired at fixed-point level. The absolute return does not pass physical admission: $(g_s, g, g') = (1.204346, 3.136046, 1.520396)$, with the colour factor too stiff relative to the weak — published as a fail, unadjusted, in the §77.3 tradition. The unnormalised maintenance hierarchy operator reaches condition number 373.2: substantial, and by its own statement not yet deep enough to populate the physical charged and neutral boundary alone.

78.4 ξ by a second, independent route

Route-M closes the coherence scale by dimensional transmutation,

$$\ln(\xi/l_e) = (1/2b)\ [\ 1/g_0^2 - 1/p_c\ ],\quad b = 14/16,\quad g_0^2 = 1/128$$

with the one remaining input — the coherent-triangle percolation threshold — computed from the **nonbacktracking spectrum of the minimal record-distinct stitch**: two 4-simplex triangle-adjacency graphs glued across their shared tetrahedron's four triangles (20 nodes, 64 edges, mean degree 6.4), giving $\rho_{NB} = 5.440226$ and $p_c = 1/\rho_{NB} = 0.1838159$ (assembler-verified, as is the exponent $(128 - \rho_{NB})/2b = 70.03416$). The return:

ξ_M = 84.0718 µm versus the independent Route-A value ξ_A = 88 µm — a relative difference of 4.46%, with Route-A nowhere used

This is the first two-route consistency on the absolute scale, the same epistemic species as the seven-figure ceiling cross-check of §72.2, at percent rather than 10^{-7} precision. The record-distinct selection is demonstrably load-bearing: the naive quotient graph returns 62.7 µm, so the 4.46% agreement is a property of the *irreversible-gluing* choice specifically. The Route-M scale ledger (E_ξ = 2.3471 meV, m_κ = 2.7102 meV, $c/\xi = 3.5659\times10^{12}$ Hz, v_cl = 255.11 GeV under the existing scale lock, $\Lambda\star\text{\^{}id}$ = 180.39 GeV) tracks Route-A's at the same ~4.5% throughout. The grade is the contract's own: conditional microphysical closure — an unconditional result requires the infinite-foam clustering theorem selecting the record-distinct cover (D45, sharpened).

78.5 What the attempt establishes

Both primitive returns of Thm 77.1: EXECUTED forward, no measured Standard Model quantity entering RCMO positivity floor: PROVED REMOVABLE — fixed point stable to 0.0029; convergence not floor-induced Internal electroweak hierarchy test: REPAIRED — Z_q/Z_2 = 153.16 > 140 at a gap-stable six-level fixed point Physical gauge admission: FAILED — (g_s, g, g′) = (1.204, 3.136, 1.520), colour/weak stiffness wrong; published, not adjusted Absolute scale: TWO INDEPENDENT ROUTES within 4.46% (84.07 vs 88 µm); record-distinct gluing load-bearing Residue, now exactly two microscopic proofs: (i) equal-bit independent-channel counting is forced by the master path measure (D44); (ii) record-distinct simplex gluing and its nonbacktracking threshold are the physical infinite-foam stability law (D45) Physical certificate: NOT ISSUED

79. The D44–D45 Proof Attempt: Consumers Closed, Hinges Named

The two proofs on which the programme's endgame rests have now been attempted. The attempt does not close them — and its value lies precisely in *how* it fails to: it proves every part that is a theorem, constructs **explicit counterexamples to the over-strong claims**, and thereby demonstrates that each debt reduces to exactly one irreducible theorem that no appeal to simplicity, positivity or bit-counting can replace. All counterexamples were re-verified by the assembler.

79.1 D44: what is now theorem-grade

Theorem 79.1 (path-law ⟹ quadratic metric). For a fixed smooth positive master history law, the relative-entropy rate against the admissible branch satisfies $\mathcal{J}(\theta) = \tfrac{1}{2}\theta\text{\^{}T } W\_\text{Fisher } \theta + O(\|\theta\|^3)$, and monotonicity under Markov coarse-graining makes the Fisher metric the **unique** local information metric up to one common scale — which the primitive one-bit result fixes to ln 2 per event. Cubic and higher path-action terms do not enter the quadratic H_CMR. If primitive innovations are conditionally independent given the complete causal past and auxiliary state, likelihoods factorise and Fisher information adds. ■

So the *consumer* is closed: **once the path law is supplied, the declared quadratic H_CMR is forced.** What is not closed is whether the path law has the assumed form — and the attempt proves that gap is real rather than pedantic.

79.2 D44: three counterexamples, three irreducible premises

(i) One-bit marginals do not force independence. $P_J(x, y) = e^{Jxy}/(4 \cosh J)$ has exactly uniform marginals (one bit each, verified to 10^{-16}) for every J, yet mutual information $I(X;Y) > 0$ and Fisher cross-term **tanh J** (assembler-verified against the analytic value at six couplings, residual $\leq 1.2\times10^{-16}$). Exchange symmetry, positivity and bit size permit arbitrarily correlated channels.

(ii) One bit per event does not force equal weights. Independent binary Poisson channels of rates ν_a all carry ln 2 per event but contribute $\nu_a \ln 2$ per proto-time: the relative quadratic weight is the **rate ratio**. Equal channel weights require equal attempt intensities — a separate theorem.

(iii) Positivity does not force quadraticity at all orders. $A_\lambda(d) = \tfrac{1}{2}d^2(1 + \lambda d)^2 + d^4$ is nonnegative for every λ, has $A''(0) = 1$ identically, and carries a free cubic coefficient. Only the Hessian is protected (by Thm 79.1); all-order uniqueness needs a symmetry.

Consequence. D44 transforms into one sharp statement:

D44′ — Primitive Innovation Factorisation Theorem. Conditioned on the complete primitive carrier and causal past, newly committed Facts are exchangeable, conditionally independent Bernoulli innovations with one universal attempt intensity, every residual dependence being mediated by an explicitly retained auxiliary variable.

The counterexamples show D44′ is not contained in the six premises of Thm 78.1 and cannot be omitted.

79.3 D45: the threshold is now a theorem — conditional on the cover

Theorem 79.2 (universal-cover percolation). For the record-history graph equal to the universal cover $\tilde{G}$ of the finite motif G, site-percolation extinction messages obey $u_e = 1 - p + p \prod_{\{f:B_{ef}=1\}} u_f$; linearising at $u = 1$ gives $\delta u = pB_G\, \delta u$, and survival occurs exactly when $p\rho(B_G) > 1$. Hence $\boldsymbol{p_c(\tilde{G}) = \rho(B_G)^{-1}}$. ■

Executed: $\rho(B) = 5.440225970823$ for the record-distinct twenty-node motif (nonbacktracking growth converging to ρ with error 4.7×10^{-13}), giving $p_c = 0.1838159$ and **ξ = 84.0718 µm** — now theorem-grade *given the cover*; the forgetful motif gives ρ = 5.952871 and ξ = 62.72 µm, quantifying exactly what the cover choice is worth. Local record persistence is also proved conditionally: an admissible gluing cannot identify two records that are distinct committed Facts, since that erases a committed distinction.

79.4 D45: the trace-monoid gap

What irreversibility does *not* prove is subtler than record erasure: a history space may identify the orderings AB and BA of two **commuting independent Facts** while preserving both Facts — a trace-monoid quotient that is record-preserving yet is not the universal cover, and can retain cycles and clustering that lower the threshold. The debt transforms accordingly:

D45′ — Persistent Provenance Covering Theorem. The terminal record is a faithful injective encoding of the reduced primitive-Fact path; gluing and refinement preserve this encoding, and histories are identified only by immediate inverse cancellation — never by forgetting simplex-side provenance or by commuting distinct Facts.

Once D45′ holds, the 84-micrometre return is unconditional.

79.5 What the attempt establishes

The mathematical consumers of both proofs: CLOSED (Thms 79.1, 79.2) The over-strong shortcut claims: DISPROVED by explicit counterexample — independence, equal rates and all-order quadraticity are premises, not consequences The critical path, final form: D44′ (Primitive Innovation Factorisation) and D45′ (Persistent Provenance Covering) — each a single named theorem about the substrate's fundamental law, each proved irreducible *(D45′ is subsequently revised in §80: the finite-distinguishability reformulation proves its substance and reduces the residue to the construction-order clause D45")* **Physical certificate: NOT ISSUED**

The transformation is worth stating plainly. Before this attempt, D44 and D45 were uniqueness *tasks* whose difficulty was unknown and whose scope could have been quietly narrowed. After it, they are two precisely stated theorems, each guarded by counterexamples on file showing exactly what a valid proof must overcome — and any future "proof" that fails to address the correlated-channel family, the rate family, or the trace-monoid quotient is thereby checkably incomplete before its first equation is read.

80. D45 Revised: the Finite Distinguishable Record-Stability Theorem

The D45′ hinge has been re-attacked — not by proving the Persistent Provenance Covering Theorem on its own ground, but by showing that ground was the wrong ontology. VERSF's first axiom is **finite distinguishability**: at every physical stage the record carrier is finite and contains only operationally distinguishable states. The universal-cover formulation of §79.3 — an infinite record-history space, a cover to be selected, clustering corrections in an infinite foam — was quietly in tension with the theory's own finitism. The revision replaces it with a finite theorem, and the trace-monoid adversary does not survive the move.

80.1 Two principles, stated as axioms of the theory

A1* — operationally distinct states have a uniform positive distinguishability floor σ_op; **A2*** — states arising from distinct admissible commitment events cannot be identified by operational indistinguishability.

These are not new assumptions imported for this proof; they are the operational form of finite distinguishability and irreversible commitment — the programme's founding axioms.

80.2 Theorem 80.1 — Record selection by A2*

For two **already committed** elementary 4-simplex cells, each of the four geometrically shared triangles occurs as a *pair* of record tokens, one per side. The forgetful 16-node quotient has rank 16 and nullity exactly 4, and its kernel is **precisely** the four orthonormal committed-provenance differences $v\_\tau = (e\_\{\tau,A\} - e\_\{\tau,B\})/\sqrt{2}$ — assembler-verified: provenance Gram = I_4 to 2×10^{-16}, annihilation residual exactly 0, all four pairs mapping record-norm 1 to quotient-norm 0. The quotient therefore erases four distinct commitment directions and is **inadmissible under A2***. Gluing must connect the records, not identify them: the admissible finite stitch has 20 record tokens. ■

Record-distinct gluing — the load-bearing choice behind the 84 μm return, previously supported by circumstantial evidence — is now **proved**, conditional on one clause (§80.5).

80.3 Theorem 80.2 — Finite stability threshold

On the 128 oriented relations of the finite 20-record graph, with immediate reversal excluded because it returns to the preceding record and *creates no new distinguishable relation* — the nonbacktracking structure is thereby **derived** from A1*/A2* rather than imported from percolation theory — the maintenance law $a\_\{n+1\} = pB\_D\ a\_n$ has, by Perron–Frobenius, the exact finite stability boundary

$p\star = 1/\rho(B\_D)$, $\rho(B\_D) = 5.440225970823$ (PF residual 1.1×10^{-14}), $p\star = 0.183815893929$

Below $p\star$, every bounded response falls below σ_op after **finitely many** updates (verified ledger: amplitudes exactly PF-gain^n, stopping depths matching $\lceil \ln \varepsilon / \ln g \rceil$ — e.g. 31 updates at gain 0.8, 688 at gain 0.99, for the 10^{-3} floor); above $p\star$, the positive Perron mode remains distinguishable through every requested finite update sequence until nonlinear saturation. **No physically infinite graph is invoked anywhere.** The Route-M scale law then returns

$\xi = 84.071785948$ μm

— the same number as §78.4, now resting on a finite-dimensional theorem rather than an infinite-volume limit; the forgetful quotient's 62.72 μm is excluded not by preference but by A2*.

80.4 What happened to the trace-monoid adversary

Honesty requires stating this precisely: the trace-monoid quotient of §79.4 was not defeated on its own ground. It was **dissolved by reformulation** — the infinite record-history space whose quotient was in question no longer enters the theorem, because the stability law acts on the finite record carrier directly, and the ordering of commuting Facts never needs to be encoded. The question "is AB distinguishable from BA?" was a feature of the wrong formulation; the finite theorem asks only whether the *record tokens* survive, and A2* answers that. When an adversary is dissolved rather than defeated, the residual risk is that the old formulation returns through some other door; the guard is that any future construction reintroducing an infinite history carrier must re-face §79.4's counterexample explicitly.

80.5 The residue: one construction-order clause

The proof is complete for gluing two **already committed** cells. What remains is a single question about the substrate's build order:

D45″ — Construction-Order Clause. Either the substrate glues already-committed record-bearing cells (in which case A2* and Theorem 80.2 close D45 outright), or gluing precedes commitment — and then the substrate must say whether the shared face creates one record or two.

This is a far smaller object than D45′: not a covering theorem over infinite histories, but one yes/no structural fact about the order of gluing and commitment.

80.6 Verdicts

Ontology corrected: infinite-foam and universal-cover language removed — the formulation now matches the theory's own finite-distinguishability axiom Record-distinct gluing: PROVED under A2* for committed cells (Thm 80.1; quotient kernel = exactly the four provenance differences) Threshold: theorem-grade finite stability boundary $p\star = \rho(B\_D)^{-1}$ (Thm 80.2); $\xi = 84.07$ µm on that basis; nonbacktracking derived, not assumed Trace-monoid adversary: DISSOLVED by reformulation, with the re-entry guard stated D45′ → D45″: one construction-order clause — STRONG CONDITIONAL PASS Physical certificate: NOT ISSUED

81. Terminal Verdict Ledger

The chronological verdict lines of the audit era are consolidated here by kind.

Structural.

Frozen transport theorem (Parts I–VIII): COMPLETE — Thm 60.1, quotient invariance (Thm 14.2), non-insertion (Thm 7.3) Current-corpus unique boundary: IMPOSSIBLE — exact non-closure certificate (Thm 72.1); certificate refusal is a theorem Current history sector: PRE-TEMPORAL — zero commitment density on every frozen kernel; H_t singular (§73.2) Identity gauge response: WHITENING TAUTOLOGY — every $G\_red = I_3$ return reinterpreted (Thm 71.2)

Derived mechanisms.

Non-scalar screening: $Z_A = c_A + b_A r_A/(b_A + r_A)$ — the wheel triple mechanically explained (Thm 71.1) Terminal record transport: log-before-polar readout, cross-checked by the positive skew-product lift (Thm 69.1) Scalar commitment block: rank-one shape, exact $\mathcal{D}_J/\mathcal{D}_T$ support, $\eta_\kappa \in [0,1]$ exact (§68); gauge screening via the scalar route EXCLUDED (§68.8) First irreversible commitment channel (ISG-1, one-bit): $\Sigma = \ln 2$, $\lambda_{TPB} = 1$, $C \neq 0$ rank 4 with the m2 pair exactly dark, sector screening 0.4–48.6%, orientation imprinted (§75) Faithful typed 243-lift: EXECUTED — FB-unique (Thm 76.1), rank 183 preserved, no new null, gauge sectors screened 2.3–2.7%, response split 2.6% (derived, non-predictive); §64.4.1F's positivity prediction confirmed live; independent rebuild at 10^{-17} (§76) TPB calibration law: implemented; force ratios, η_κ and branch ordering proved clock-invariant (§73) Both primitive returns of the reduction executed conditionally (§78): floorless six-premise H_CMR with a gap-stable six-level fixed point repairing the hierarchy test ($Z_q/Z_2 = 153.2 > 140$); ξ by two independent routes within 4.46%; physical gauge admission failed and published

Fired falsifiers (all documented, all repaired or re-graded).

F34 ×2 — multi-wheel chain (numerical, §66.8) and diamond family (analytic, §71.3) excluded as regulators; $K_{\{N,N\}}$ sole surviving candidate, uniform gap ½, physical selection open (D34) F37 ×2 — entry-polar transport readout (§69.1) and its Stage-A recurrence (§74.2); re-graded under the pre-existing Thm 69.1 F39 — factorised two-level "test" exposed as untestable by construction; Requirement 2 re-typed NOT TESTED (§74.4) Remark 4.2 proximity list — fired on the derived canonical I_3 (§67.6) and holds I_3, the wheel triple, diag(2/3, ½, 1), $\Lambda\star$^id and the inverse-Yukawa forgery witness (§72.4)

Certified degeneracies and audited provenance.

Sign $k_\Omega = \pm 1$: CERTIFIED DEGENERATE — modulus-tie theorem (Thm 70.1); resolvable only by the commitment channel's winding orientation Occupancy: reframed by Thm 77.1 — under Premises PF + FP the $k = 0$ sector lies outside the primitive-Fact domain and is no competitor; the quantified burden $\Delta f_{occ} = 0.0074147821$ (§72.3) survives as the fallback test if either premise is contested PMNS/CKM conditional frames: FAIL for blind promotion — open candidate benchmark, sealed-manifest repair specified (§71.5) Strong phase: branch-dependent conditional indications on record. The positive-real Hermitian charged branch gives $\bar{\theta} = 0$ conditionally (§66.7); the companion corpus's RCMO branch returns a regulator-stable determinant phase near π at $\theta_{top} = 0$, typed stability ≠ correctness and held UNRESOLVED with a stable target (SMC-1U, D-STRONG). The two are conditional on different branches; neither is promoted, and the physical branch selection must resolve them — citing the near-π feature as a resolution is SMC-1U's F29

Cross-checks.

$r_{u,crit}$ = 0.666093460291 vs FRGM-1C's 0.666093443388 — seven figures across two independent pipelines, eighth digit certifying their independence; derived $R_u = 0.580788\cdot\mathbb{1}_3$ inside the bound with 12.8% margin (§72.2, §74.7) Colour catastrophe repairable in-family: Λ_3 = 0.226 GeV vs 2×10^{-20} unscreened; NQTC and FRGM cascade values 4.34% apart — suggestive, not certifying (§72.2, §74.7) Diagnostic top consistency: 167.509848 / U_6 = 171.784 GeV = the FRGM threshold m_t exactly (§74.7) Absolute-scale two-route agreement: ξ_M = 84.07 μm (nonbacktracking percolation) vs ξ_A = 88 μm, 4.46% apart, fully independent constructions; record-distinct gluing load-bearing (§78.4)

The reduction (§77).

Six inputs → two primitive returns: { H_CMR, ξ } (Thm 77.1, candidate grade) — occupancy premise-derived, boundary arrays and regulator maps reclassified as H_CMR's compressions and discretisation law; uniqueness of the candidates open — since transformed to D44′ and, after §80, D45″

Blockers — after §§77–78, the critical path is two proofs.

D44′ — Primitive Innovation Factorisation: newly committed Facts are exchangeable conditionally independent one-bit innovations at one universal intensity, given the complete carrier and causal past. Consumer closed (Thm 79.1); irreducibility proved by the correlated-channel, unequal-rate and free-cubic counterexamples (§79.2) D45″ — Construction-Order Clause: the substrate glues already-committed record-bearing cells, or states whether a pre-commitment shared face creates one record or two. Everything else in D45 is now theorem-grade (§80): record-distinct gluing proved under A2*, the finite stability threshold $p\star = \rho(B_D)^{-1}$ proved by Perron–Frobenius, the trace-monoid adversary dissolved with a re-entry guard

Downstream of those two, in dependency order: the sector-internal score generators (D41); the physical boundary embeddings, completion morphisms and M_R_direct as compressions of the proved H_CMR (D12); the interacting regulator selection (D34 — the §78 cascade is gap-stable and awaits the whole-action certificate); the sign orientation and the residual scale conditionalities (D27 residue, D45's Z_comp). The older blocker statements — D35's weights as H_CMR spectral data, D36's action-derived channel, D32's premises — remain true and are now *contained* in D44's object rather than parallel to it.

Final lines.

HFB-1 physical boundary: NOT SUPPLIED RPC-1 numerical execution: NOT ADMITTED Renormalised Standard Model Parameter Closure: NOT ISSUED — and, by Theorem 72.1, correctly so

The frozen inventory awaiting those proofs: the primitive differential and its factored decomposition, the potential Hessian, the exact kinematic quotient, the continuous proposal family and minimum-norm lift, the conditional W_core, the Schur screening formulas, the log-before-polar transport, the TPB bridge, the one-bit channel and its faithful typed lift, the six-premise H_CMR construction with its gap-stable fixed point, the Route-M transmutation formula, the finite distinguishable record-stability theorem, the reduction theorem itself, and the complete assembler. Every formula that converts the missing returns into a physical Standard Model boundary already exists, is hashed, and cannot be altered by what those returns turn out to say. The refusal of every benchmark, tautology and forgery along the way is the non-insertion theorem operating as designed — and it is the reason a future PASS, if one comes, will mean something.

Appendix A — One-Loop Reference RG System

The reference system is the minimum implementation against which the production truncation is validated; it is not the production truncation.

Gauge. $16\pi^2\, dg_i/dt = b_i\, g_i^3$, with $(b_1, b_2, b_3) = (41/6, -19/6, -7)$ in conventional hypercharge normalisation on the full three-generation, one-doublet interval.

Yukawa. §17, in full matrix form; the trace T_Y is recomputed at every threshold from the active content.

Scalar. §18, with the vertex-coherence check 18.1 applied at whatever order is selected.

Neutral. §19, branchwise per Appendix C.

Strong phase. $d\theta/dt = 0$ within a fixed EFT and fixed global section; threshold shifts per §20.

Validation requirements: reproduction of the reference system by the production code with ε_RGE below the declared tolerance; agreement of upward and downward integration through a closed loop of thresholds within Δ_h; and stability of every invariant under the frame-randomisation test.

Appendix B — Threshold Matching Schema

Each ledger entry carries: field identity and representation; running mass operator; identifiability report ($d \ln M / d \ln \mu$ and the sign-change interval); decoupling scale and its solution residual; matching map with loop order; the finite coefficients and their derivation trace; the threshold uncertainty interval $[\ \xi_-, \xi_+\ ]$; near-degeneracy flags with the partner entry; determinant-phase contribution with single-counting hash; and the resulting effective theory identifier $\mathfrak{E}\_r$.

Appendix C — Neutral-Branch Transport Taxonomy

Branch type	Object	Transport	Low-energy reduction	Distinctive prediction
Pure Dirac	Y_ν	§17 Yukawa equation	none required	$\Delta_{NU} = 0$; no $m_{\beta\beta}$ contribution
Type-I seesaw	$\{ Y_\nu, M_R \}$	§17 + singlet mass equation	$\kappa = C^{(5)}$, then §26	$\Delta_{NU} \simeq M_D M_R^{-1}(M_R^{-1})^\dagger M_D^\dagger$
Type-II / triplet	explicit triplet parameters	triplet vertex terms	κ contribution	modified $m_{\beta\beta}$ normalisation
Pseudo-Dirac	near-degenerate Takagi pairs	§19, block-conditioned	blockwise	small splittings, per-block conditioning
General mixed	$\{ Y_\nu, M_R, \kappa, C^{(6)} \}$	§17, §19 and the coefficient ledger	§26 with Lemma 19.1 bound	Δ_{NU}, active fractions, heavy residues

Symmetric-phase entries are the gauge-invariant objects per Convention 19.0; the broken-phase block $\mathbb{M}_\nu$ is assembled below the electroweak scale. Nonunitarity is quoted as Δ_{NU} (Def. 37.1), never as η (Def. 37.2), unless the convention is named.

A branch is transported in its returned type. Reclassification during transport is F8.

Appendix D — Pole and Mass-Scheme Ledger

State	Primary published object	Formal pole	Note
W, Z	complex pole s_p	yes	gauge-parameter scan mandatory
γ	$s_\gamma = 0$	protected	Ward residual published
H	complex pole s_H	yes	Nielsen order-consistency required (Thm 41.2)
e, μ, τ	pole mass	yes	mixing self-energies retained to diagonalisation
t	complex pole or declared short-distance mass	qualified	MC-mass conversion never implicit
c, b	short-distance mass	formal only	renormalon ambiguity of order Λ_{QCD} attached

State	Primary published object	Formal pole	Note
u, d, s	MS-bar running mass at declared scale	**not claimed**	confinement removes the asymptotic one-quark pole
light ν	Takagi value with self-energy correction	yes	active fraction published
heavy N	complex pole	yes	residue and active fraction published

Appendix E — Cross-Sector Residual Definitions

The fifteen residuals of §55, each with: its definition; the norm used; the declared threshold; the order at which it is expected to vanish; and the falsifier it triggers on exceedance. Residuals are published whatever their value; suppression of a residual is F25.

Appendix F — Machine-Readable Publication Schema

The file list of §58, with per-file schema: content type, generating stage, dependency hashes, and the assertion set the file must satisfy on load. The rpc_certificate.json entry records the verdict, the branch set, the manifest hash and the Stage-12 timestamp hash that establishes the ordering of Stage 12 before Stage 13.

Appendix G — Programme Source Map

Consolidation note. The companion documents FRGM-1C, SMC-9B and RPC-1R have been merged into one self-contained paper, **SMC-1U — "VERSF Conditional Standard Model Derivation and Parameter-Closure Audit"** — and retired as separate files. Citations to those three names in §§65, 72, 74 and the ledgers refer to the corresponding parts of SMC-1U; the historical names are retained where they record what was believed and executed at the time. RPC-1 remains the assembly-layer transport document; SMC-1U holds the conditional derivation and audit corpus. Cross-ledger mapping: RPC-1's D44 and SMC-1U's D43 name the same uniqueness obligation (the metric-graph/channel-counting action); RPC-1's D42-adjacent hierarchy discussion (§77.5, §78.3) addresses SMC-1U's D42 at capability level; premise families are disjoint by construction (RPC-1: P1–P11, PF, FP, FB, D30-P; SMC-1U: H/T/Q blocks plus N1–N3). **The falsifier namespaces are likewise disjoint**: SMC-1U's F1–F29 are its own series — its F27 (factorising Level-2) parallels RPC-1's F39, its F28/F29 (blocking-map provenance; near-π phase cited as resolved) have no RPC-1 counterparts and are not RPC-1's F28/F29. Two SMC-1U results bear directly on RPC-1's requirements and are cited here as companion returns: **NFDMA-1** (Part XII-bis) — the first genuine non-factorising two-level refinement pass in the corpus, whole-action, all predeclared tolerances met, followed by an honest physical FAIL diagnosed as shallow spectrum plus over-mixing (the origin of D42); and **RCMO-1** (Part XII-ter) — a regulator-covariant maintenance-record operator family with derived (not fitted) blocking maps, repairing a distinct later action's 53–93% inter-level drifts to the few-percent level.

RPC-1 consumes: the six sector-completion papers (electroweak vacuum and Higgs completion; neutral-fermion branch and carrier census; gauge action and coupling; quantum gauge completion; strong CP and the global θ-sector; QCD running and confinement), the closure-Hessian and Yukawa evaluation papers, MASD-1, HMGBC-1 and HFB-1. It supplies the Final Derivation Audit. It revisits none of them.

Appendix H — Open-Debt Ledger

Debt	Description	Blocking
D1	HFB-1 boundary return with passing certificate	numerical execution (R3)
D2	Production beta-function truncation fixed sector by sector in the manifest	Stage 4
D3	Finite bridge coefficients $\Delta^{(\ell)}p$ computed from the HFB action	Stage 2
D4	Declared second scheme $\mathfrak{S}_2$ for the scheme-truncation estimate	§50
D5	Nonperturbative matching uncertainty model for the strong sector handoff	§46, $\Sigma_O^{nonpert}$
D6	Independence proof or triviality certificate for the determinant line	§13, $\bar{\theta}$ classification
D7	Resampling prescription at non-differentiable points of F	§54
D8	Renormalon-ambiguity quantification for the c, b formal pole conversions	Appendix D
D9	Quarantine verification against the resolved dependency tree	§56
D10	The quark matching operator R_u (and R_d), constrained by §65 to σ_{max} suppression ≤ 0.615 at one loop	Stage N6, top sector
D11	Colour-adjoint bath relaxation lowering Z_3 from the unit unscreened value	Stage N3, Λ_{QCD}
D12	The fifteen physical embedding/completion arrays of §64.2 plus M_R_direct, at two regulator levels	Stages N3–N5; the whole of R3
D12a	Physical typed history metric. W_{core}, $G_{op} = I_{187}$, Ω_Q^2 and $C = 0$ are now all derived on the canonical separable branch (§67); $W_{prim}^{K=7} = W_{core}$ is calculated. Remaining: the same package on the *physical nonseparable* branch at two regulator levels	Stages N1–N2
D12d	**DISCHARGED NEGATIVELY (Thm 71.2)**: the identity response is a whitening/projector tautology. Replacement obligation: an operational metric and response readout derived independently of the J used to	§71.2; F29, F36

Debt	Description	Blocking
	whiten the carrier, or a proof that all admissible operational metrics give equivalent boundary observables	
D12e	Physical unresolved-bath operator A_Q, defect–bath coupling C, range certificate ran C ⊆ ran A_Q, and positivity of W_core − C† A_Q^{+} C. **Hardened by §66.2** (η-continuum: sole determinant of the gauge normalisation) and **sharpened by §67** (canonical branch computes C = 0, η = 0): the debt is now exactly the nonseparable QP block — see D28	Stages N1–N2
D12f	Fermionic positivity route for the complete proposal transfer. **Sharpened by §74.5**: determinant-sign positivity is achieved and is *not* OS positivity — the 45D one-particle transfer (min eig −0.146) and the 6-mode Fock audit (min eig 1.0) disagree spectrally; a certified reflection/transfer-positivity construction remains the open content	HMGBC admission; §74.5
D12b	Primitive scales κ_e, Λ⋆, λ_sub ρ_c^{2}, inserted into the frozen J_0 + κJ_κ + Λ⋆^{−1}J_H decomposition	Stage N2
D12c	Refinement-compatible multi-cell auxiliary census; positivity and regulator stability of H_ηη	Stage N2
D16	Singular spectrum of J_D and J_full in the neighbourhood of both rank cuts (183/184 and 187/188), so the rank claims are evaluable at a stated tolerance rather than an implicit one	F31 evaluability
D17	Restricted-rank certificate: rank of the 22×226 potential block restricted to ker J_D, required to equal exactly 4	the "four lifted moduli" claim
D18	Independent confirmation that dim ker J_CFB1 = 39 under the same tolerance, establishing subspace equality rather than containment	CFB-1 transport claim
D19	Declared P10 ordering: which operator's Doob normalisation defines the W_prim scores, fixed before execution	§64.4.1; F32
D20	Coverage ledger for the 243×243 metric: full conditional W_core, physical bath-corrected subspace, Fisher/bath-Schur overlap, and residuals with dimension counts	§64.4.1I; F33
D21	Both κ_e routes computed on the homogeneous vacuum with the residual ε_κ published; canonical response direction pre-registered	§64.4.2
D22	Per-level spectral gap δ_n published alongside ε_n	§64.4.7; P11, F34
D23	Two genuine regulator complexes with explicit lift and coarse maps for all seven carrier classes, preserving persistence support	§64.4.7
D24	Continuum-convergence certificate: analytic bound, monotonicity theorem or controlled Cauchy estimate beyond two-level agreement	§64.4.7
D25	Physical continuous-proposal evaluation at both genuine regulator levels, including drift, covariance, score and Fisher-refinement residuals — the 8→16 multi-wheel candidate is excluded (§66.8), so this debt now includes finding a regulator family with a stable gap	§64.4.1G, §64.4.7
D26	**AUDITED — FAIL FOR PROMOTION (§71.5)**: the five lepton numbers reproduce an openly-constructed candidate benchmark	§71.5

Debt	Description	Blocking
	(coefficients 1, 6/5, 0.02475, $\beta = \sqrt{3}/20$, $\psi = 3\pi/4$), not a blind derivation and not concealed copying. Repair: derive β, the kernel ratios and frame assumptions from the projected closure Hamiltonian under a sealed manifest, then rerun blind	
D27	**CLOSED AS CERTIFIED DEGENERATE (§71.4, Thm 70.1)**: operator-level conjugation makes the ±1 tie exact; the return is DEGENERATE per §52 unless a CP-odd time-oriented term is derived. **The required term is now identified with the commitment channel's winding orientation (§73.5, D36)**	§70.1, §71.4, §73.5
D28	The nonseparable QP block. **Partially discharged (§68)**: the scalar commitment block is derived in rank, orientation, exact support and positivity interval. Remaining under this debt: nothing — the residue is split into D29–D31	§67.7, §68
D29	The action-normalised $\hat{g}_\kappa$ and ω_0. **Conditionally returned by score matching (§77.2)**: $\omega_0^2 = 4/3$, $\hat{g}_\kappa = 0.698840$, $\eta_\kappa = 0.058605$ — read from the executed irreversible score law, satisfying the frozen §68.6 formula exactly. Remaining: the unconditional master-action derivation; never from a downstream observable (F5/F29/F36)	§68.9, §77.2
D30	The three-factor embedding. **Reframed by Lemma 70.2**: unique under factor-exchange covariance (Premise D30-P); otherwise determined by one derived weight vector $w \in S^2$, symmetric point $(1,1,1)/\sqrt{3}$. Remaining: certify D30-P or derive w — never select w for its downstream fingerprint (F5/F29)	§70.2
D31	**PARTIALLY DISCHARGED (Thm 71.1)**: the link–current–record Schur mechanism is derived and explains the wheel triple; completion stretch is a no-go at linear order; the CAR/Fock block is absent from the 226-carrier. Remaining: the physical primitive weights (see D35) and the fermionic block on an enlarged carrier	§71.1
D32	Gate-7 physical provenance. **Reframed by Thm 77.1**: under Premises PF + FP, a primitive commitment carries nonzero winding and the $k = 0$ sector is outside the primitive-Fact domain — the debt becomes certifying those premises, with the quantitative threshold $\Delta f_{occ} = 0.007414782101$ retained as the fallback test if either is contested (clearing it by construction-to-target remains F5). Also: Gate-2 detwisting; non-bounding primitive-Fact loop; terminal generation typing	§69.7, §72.3, §77.1
D33	**EXECUTED (§71.3)**: the diamond family fails analytically (gap ~ $\pi^2/16k^2$); the $K_{N,N}$ antichain family passes with uniform gap ½, exact intertwining and exact conductance refinement at every level	§71.3
D34	Physical admissibility of the regulator family: derivation that VERSF's admissibility rules select the physical refinement. **Annotated by F39**: the $K_{N,N}$ clone-lift's exact intertwining is a theorem of the family's form, settling gap uniformity only. **Genuine interacting non-factorised**	§71.3; §74.4; §78.3; D24

Debt	Description	Blocking
	two-level passes now exist in the companion corpus — NFDMA-1's whole-action Level-2 and RCMO-1's operator family (SMC-1U, Parts XII-bis/ter) — and §78.3's six-level cascade is of the same genuine type; D34's remaining content is therefore the *selection certificate* (which family is the substrate's), not the existence of honest refinement evidence	
D35	The one action/history normalisation return: { $\hat{g}$_κ, ω₀ } ∪ { c_A, b_A, r_A, cross-blocks }_{A=3,2,1} ∪ { Λ⋆ } from one master history operator — **proved non-recoverable by downstream inversion (Thm 72.1, witnesses 1–3)** and **proved not suppliable by time calibration (§73.4)**; the sole remaining input to Theorem 71.1's exact Schur formulas, never read from a desired force strength (F5/F29)	§71.7, §72.1, §73.4
D36	The commitment entropy-production operator Σ_commit. A diagnostic one-bit irreversible instance and its factor-blind rank-183 typed lift have been **executed in §§75–76**. Remaining physical content: the action-derived affinity, attempt-rate normalisation, drive orientation and branch dependence — each a forward return, never fitted (F38). The representation-dependent internal score generators are separated into D41	§73.5, §§75–76
D37	The absolute substrate length ξ. **Two independent conditional candidates**: Route-A ξ = 88 µm (§77.4) and Route-M ξ = 84.07 µm from the nonbacktracking percolation threshold (§78.4), agreeing to 4.46% with neither using the other. Remaining: the infinite-foam theorem selecting the branch (D45)	§73.5, §77.4, §78.4
D39	Revision-registry check in the publication package: every hashed input verified as the latest sealed revision of its source before Stage 0, closing the integrity-vs-currency gap exposed by the Stage-A manifest	§74.6; F26
D40	Independent-rebuild specification of the ISG-1 driven kernel: attempt-rate convention and common-step definition published to the standard that a frozen re-implementation reproduces Σ = ln 2 and the stationary measure exactly — an assembler rebuild from the narrative alone did not (§75.5.iv). The §76 lift layer meets this standard; the kernel layer still owes it	§75.5; F31 spirit
D41	The sector-internal score generators that Premise FB averages away: representation-dependent internal-gauge, terminal-record, completion and CAR/Fock transition laws — the residue between the faithful factor-blind lift (§76) and a physical W_prim	§76.6
D44	**Transformed by §79 into D44′ — the Primitive Innovation Factorisation Theorem**: conditionally independent, exchangeable Bernoulli innovations with one universal attempt intensity after the full auxiliary census. The consumer side is closed (Thm 79.1: path law ⟹ Fisher-unique quadratic H_CMR at scale ln 2); the counterexamples (correlated one-bit channels with Fisher cross-term tanh J; unequal-rate channels; free-cubic positive actions) prove D44′ irreducible	§78.1, §79.1–2

Debt	Description	Blocking
D45	**Revised by §80 into D45″ — the Construction-Order Clause**: the infinite-cover formulation is replaced by the finite distinguishable record-stability theorem; record-distinct gluing is proved under A2* for committed cells (Thm 80.1) and the threshold $p\star = \rho(B\_D)^{-1}$ is a finite Perron–Frobenius boundary (Thm 80.2), making $\xi = 84.07$ μm theorem-grade conditional on one clause: that the substrate glues already-committed cells (else it must say whether a pre-commitment shared face creates one record or two). Plus the independent Z_comp releasing Λ⋆	§79.3–4, §80
D13	Wilson-coefficient ledger: anomalous dimensions and matching for C^{(5)}, C^{(6)} generated at heavy-neutral thresholds	§15, §26; P1 completeness
D14	Envelope models for the non-probabilistic uncertainty categories, and the decorrelation demonstration if the additive form is to be used	§54
D15	Domain-defining functionals monitored by the solver, with their escape thresholds	Remark 22.1a

Each debt is stated as a debt rather than deferred silently. None of them can be discharged by inspecting an observable.