FMEA-to-AMT Alignment: Closing the Gap Between Analysis and Execution

Maintenance Strategy - Correlation Assessment, Gap Classification, and Governance

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Executive Summary. *In a well-functioning maintenance system, every scheduled task in the CMMS should be traceable to a failure mode it is designed to detect, mitigate, or prevent. In practice, the correlation between an organisation's FMEA library and its Asset Maintenance Templates is rarely better than partial and the gap is often larger than any single maintenance improvement initiative has accounted for. This Methodology Paper describes the SEAMPAS approach for conducting an AMT-to-FMEA correlation assessment, classifying gaps using a structured four-category scheme (Direct, Partial, Gap, Orphan), prioritising remediation on a consequence-weighted basis, and establishing the governance structures that prevent the gap from re-emerging over successive maintenance cycles. The methodology has been applied across multi-workbook FMEA libraries in minerals processing; a summarised case, a prioritisation matrix, and governance requirements are included.*

1. Introduction - Why the Gap Matters

Most mature asset management programmes maintain two large repositories that are assumed to align but rarely do. The first is the **FMEA library**, a collection of workbooks describing, for each significant equipment item, the functions, failure modes, consequences, and recommended maintenance tactics. The second is the **CMMS**, populated with Asset Maintenance Templates (AMTs) that drive the day-to-day scheduled work.

The assumption is that AMTs implement the tactics recommended by the FMEAs. The reality is that they frequently do not. AMTs have often been developed from vendor recommendations, plant history, and custom practice, with FMEAs developed later as a parallel analytical exercise. Where the two were ever reconciled, the reconciliation was rarely preserved through subsequent changes. The result is a maintenance programme whose effectiveness cannot be traced to a specific failure-mode analysis, and whose periodic review produces either no material change or unjustified edits.

The cost of the gap is twofold. First, resources are consumed on tasks whose value is unknown, some addressing failure modes that no longer apply, others addressing modes that are no longer material. Second, failure modes that were identified by the FMEA work are not being addressed by the live programme, despite having been recognised. The maintenance programme looks complete but is not traceable; the FMEA library looks thorough but is not operationalised.

The SEAMPAS methodology described in this paper is designed to close this gap systematically, to document the closure in a live register, and to govern it through subsequent operating cycles. It is an alignment discipline, not a strategy or optimisation exercise; it does not tell an organisation what its maintenance programme should be, but it ensures the programme matches the analysis already done.

2. Terminology and Scope

For the purposes of this paper the following terms are used precisely:

- **FMEA (**Failure Modes and Effects Analysis) - the structured identification of an item's functions, failure modes, effects, consequences, and recommended maintenance response, typically produced per equipment class in a workbook format.
- **AMT (**Asset Maintenance Template) - the CMMS representation of a scheduled maintenance plan, typically defined at an equipment-class or asset-type level and applied to multiple individual assets.
- **PM (**Preventive Maintenance task) - the individual scheduled work item generated from the AMT and executed by the maintenance workforce.
- **Correlation Register -** the live, versioned document that maps each FMEA-recommended tactic to one or more AMT tasks, records the nature of the pairing, and carries the gap classification for any unpaired tactic or task.

Scope. The methodology applies to any operating environment with an established FMEA library and an AMT-driven CMMS. It assumes both artefacts exist and are at least partially populated; it does not cover the development of an

FMEA library from scratch (see SEAMPAS Technical Note 01) or the initial configuration of a CMMS. Out of scope for this paper: maintenance cost optimisation, reliability growth analysis, and spares strategy, all of which may be informed by the Correlation Register but are not the subject of the methodology itself.

3. Methodology Overview

The methodology comprises five sequential phases. Each phase produces a defined artefact; the phases can be executed as a single improvement project or staged across an operating year, but the artefact chain is fixed. The Correlation Register is versioned from Phase 1 and iterated thereafter - it is a permanent asset of the maintenance programme, not a one-off project deliverable.

Phase	Objective	Artefact Produced	Typical Effort
1	Establish scope and baseline extract	Correlation Register Rev 0 (joined extract, no pairings assigned)	2–4 weeks elapsed; 0.3 FTE
2	Classify every pairing against the four-category scheme	Register Rev 1 with Direct / Partial / Gap / Orphan labels	4–8 weeks elapsed; 0.5 FTE
3	Prioritise remediation on a consequence-weighted basis	Gap Closure Roadmap (P1 / P2 / P3 schedule)	1–2 weeks; reliability + maintenance leadership
4	Execute remediation; update CMMS and register in lockstep	Register Rev 2–3; revised CMMS AMT population	3–12 months; cross-functional
5	Establish governance to prevent re-drift	Governance procedure; KPI dashboard; ownership assignment	2–4 weeks to establish; continuous thereafter

The sections that follow describe each phase in detail, identifying inputs, outputs, and the practical disciplines required to execute the phase well.

4. Phase 1 - Establishing the Correlation Register

Objective. To produce a single baseline document that lists, for every equipment item in scope, every FMEA-recommended tactic and every AMT-defined task, at sufficient granularity to support pairing in Phase 2.

Inputs. The existing FMEA library; the CMMS AMT export; the asset register (for in-scope equipment identification).

Outputs. The Correlation Register Rev 0, structured as a joined extract with standard row fields on each side.

Practical guidance.

- Scope the register to an operational area (e.g., comminution circuit) rather than the entire plant. Manageability is essential; 75–150 equipment items is a workable first pass.
- For each in-scope asset, extract FMEA-recommended tactics to a standard row format: equipment class, failure mode, recommended tactic, frequency, resource discipline, criticality.
- For each in-scope asset, extract AMT-defined tasks to a parallel row format: equipment class, task description, frequency, resource discipline.
- Do *not* attempt pairing at this stage. The register is simply a joined extract with the two sides aligned on equipment class. Pairing discipline is a separate phase.

Typical scale. For a minerals-processing comminution area, expect several hundred rows on each side, often 500–1,500 FMEA-side and 400–1,000 AMT-side. The asymmetry is itself informative; an AMT side markedly smaller than the FMEA side is an early indicator of under-coverage.

5. Phase 2 - Gap Classification

Each FMEA-recommended tactic - and each AMT-defined task - is classified against the four-category scheme below. The classification is carried on the Correlation Register alongside the pairing.

Classification	Definition	Typical Response
Direct	One or more AMT tasks implement the FMEA-recommended tactic at appropriate frequency, technique, and discipline.	Accept; record the pairing in the register as the traceability note.
Partial	An AMT task addresses the failure mode but at insufficient frequency, wrong technique, incomplete scope, or wrong resource discipline.	Remediate: adjust the AMT to align with the FMEA-recommended tactic.
Gap	No AMT task addresses the failure mode; the FMEA-recommended tactic has no execution path.	Remediate: create a new AMT task or document a justified omission with reviewer sign-off.
Orphan	An AMT task exists that cannot be traced to any FMEA-identified failure mode.	Investigate: update the FMEA to capture the mode (if valid) or retire the AMT (if legacy waste). Orphans are not automatic waste.

The Orphan category. The Orphan classification is the one most often overlooked or dismissed. Orphan tasks are not automatically waste. They frequently reflect genuine operational knowledge that never made it into the FMEA - a known failure mode addressed by long-established practice, or a regulatory requirement pre-dating the formal FMEA. The correct response to an Orphan is investigation, not reflexive retirement.

Classification discipline. Classifications are assigned by a reliability engineer familiar with both sides of the register, ideally with consultation from site maintenance leadership. Disputed classifications - typically on frequency or technique adequacy in the Partial category - are flagged rather than forced and resolved in Phase 3 with the wider stakeholder group. A Rev 1 classification is provisional; it is refined through Phase 3 and re-issued as Rev 2.

6. Phase 3 - Remediation Prioritisation

Not every gap is equally important. Prioritisation draws on the SEAMPAS four-level consequence framework (see Technical Note 03) combined with the gap classification. The matrix below defines the priority assigned to each intersection; Direct pairings carry no remediation priority but are confirmed in the register and audited thereafter.

Consequence	Gap	Partial	Orphan	Direct
Critical	**P1**	**P1**	**P2**	Confirm
High	**P1**	**P2**	**P2**	Confirm
Medium	**P2**	**P3**	**P3**	Confirm
Low	**P3**	**P3**	**P3**	Confirm

Priority definitions. Priorities are operational, not rhetorical. They map directly to remediation timeframes:

- P1 - remediation within the current maintenance cycle (typically 30–90 days).
- P2 - remediation within the next maintenance review cycle (3–6 months).
- P3 - remediation at the next scheduled AMT review (6–12 months).

Output. Phase 3 produces the **Gap Closure Roadmap** - a single document listing every Partial, Gap, and Orphan with its priority, the named remediation owner, the planned completion date, and the remediation action summary. The roadmap is an input to maintenance leadership planning and is tracked to completion.

7. Phase 4 - Implementation and Change Control

Phase 4 is the operational work of editing the CMMS to implement the remediation plan. The most important discipline at this phase is **traceability in lockstep**: every CMMS change is reflected in the Correlation Register, with a revision number and date, and no CMMS change is accepted unless that reflection has been made.

Common implementation activities:

- Creating new AMT tasks to close Gap classifications, with task description, frequency, resource discipline, and traceability back to the originating FMEA row.
- Adjusting frequency, technique, or resource discipline on Partial-classified AMTs to align with the FMEA recommendation.

- Retiring AMTs confirmed as legacy waste through Orphan investigation, with retirement rationale recorded in the register.
- Creating new FMEA entries where Orphan investigation revealed an unacknowledged but valid failure mode; the FMEA update propagates back through the register and may reveal further pairings.

Change-control principle. The Correlation Register and the CMMS must be updated together, never one without the other. The Register is the authoritative record of intent; the CMMS is the execution engine. Divergence between the two is the condition the methodology is designed to eliminate - and the principle applies equally during remediation as it does afterward.

8. Phase 5 - Governance and Sustainment

The gap recurs if governance does not prevent it. Three governance elements are non-negotiable:

- **Ownership.** A named role - typically the reliability engineer or maintenance strategy lead - is accountable for the Correlation Register. Without a named owner, the register decays within a single operating cycle.
- **Change control.** Any change to the CMMS AMT population must be accompanied by a review of the Correlation Register, and any change to the FMEA library must likewise trigger a register review. This is typically implemented as a field in the management-of-change process: “Has the Correlation Register been updated?” No change is closed without a yes.
- **Scheduled review.** The register is audited at a defined cadence - typically annually, or in line with the FMEA review cycle. Audit output is tabled with maintenance governance alongside the KPIs below.

Sustainment KPIs. The KPIs below make sustainment visible and testable:

KPI	Definition	Target
Direct Match Rate	Proportion of FMEA-recommended tactics classified as Direct	≥ 85% within two revision cycles
Orphan Rate	Proportion of AMTs with no traceable FMEA origin	≤ 10%
P1 Ageing	Average age, in days, of unresolved P1-priority items	≤ 60 days
Register Currency	Days since last register revision	≤ the FMEA review cycle

9. Worked Example - Minerals Processing Comminution Area

Context. A mid-sized minerals-processing operation held an FMEA library of 28 workbooks covering primary and secondary crushing, SAG milling, ball milling, classification, and slurry pumping. The asset register in scope listed 75 equipment items. The CMMS held an AMT population covering broadly the same asset set, but the two artefacts had never been systematically correlated.

Phase 1 baseline (Rev 0). Extracts produced approximately 600 rows on the FMEA side and around 500 on the AMT side. The asymmetry was the first diagnostic signal; a smaller AMT side than FMEA side implied under-coverage.

Phase 2 first-pass classification (Rev 1). A reliability engineer, with site maintenance leadership consultation, classified every FMEA tactic against the AMT population. The first-pass Direct rate was well below the 85% target, with material Partial and Gap counts - reflecting the scale of the pre-existing alignment gap rather than a failure of the methodology. A significant share of the AMT side was initially classified as Orphan pending investigation.

Phase 3 roadmap. Prioritisation identified a manageable P1 queue on Critical- and High-consequence equipment (SAG mill drive, hydrocyclone feed pumps, primary crusher lubrication), a larger P2 queue across Medium-consequence equipment, and a P3 tail on Low-consequence items. The P1 queue was scheduled for closure within 90 days.

Phase 4 remediation outcome (Rev 3). After nine months of remediation - new AMT tasks, adjusted frequencies, retired legacy tasks, and one round of FMEA supplementation driven by Orphan investigation - the register stabilised at **67 Direct matches, 8 Partial, and 8 open Gaps** across the 83 FMEA-identified tactics actively tracked. Approximately two-thirds of the initial Orphan AMTs were confirmed as legitimate tasks addressing failure modes the FMEA library had not captured; the remainder were retired.

Phase 5 governance. A named reliability-engineering owner was assigned to the register. Management-of-change process was modified to require register review as a closure gate. Annual audit was scheduled in line with the FMEA review cycle. KPIs were established and tabled quarterly with maintenance leadership.

Key observations. Two outcomes from the example are worth highlighting as characteristic of first-pass applications: (a) the first-pass Direct rate is typically lower than practitioners expect, and that shortfall is a measure of the scale of the pre-existing gap, not of methodology weakness; and (b) a substantial share of Orphan tasks reflects genuine operational knowledge, and the methodology surfaces rather than discards that knowledge.

10. Limitations and Preconditions

Preconditions. The methodology assumes:

- A populated FMEA library at a useful level of detail - task-level recommendations, not merely failure-mode enumeration.
- A CMMS with AMTs defined at equipment-class granularity, with sufficient structure to allow export to a row-based register.
- Reliability engineering capacity to perform the classification work; as a rule of thumb, 0.5 FTE for approximately three months for a 75-item scope, plus stakeholder time.
- Organisational willingness to act on the results, not merely to document them. Without sponsorship to accept the roadmap outputs, the register becomes another unused artefact.

Limitations. The methodology is an alignment discipline. It does not generate new maintenance strategy and does not, on its own, improve maintenance cost or availability performance; those outcomes depend on the quality of the underlying FMEA library and on the remediation actions chosen in Phase 4. Where the FMEA library is itself incomplete or low-quality, the methodology will correctly expose that as a Gap classification but will not remediate it; FMEA rebuild (see Technical Note 01) is a prerequisite in those cases.

Finally, the methodology is iterative by design. Rev 1 is rarely final, and first-pass classifications frequently shift as stakeholder understanding improves. A register that has reached Rev 3 is characteristically more reliable than one at Rev 1, regardless of how the numbers appear on first inspection.

11. Conclusion

Closing the FMEA-to-AMT gap produces a maintenance programme that is **traceable, defensible, and governable**. The methodology is structured, incremental, and builds a permanent artefact - the Correlation Register - that survives personnel change and organisational restructure. In SEAMPAS practice, it is the single highest-leverage intervention available in a mature but misaligned maintenance programme, precisely because it converts existing analysis and existing scheduled work into a coherent, auditable whole rather than requiring either to be rebuilt.

The methodology is deliberately modest in its ambitions. It does not optimise; it aligns. But alignment is the precondition for every subsequent optimisation - without a traceable link from failure mode to scheduled task, no change to the programme can be made with confidence that the change will improve the outcome rather than merely modify the workload.

Appendix A - Correlation Register Row Structure

The Correlation Register is a row-based artefact, with each row representing a single FMEA-recommended tactic (paired or unpaired) or a single Orphan AMT task. The schema below is the SEAMPAS reference structure; it may be extended with site-specific fields but should not be reduced below this minimum. The register is typically implemented as a spreadsheet in early revisions and migrated to a database or CMMS-integrated register when sustainment governance is mature.

Field	Description / Example
Equipment class	Standard equipment-class identifier matching FMEA workbook scope (e.g., “Centrifugal slurry pump - Warman MCR 450”).
Asset tag	Plant-specific asset identifier as registered in the CMMS (e.g., “PUM-3102”). Multiple assets may share an equipment class.

Field	Description / Example
FMEA row ID	Source row reference within the originating FMEA workbook (e.g., "FMEA-PUM-014"). Enables bidirectional traceability.
Failure mode	Failure mode as stated in the FMEA (e.g., "Impeller wear – volute clearance loss").
FMEA-recommended tactic	Tactic type (CBM / time-based / failure-finding / redesign); frequency; resource discipline; detection or intervention threshold.
AMT ID	CMMS template identifier linked to this row (null if Gap; may be multi-valued if one FMEA tactic maps to multiple AMTs).
AMT task description	Task description, frequency, and resource discipline as defined in the CMMS.
Classification	Direct / Partial / Gap / Orphan, per Section 5 of this paper.
Criticality	Consequence rating per the SEAMPAS four-level framework (see Technical Note 03): Critical / High / Medium / Low.
Priority	P1 / P2 / P3 / Confirm, assigned from the prioritisation matrix in Section 6.
Owner	Named role accountable for remediation of this row (not an individual; a role ensures continuity across personnel change).
Target close date	Committed completion date derived from priority level; feeds the Gap Closure Roadmap schedule.
Revision	Register revision carrying this classification (e.g., Rev 1, Rev 2, Rev 3). Provides audit traceability.
Notes	Free-text field for classification rationale, disputed-item flags, Orphan investigation outcomes, and justified omissions.

References and Further Reading

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About this Methodology Paper

SEAMPAS Methodology Papers are structured descriptions of methods developed and applied in SEAMPAS practice for specific problems in physical asset management and reliability engineering. They complement the shorter SEAMPAS Technical Notes series by treating a method in depth - its phases, artefacts, preconditions, and governance - rather than addressing a conceptual or diagnostic question. Methodology Papers are intended for reliability engineers and maintenance strategy leads responsible for the design and governance of site-level maintenance programmes.

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