4. J4 — Nuclear Domain Guard (J4 / L4C* / L4E*)

Concept (invariant): a nuclear claim is evaluable only if the nuclear domain is explicitly declared and observationally anchored with reproducible provenance. J4 is not an optional add-on; it is the domain continuation of J0-J3.

4.1 Why J4 is unavoidable

Without domain declarations, nuclear claims become tuneable narratives: the same statement can be made compatible with mutually incompatible channels or detector regimes. J4 prevents this by forcing explicit energy windows, isotopes, reaction channels, detector context, and evidence anchors.

4.2 Concept-to-equation bridge

Invariant concept: evaluability in Ω_I and no hidden nuclear knob reinjection. Data-dependent equations: threshold checks, residual checks, and anchor tests.

```
Eq. (1): 0 <= E_min < E_max [MeV]
Eq. (2): z = |sigma_pred - sigma_obs| / sigma_obs_err
PASS(E) iff z <= z_max; FAIL(L4E5) iff z > z_max.
```

4.3 L4C* locks (consistency/evaluability)

L4C1. Declare domain.energy_range_mev.{min_mev,max_mev}; missing -> NO-EVAL.

L4C2. Declare isotopes[] and reaction_channel; missing -> NO-EVAL.

L4C3. Declare detectors[] and operational resolution context.

L4C4. Units and thresholds must be explicit and internally consistent.

L4C5. Channel and isotope mapping must be non-ambiguous in Ω_I.

L4C6. No hidden control knob may carry claim support in Ω_I.

L4C7. Finite, reproducible computation path is mandatory for judgment.

4.4 L4E* locks (evidence/provenance)

L4E1. Evidence anchor must include dataset_ref.

L4E2. Provenance locator is required: source_url or dataset_doi.

L4E3. sigma_obs and sigma_obs_err must be declared with units.

L4E4. sigma_pred must reference the same observable definition.

L4E5. Residual z-test is mandatory; violation -> FAIL(L4E5).

L4E6. Evidence timestamp/version and run trace must be reproducible.

L4E7. If anchors are incomplete/untraceable -> NO-EVAL(L4E*).

4.5 Integration with J0-J3 flow

Evaluation order remains J0 -> J1 -> J2 -> J3 -> J4. J4 certifies domain-specific evaluability after projection, identifiability, and finite-resource stability are already satisfied.

4.6 Runtime coupling (MRD and predictions)

Runtime assets: occ/judges/nuclear_guard.py, ILSC_MRD_suite_extensions/mrd_nuclear_guard/, examples/claim_specs/nuclear_*.yaml, and predictions/registry.yaml (P-0004).

```
CLI path:
occ judge examples/claim_specs/nuclear_pass.yaml --profile nuclear
occ verify --suite extensions --strict --timeout 60
```