PRACTITIONER ASSURANCE SERIES

DP System FMEA
Gap Analysis Tool

Practitioner User Manual

A complete field guide for factual, configuration-aware review; justified findings; and evidence-based close-out.

EVIDENCE	CONFIGURATION	WCFDI	CLOSURE

Document	Issue	Date
Practitioner User Manual	Final revision	9 October 2026

Purpose of this manual

To help a competent DP FMEA practitioner use the final tool consistently, transparently and efficiently while reviewing a DP System FMEA report and its supporting evidence. It does not confer Class, Flag, client or contractual approval.

Use with the controlled workbook and the vessel's project-applicable source set.

Document control and use

Item	Controlled statement
Tool covered	DP-FMEA-Gap-Analysis-Tool.xlsx: seven practitioner sheets, 388 unique review criteria, ten Office-native slicers across the Gap Analysis and Findings Register, nine filterable workstreams, integrated findings register and dashboard. Final revision (9 October 2026): GAP ANALYSIS, FINDINGS REGISTER and the upper part of VESSEL OVERVIEW are protected without a password; sorting is disabled.
Intended users	Competent DP FMEA practitioners, independent assurance providers, vessel technical authorities and suitably qualified reviewers.
Assessment object	The technical comprehensiveness, factual basis, traceability and validation of a vessel's DP System FMEA and the evidence on which it relies.
Authority	The workbook records an assurance opinion against an adopted basis. It is not a Class certificate, Flag approval, contractual acceptance or instruction to conduct live fault tests.
Issue control	The live workbook is the assessment record. Any PDF, Word, PowerPoint or extracted Excel output is a controlled snapshot and must be re-issued after relevant changes.

How to use this manual

- **First-time user:** read Sections 1–8 in order, then keep the aide-mémoire beside the FMEA.
- **Experienced practitioner:** use the Quick Start, outcome/weighting tables, technical challenge prompts, closure gates and issue checklist.
- **Independent reviewer:** challenge applicability, evidence sufficiency, WCFDI consequence, finding consistency, accepted closure and dashboard reconciliation.

> **Core assurance rule**
>
> A document being present is not proof that its technical claim is correct. A planned test is not an executed result. A completed action is not an accepted closure. Always preserve the chain from criterion to evidence to reasoning to conclusion.

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1. Objectives and assurance philosophy

The tool is a practitioner guide for deciding whether the DP System FMEA is technically comprehensive, configuration-aware, traceable to objective evidence and supported by adequate verification and validation. It is deliberately more than a document-completeness checklist, while remaining usable beside the FMEA report.

1.1 Objectives

- Establish the vessel, DP equipment class, redundancy concept, operating configurations, industrial mission and WCFDI basis before judging coverage.
- Focus the practitioner on criteria relevant to the selected vessel: DP2/DP3, open/closed/common bus, AC/DC/mixed distribution, specialist energy systems, fuels, fuel cells and cyber applicability.
- Test each conclusion against exact FMEA locators and objective supporting evidence, not generic statements or document titles.
- Distinguish sufficient coverage, partial coverage, absence of coverage, inability to verify and genuine non-applicability.
- Prioritise material deficiencies using the original weighting philosophy and the potential relationship to the redundancy concept and WCFDI.
- Give every gap a clear technical consequence and measurable pathway to closure, then record independent acceptance evidence.
- Provide transparent metrics without allowing the score or traffic-light colours to replace professional judgment.

1.2 What the tool does not do

- It does not recreate the vessel FMEA or prove fault tolerance by itself.
- It does not determine contractual or legal obligations; those are established by the project authority and controlled source set.
- It does not approve work on behalf of Class, Flag, the owner, charterer or management of change process.
- It does not authorise live failure tests. Trial execution requires a separately approved programme, risk controls, initial conditions, abort criteria, competent personnel and relevant witnesses.
- It does not convert a missing record into technical non-compliance automatically. Where the technical state cannot be established, use Unable to verify and state the missing evidence.

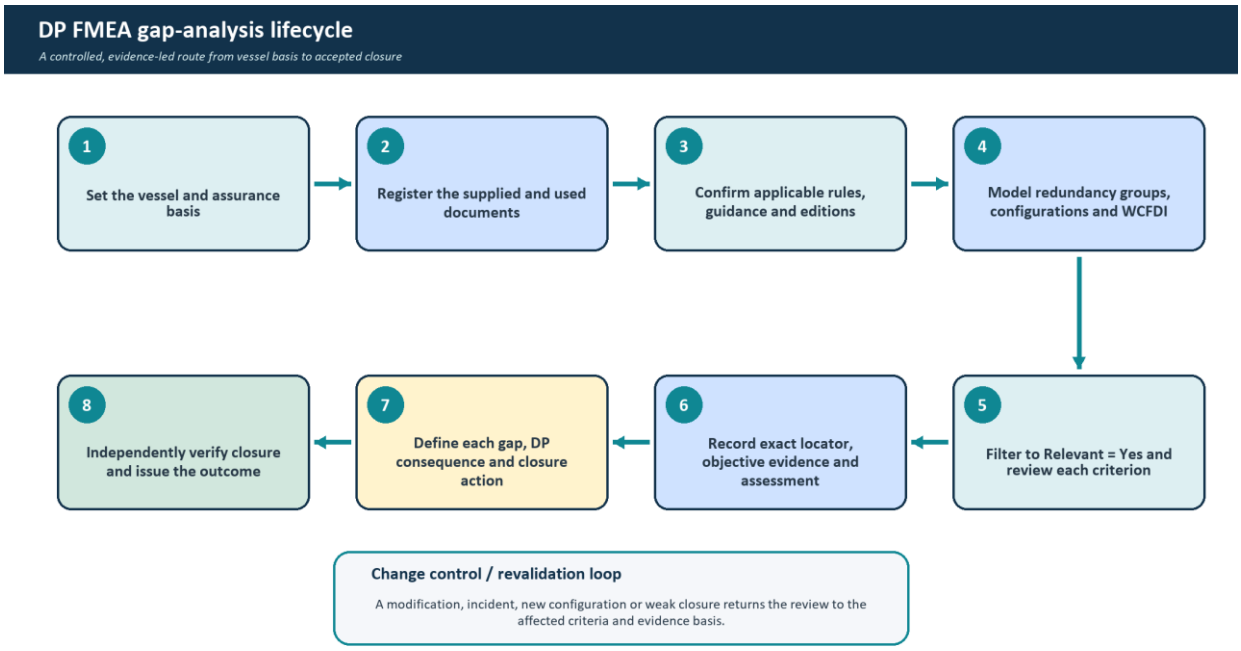


Figure 1 — End-to-end DP FMEA gap-analysis lifecycle.

1.3 Practitioner stance

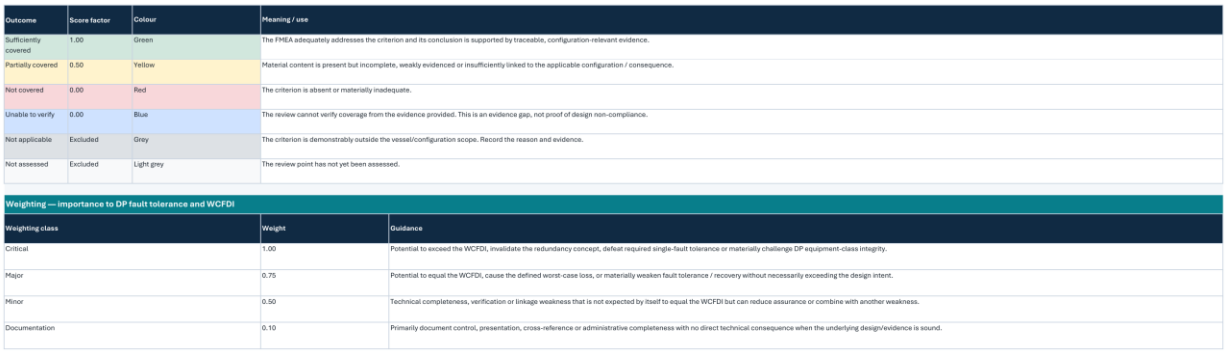
Use a worst-case-failure lens. For every material issue, state the initiating condition, the propagation path, the surviving configuration, the effect on power/thrust/control/reference systems, the station-keeping consequence, the relationship to WCFDI/WCF, the detection and compensating provisions, and the evidence that validates the conclusion.

> **Fact / inference / conclusion**
>
> Write the record so another competent practitioner can identify: (1) what the FMEA and evidence state; (2) what you infer; (3) any assumption or unknown; and (4) why the assessment outcome follows. Do not merge these into an unsupported assertion.

2. Tool architecture and practitioner journey

The workbook has seven visible sheets. The practitioner works from the vessel's controlled evidence, the embedded review criteria and the Reference Register.

Sheet	Purpose	Primary practitioner action
GUIDE	Definitions, outcome colours, weighting, finding classification, workflow and scoring.	Read before first use; return whenever an outcome or weighting requires calibration.
VESSEL OVERVIEW	Vessel identity, class/configuration selectors, specialist applicability, WCFDI context, simplified one-line and configuration register.	Complete first; use To confirm where unknown so criteria are not prematurely hidden.
DOCUMENT REGISTER	Controlled list of all documents supplied, reviewed or relied on.	Record identity, revision, status, issuer, locator and use.
GAP ANALYSIS	Filterable criterion-by-criterion assessment beside the FMEA.	Filter Relevant = Yes; enter assessment, exact locator, evidence note and gap summary in the blue input columns I to L.
FINDINGS REGISTER	Extracted findings plus consequence, action, ownership and close-out controls.	Filter Track? = Yes; manage L–S through accepted closure.
DASHBOARD	Scope, progress, weighted coverage, finding priority, closure signals, issue control and export workflows.	Interpret after reconciling findings and limitations; complete issue controls before release.
REFERENCE REGISTER	Reference IDs, issuer, title, edition, issue date, issuer link and project-applicability note.	Confirm exact governing edition and clause against the controlled source.



Outcome	Score factor	Colour	Meaning / use
Sufficiently covered	1.00	Green	The FMEA adequately addresses the criterion and its conclusion is supported by traceable, configuration-relevant evidence.
Partially covered	0.50	Yellow	Material content is present but incomplete, weakly evidenced or insufficiently linked to the applicable configuration / consequence.
Not covered	0.00	Red	The criterion is absent or materially inadequate.
Unable to verify	0.00	Blue	The review cannot verify coverage from the evidence provided. This is an evidence gap, not proof of design non-compliance.
Not applicable	Excluded	Grey	The criterion is demonstrably outside the vessel/configuration scope. Record the reason and evidence.
Not assessed	Excluded	Light grey	The review point has not yet been assessed.

Weighting — importance to DP fault tolerance and WCFDI

Weighting class	Weight	Guidance
Critical	1.00	Potential to exceed the WCFDI, invalidate the redundancy concept, defeat required single-fault tolerance or materially challenge DP equipment-class integrity.
Major	0.75	Potential to equal the WCFDI, cause the defined worst-case loss, or materially weaken fault tolerance / recovery without necessarily exceeding the design intent.
Minor	0.50	Technical completeness, verification or linkage weakness that is not expected by itself to equal the WCFDI but can reduce assurance or combine with another weakness.
Documentation	0.10	Primarily document control, presentation, cross-reference or administrative completeness with no direct technical consequence when the underlying design/evidence is sound.

Figure 2 — GUIDE sheet: the in-workbook reference for workflow, outcomes, weighting, classification and scoring.

2.1 Recommended working arrangement

- Use two screens where possible: the controlled FMEA/PDF and drawings on one; the workbook on the other.
- Use the top-only frozen header row while moving across evidence and gap fields. Use the slicers, table filters, Criterion ID filter, Name Box or Find to retain row identity; no left columns are frozen.
- Review in evidence-centred blocks (for example power generation, distribution/protection, thrusters, DP control, auxiliaries, fire/flood segregation) rather than racing down the list.
- Use filters to manage focus. The protected sheets prevent deleting criteria, inserting rows or overwriting calculated fields, and sorting is disabled.
- Save controlled checkpoints and preserve the live workbook before issuing static exports.

2.2 Quick Start — the shortest defensible route

1. **Open a controlled working copy.** Confirm the file name, issue and vessel/report identity.
2. **Complete VESSEL OVERVIEW.** Set DP class, bus mode, distribution, specialist systems, WCFDI and assessment scope.
3. **Populate DOCUMENT REGISTER.** Record every file supplied or used, including status and revision.
4. **Confirm the source basis.** Use REFERENCE REGISTER and the vessel's Class/Flag/contract documents; label current comparators that are not governing.
5. **Reapply and filter.** On GAP ANALYSIS choose Data > Reapply, then use the Relevant slicer to select Yes. Use the remaining slicers or table filters to create a manageable work queue.
6. **Assess each visible criterion.** Record an exact FMEA locator, objective evidence/reasoning, result and concise gap/concern where needed.
7. **Manage findings.** The FINDINGS REGISTER opens with Track? = Yes. Choose Data > Reapply after assessment changes, then use its slicers to manage consequence, closure action, owner, date and status.
8. **Read the dashboard together.** Check completion, score, major findings, UTV, workstream hotspots and closure signals.
9. **Independently review and issue.** Complete the issue controls, disclose limitations and export the required controlled snapshot.

3. Establish the review basis before assessment

3.1 Minimum information to request

Information group	Typical minimum evidence
Vessel and Class	Vessel name/IMO; build/major conversion dates; Flag; full Class notation; DP equipment class; applicable rule/approval edition; conditions, memoranda or limitations relevant to DP.
FMEA package	Current DP System FMEA, revision history, appendices, action register, proving-trials programme/report, annual trials and revalidation/major-modification reports.
Power and distribution	As-built AC/DC one-lines; generator/ESS/fuel-cell data; switchboard/bus topology; protection philosophy, settings and coordination; PMS/VMS cause-and-effect; blackout/recovery and load-flow studies.
Thrusters and auxiliaries	Thruster drives/controls; cooling, ventilation, fuel, lubrication, hydraulics, seawater/freshwater, compressed air and other shared services; valves, cross-connections and remote controls.
DP control and sensors	DP control architecture; networks; software/firmware baselines; IJS; operator stations; independent joystick; PRS and environmental sensors; UPS/DC supplies; alarm/event and time-synchronisation basis.
Segregation and safety	Fire/flood boundaries; cable and pipe routes; penetration/fire-stop records; F&G/ESD cause-and-effect; hazardous-area and alternative-fuel safety documents.
Operations	DP operations manual; ASOG/CAM/TAM/WSOG; activity limitations; capability/footprint information; maintenance, test and recovery procedures; incident/modification records.
Specialist systems	BESS/hybrid, closed/common bus, DC grid, future-fuel, fuel-cell and cyber design, control, safety, validation and Class evidence where installed/applicable.

If documents are unavailable

Do not fill the gap with an assumption. Record the missing item in DOCUMENT REGISTER where appropriate, preserve the relevant criterion, and use Unable to verify when the evidence is insufficient to judge the technical claim.

3.2 Define the adopted source hierarchy

The practitioner should agree and record the source hierarchy for the project. A current publication is not automatically the vessel's governing requirement; contract date, build date, Class society, notation, approval basis, Flag instructions and owner/charterer adoption all matter.

1. Mandatory statutory/Flag requirements and any applicable IMO basis.
2. The vessel's Class rules, notation qualifiers, approval correspondence and project-applicable editions.
3. Contract, charterer, owner and project technical requirements.
4. Adopted industry guidance (for example IMCA, MTS, OCIMF and JDP01).
5. Current good-practice comparators, clearly labelled where not governing or retroactive.

Applicability rule

Never cite a reference merely because it is in the workbook. Confirm the exact title, revision/edition, clause, vessel type, contract/build applicability and adoption basis. Record the controlled source in DOCUMENT REGISTER and use the Reference ID shown in GAP ANALYSIS for traceability.

3.3 Current source context requiring explicit care

- IMO MSC.1/Circ.1580 is generally applicable to new DP vessels/units; the predecessor MSC/Circ.645 remains relevant to existing vessels. Establish the vessel's basis and DPVAD/Class documentation before applying either [S1].
- IMCA M166 Rev.3 (May 2024) is the current IMCA Code of Practice page verified for this manual and emphasises redundancy, configuration and validation through practical trials [S2].
- MTS TECHOP D-05 Rev.1 (January 2021) remains an important gap-analysis methodology and content source; the new workbook resolves its important content through modernised criteria rather than displaying the historical 737 rows [S3].
- JDP01 provides a unified approach to verification, validation and assurance of single-fault tolerance. Apply it according to the project-adopted issue and scope; it is guidance unless adopted by Class, Flag, contract, owner or the project assurance basis [S4].
- IACS UR E26 Rev.1 and E27 Rev.1 superseded the withdrawn originals and apply through member Class rules to defined new ships contracted for construction on or after 1 July 2024, with mandatory/non-mandatory applicability categories. Confirm vessel type and Class implementation [S5–S7].
- Class rules change. Use the vessel's project-applicable controlled issue and the current official ABS, DNV, LR or BV portal to identify amendments and present-day comparators [S8–S11].

4. Step 1 — complete VESSEL OVERVIEW

1

Set the vessel, FMEA and configuration basis

The automatic relevance filter is only as reliable as the vessel inputs. Unknowns must remain visible, not be guessed away.

4.1 Complete the selectors first

Selector	Allowed basis	Assurance use
Class society	ABS; DNV; Lloyd's Register; Bureau Veritas; Other/multiple; To confirm	Sets the Class-focused reference/relevance logic; record full notation separately.
DP equipment class	DP2; DP3; To confirm	Controls equipment-class-specific criteria, including physical separation/fire-flood expectations.
Bus operating mode	Open bus; Closed/common bus; Both/multiple; To confirm	Controls common/closed-bus criteria. Select the modes the FMEA is required to substantiate, not only the current daily preference.
Power distribution	AC; DC; Mixed AC/DC; To confirm	Controls DC-specific criteria and mixed-system interfaces.
ESS/hybrid installed	Yes; No; To confirm	Controls BESS/hybrid review points.
Fuel cell installed	Yes; No; To confirm	Controls fuel-cell review points.
IACS E26/E27 basis	Mandatory; Contractual; Voluntary; Not applicable; To confirm	Records the adopted cyber applicability basis; confirm against Class rules and contract date.
Fuel type	Conventional only; specific alternative fuel; multiple; To confirm	Controls future-fuel criteria. Select the actual/adopted fuel basis.

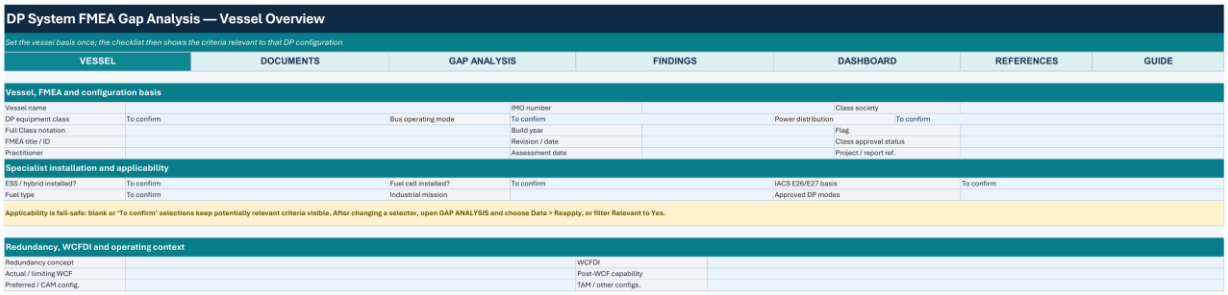


Figure 3 — VESSEL OVERVIEW: identity, configuration selectors, specialist applicability and WCFDI context.

4.2 Fail-safe applicability

Blank or To confirm selections intentionally retain potentially relevant criteria. This is conservative. Resolve uncertainty by obtaining the vessel evidence; do not choose No or Not applicable simply to reduce the review list.

- After changing a selector, open GAP ANALYSIS and choose Data > Reapply.
- Filter Relevant to Yes before assessment.
- When a vessel legitimately has multiple approved modes, select Both/multiple and record the configuration table. Assess any mode-specific divergence explicitly.
- If a required operational mode is not analysed or validated by the FMEA, that is not solved by excluding it from the selector; define the scope/limitation and raise the appropriate gap.

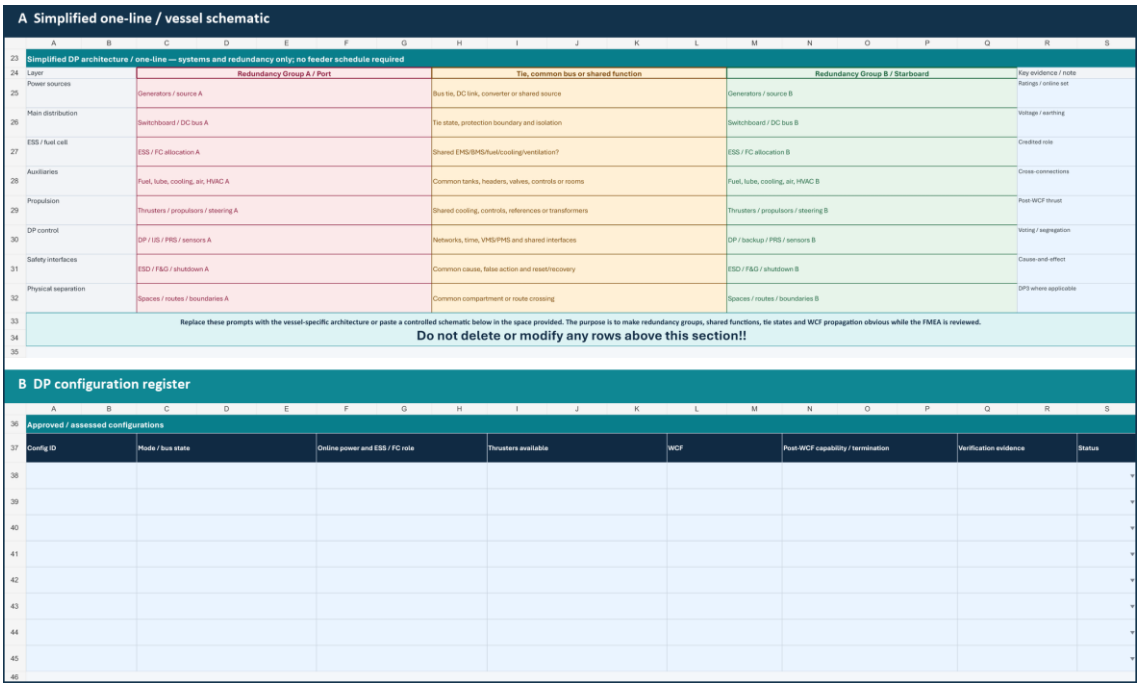
4.3 Record the redundancy and WCFDI context

Field	What to record
Redundancy concept	Redundancy groups, split philosophy, physical/logical independence, bus topology and intended fault-tolerance basis.
WCFDI	The declared worst-case single failure (DP2) or worst-case fire/flooding casualty (DP3) and the expected surviving capability.
Actual / limiting WCF	Any analysed or observed failure more limiting than, different from or conditional relative to the design intent.
Post-WCF capability	Surviving generators, distribution, thrusters, DP control, PRS/sensors and station-keeping capability; include operational limitations.
Preferred / CAM configuration	Normal configuration used for the critical activity and the basis for Critical Activity Mode.
TAM / other configurations	Task-appropriate or alternate modes, degraded configurations and any configurations not permitted.
Time to safely terminate	Activity-specific time to reach a safe state; do not invent where the operational analysis is absent.
Assessment scope	FMEA title/revision and boundaries, vessel configurations, modification/revalidation scope, operations and limitations.

4.4 Build the simplified one-line and configuration register

Use the one-line area as an orientation aid while reading the FMEA. Show the major generating/energy sources, bus sections or DC zones, ties/converters, thruster groups, DP control groups and key redundant auxiliaries. It is not a substitute for controlled drawings. Rows 1 to 22 of VESSEL OVERVIEW are protected except the blue selector and particulars cells; the one-line and configuration areas from row 23 down are editable and accept pasted pictures.

- Use consistent redundancy-group colours/names across power, thrusters, control and auxiliaries.
- Mark normally open/closed ties and the configurations that are approved and tested.
- Identify shared/common points and cross-connections; do not hide them in an undifferentiated box.
- Record configuration status as Approved and tested; Approved—evidence pending; Assessed only; Not permitted; or To confirm.



A Simplified one-line / vessel schematic

Simplified DP architecture / one-line — systems and redundancy only; no feeder schedule required

Layer	Redundancy Group A / Port	Tie, common bus or shared function	Redundancy Group B / Starboard	Key evidence / note
Power sources	Generators / source A	Bus tie, DC link, converter or shared source	Generators / source B	Ratings / online set
Main distribution	Switchboard / DC bus A	Tie state, protection boundary and isolation	Switchboard / DC bus B	Voltage / earthing
ESS / fuel cell	ESS / FC allocation A	Shared EMS/BMS/fuel/cooling/ventilation?	ESS / FC allocation B	Credited role
Auxiliaries	Fuel, lube, cooling, air, HVAC A	Common tanks, headers, valves, controls or rooms	Fuel, lube, cooling, air, HVAC B	Cross-connections
Propulsion	Thrusters / propulsors / steering A	Shared cooling, controls, references or transformers	Thrusters / propulsors / steering B	Post-WCF thrust
DP control	DP / I/S / PRS / sensors A	Networks, time, VMS/PMS and shared interfaces	DP / backup / PRS / sensors B	Voting / segregation
Safety interfaces	ESD / F&G / shutdown A	Common cause, false action and reset/recovery	ESD / F&G / shutdown B	Cause-and-effect
Physical separation	Spaces / routes / boundaries A	Common compartment or route crossing	Spaces / routes / boundaries B	DP3 where applicable

Replace these prompts with the vessel-specific architecture or paste a controlled schematic below in the space provided. The purpose is to make redundancy groups, shared functions, tie states and WCF propagation obvious while the FMEA is reviewed.

Do not delete or modify any rows above this section!!

B DP configuration register

Approved / assessed configurations

Config ID	Mode / bus state	Online power and ESS / FC role	Thrusters available	WCF	Post-WCF capability / termination	Verification evidence	Status

Figures 4–5 — (A) simplified one-line / vessel schematic and (B) configuration register.

5. Step 2 — populate DOCUMENT REGISTER

2

Establish the evidence inventory

The register records what was supplied and what was actually relied on. It is the audit trail for the assessment scope and limitations.

DP System FMEA Gap Analysis — Document Register

Record every FMEA, drawing, study, trial record and approval basis actually used in the review

VESSEL | DOCUMENTS | GAP ANALYSIS

A document is not evidence merely because it is listed. Record its exact identifier, revision/status and where it was used. Add rows in Excel if the project set is larger.

Ref ID	Document title / type	Document no. / drawing ID	Revision	Date	Status / approval	Issuer / author	Location / link	Used for / notes
DOC-01	DP System FMEA							
DOC-02	DP FMEA Proving Trials programme							
DOC-03	DP FMEA Proving Trials report							
DOC-04	Latest annual DP trials programme/report							

Figure 6 — DOCUMENT REGISTER: controlled identity, status, locator and use of supplied evidence.

5.1 Entry rules

- Create a short unique Ref ID and use it consistently in reviewer notes where useful.
- Record the exact document number/drawing ID, revision and date. A title alone is not a controlled identity.
- Select the actual status: Approved, As built, Issued for use, Final, Draft, Superseded, Not provided or To confirm.
- Record issuer/author and a stable location or link. Avoid links that depend on one reviewer's temporary folder if the file will be handed over.
- In Used for/notes, state the claim or system the document supports, and identify supersession/conflicts.

- Include documents reviewed but found inadequate or superseded; status is part of the evidence judgment.

5.2 Evidence status versus evidence sufficiency

Status answers whether the record is controlled and intended for use. Sufficiency answers whether it proves the technical criterion for the relevant configuration. These are separate questions.

Record	What it can show	What it cannot show by itself
Approved/as-built drawing	Controlled topology, routing, equipment identity or arrangement at its stated revision.	That installed configuration and settings match, or that the failure response was validated.
FMEA narrative	The author's analysis and declared consequence/barriers.	That every claim is factually correct or tested.
Proving-trials programme	Intended objective, initial conditions, method and acceptance criteria.	That the test was executed or passed.
Signed result / data record	Observed response under stated conditions.	That the condition represented every required configuration or common-cause case.
Action tracker marked closed	Administrative status and claimed completion.	That closure evidence meets the original criterion and has been independently accepted.

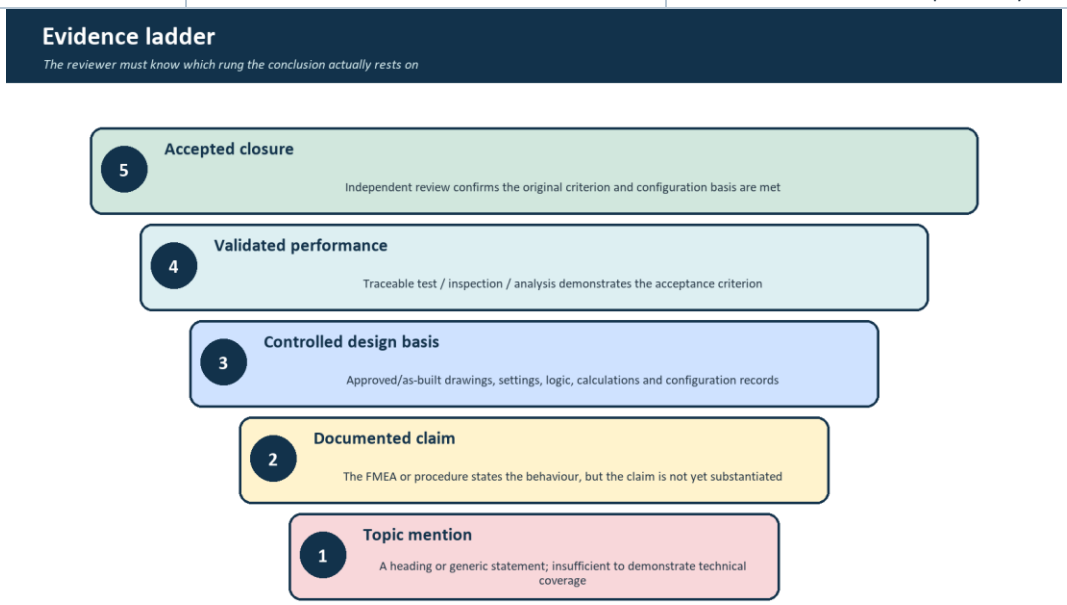


Figure 7 — Evidence ladder: calibrate the conclusion to the strongest substantiated rung.

6. Step 3 — confirm REFERENCE REGISTER and applicability

3

Confirm the adopted criteria and source basis

The workbook points to sources; the practitioner confirms the vessel's governing issue, clause and adoption basis.

DP System FMEA Gap Analysis — Reference Register

Applicable sources cited by the checklist; confirm the vessel's governing edition and project applicability before assessment.

VESSEL			DOCUMENTS				GAP ANALYSIS	
Reference IDs match GAP ANALYSIS. Use the revision, issue date and applicability note to select the applicable edition for the vessel; verify clauses against the controlled document.								
Reference ID	Issuer	Document title	Type	Revision / edition	Issue date	Last verified	Official source / locator	Project applicability / note
ABS-DC-2022	ABS	ABS Requirements for Direct Current (DC) Power Distribution Systems for Marine and Offshore Applications	Class Requirements	July 2022	2022-07	2026-07-23	https://ww2.eagle.org/content/dam/eagle/rules-and-	Confirm exact project applicability, controlled edition and clause before use.
ABS-DP-2024	ABS	ABS Guide for Dynamic Positioning Systems	Class Guide	February 2024	2024-02	2026-08-10	https://ww2.eagle.org/content/dam/eagle/rules-and-	Confirm exact project applicability, controlled edition and clause before use.
ABS-FUELCELL-2023	ABS	ABS Requirements for Fuel Cell Power Systems for Marine and Offshore Applications	Class Requirements	August 2023	2023-08	2026-07-23	https://ww2.eagle.org/content/dam/eagle/rules-and-	Confirm exact project applicability, controlled edition and clause before use.
ABS-HYBRID-2024	ABS	ABS Requirements for Hybrid Electric Power Systems for Marine and Offshore Applications	Class Requirements	April 2024	2024-04	2026-07-23	https://ww2.eagle.org/content/dam/eagle/rules-and-	Confirm exact project applicability, controlled edition and clause before use.

Figure 8 — REFERENCE REGISTER: source identity, edition, issuer link and project-applicability note.

6.1 Reference workflow

1. Read the Reference IDs in the GAP ANALYSIS row.
2. Find those IDs in REFERENCE REGISTER and confirm title, issuer, revision/edition, issue date and issuer link.
3. Locate the controlled project copy in DOCUMENT REGISTER, or record that it was not provided.
4. Verify the exact clause and its applicability to the vessel's build/contract, Class notation, vessel type and adopted assurance basis.
5. Where a newer reference is used only as good-practice comparison, say so; do not present it as retroactive compliance.
6. If references conflict, record the hierarchy/decision and seek Class/Flag/client clarification where authority is required.

Citation quality

Use a specific locator whenever the controlled source supports it: document ID/revision, section/clause/table/figure/page and, for evidence, test/result/drawing identity. Avoid generic phrases such as 'per Class' or 'industry standard'.

6.2 Source types in the tool

The source set combines core DP requirements and guidance (IMO, IMCA, MTS, OCIMF and JDP01); project-applicable ABS, DNV, Lloyd's Register or Bureau Veritas rules/notations and approval correspondence; specialist battery/hybrid, alternative-fuel, fuel-cell, DC, closed-bus and cyber requirements; and operational evidence including ASOG/CAM/TAM, capability, industrial mission, restrictions, maintenance and revalidation records.

7. Step 4 — filter and execute GAP ANALYSIS

4

Review the FMEA beside the checklist

One row is one justified practitioner decision. Preserve the exact chain from applicability and evidence to result and finding.

7.1 Reapply and filter

1. After completing or changing VESSEL OVERVIEW, open GAP ANALYSIS.
2. Choose Data > Reapply so the relevance formula and any active filter reflect the selectors.
3. Use the Relevant slicer to select Yes. The five GAP ANALYSIS slicers are Relevant, Workstream, Weighting, Assessment result and Finding classification.
4. Use the slicers or the table's System/topic filter to create manageable review blocks. Ctrl-click for multiple slicer selections; use each slicer's clear-filter control to reset only that focus.
5. Clear only the focus filters when moving to the next block; retain Relevant = Yes unless deliberately auditing excluded items. Dashboard metrics remain the overall applicable assessment and are not recalculated to the temporary slicer view.
6. Blank or To confirm retains potentially relevant specialist checks. Confirmed selections narrow the review without deleting criteria. Open ties do not remove within-group parallel-generation/protection checks. Include shared DC links and cross-group hybrid paths even where main distribution is AC. Justify every exclusion against the actual scope.

Do not delete or hide the technical record

Filtering is a presentation aid. GAP ANALYSIS is protected without a password: only the blue input columns (I to L) accept entries, rows and columns cannot be inserted or deleted, and sorting is disabled; filters, slicers and Data > Reapply work. Do not delete rows, replace Criterion IDs, overwrite weights/references or paste values over calculated fields. If a criterion appears incorrectly relevant or irrelevant, document the issue and correct the vessel/applicability basis rather than editing the formula output.

7.2 Read the row from left to right

Column group	Use
Relevant / Criterion ID	Calculated relevance and stable technical identifier. The ID is the finding/export trace key.
Workstream / System / Review point	The review context and concise question to answer.
Weighting / Weight	Materiality assigned by the tool. Use it for prioritisation; do not change it to influence the score.
What good looks like / evidence to check	The acceptance/evidence prompt. Apply it to the exact vessel configuration and source basis.
Assessment result	Practitioner choice: Sufficiently covered; Partially covered; Not covered; Unable to verify; Not applicable; Not assessed.
FMEA reference	Exact locator in the reviewed FMEA: section, page, table, figure, failure-mode row and/or test reference.
Evidence / reviewer note	Objective evidence, cross-checks, assumptions/inferences and concise reasoning.
Gap / concern summary	Specific deficiency or residual concern. Text here intentionally creates a finding even if the result is Sufficiently covered.
Finding classification	Calculated from weighting, outcome and whether a concern is recorded; None for any criterion that is not relevant.
Applies when / Reference IDs	Configuration/applicability rule and source trace. Verify against VESSEL OVERVIEW and REFERENCE REGISTER.

Figure 9 - GAP ANALYSIS worksheet view: five slicers, identity, weighting and evidence prompts.

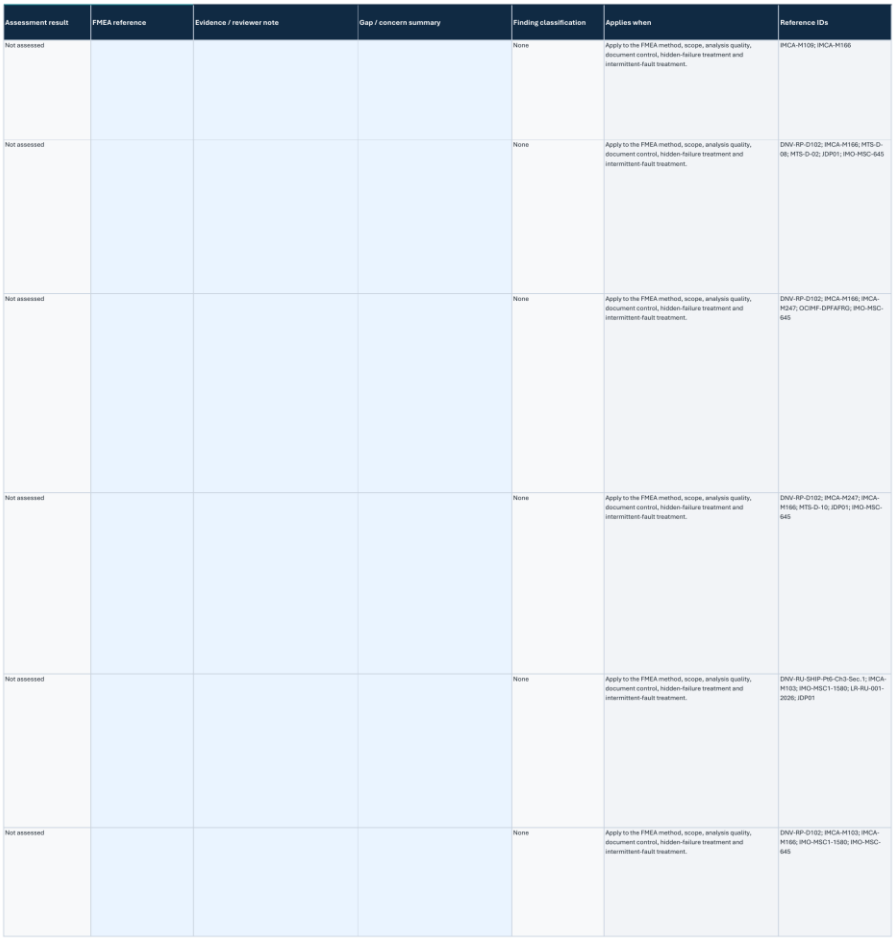


Figure 10 — GAP ANALYSIS right side: locator, evidence note, gap summary, classification, applicability and references.

7.3 Per-criterion technical challenge

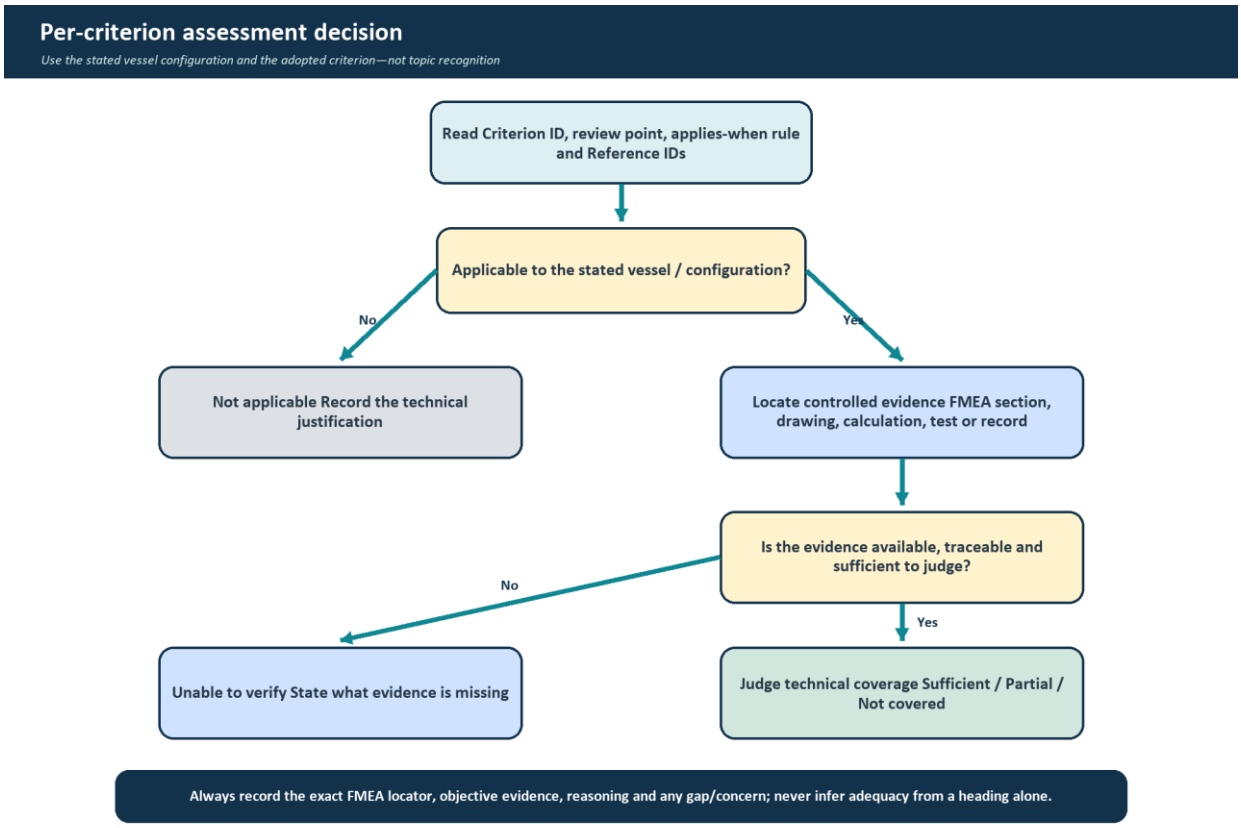


Figure 11 — Decision flow for applicability, evidence sufficiency and technical coverage.

1. **Understand the question.** Read the criterion, evidence prompt, applies-when rule and cited sources before searching the FMEA.
2. **Confirm applicability.** Use the stated vessel configuration and adopted source basis. For Not applicable, write a technical justification.
3. **Locate the claim.** Record the exact FMEA locator; do not award credit for a chapter title or generic statement.
4. **Cross-check the claim.** Use controlled drawings, settings, logic, calculations, vendor evidence, inspections, trials and operational records as appropriate.
5. **Trace failure propagation.** Follow dependencies and shared/common points through the surviving configuration to station keeping.
6. **Judge analysis quality.** Decide whether the FMEA identifies the failure, propagation, detection, protection, compensating provision, recovery and validation at sufficient depth.
7. **Record the result and reasoning.** Use the exact outcome definitions below and state evidence gaps or technical gaps plainly.
8. **Check the calculated finding.** Ensure the resulting classification is proportionate and that the gap summary supports it.

7.4 Failure-propagation chain

Use this sentence logic

Initiating failure → dependency/cross-connection/common cause → protection and isolation response → surviving power/thrust/control/reference capability → DP/station-keeping effect → WCFDI/WCF comparison → detection/compensating provision → recovery → verification/validation evidence.

- Identify active, passive, hidden, intermittent, software/configuration, common-mode and common-cause failures where relevant.
- Do not stop at local effect. State the system effect and DP consequence.
- Test the claimed boundary: cables, pipes, ventilation, cooling, fuel, controls, networks, UPS/DC, time source, F&G/ESD and human action can bridge redundancy groups.
- For DP3, challenge fire/flood compartment assumptions, penetrations, co-routes, shared services and post-casualty control/indication.
- For closed/common bus, DC grids, BESS/hybrid and fuel cells, challenge protection selectivity, fault ride-through, energy control, isolation, stability and recovery as an integrated system.

8. Assessment outcomes, colours and evidence thresholds

Outcome	Factor	Colour	Use when
Sufficiently covered	1.0	Green	The applicable requirement is analysed at adequate depth, is internally consistent and is substantiated by appropriate controlled evidence/validation.
Partially covered	0.5	Yellow	Material elements are present, but scope, depth, configuration coverage, traceability, analysis or validation is incomplete.
Not covered	0.0	Red	The applicable element is absent, materially incorrect, contradicted by evidence or fails the adopted criterion.
Unable to verify	0.0	Blue	The technical state cannot be judged because required evidence is missing, inaccessible, conflicting or not controlled.
Not applicable	Excluded	Grey	The criterion does not apply to the stated vessel/configuration/source basis, with a recorded technical justification.
Not assessed	Excluded	Light grey/white	The criterion has not yet been assessed; it is not a neutral or acceptable result.

UTV is not the same as Not covered

Example: the FMEA claims DP3 cable-route separation but no controlled routing evidence is available. Use Unable to verify and state the missing drawings/inspection. Use Not covered only when adequate evidence shows the adopted criterion is absent or not met.

8.1 Writing the evidence record

Field	Recommended format
FMEA reference	§6.4.3, pp.142–145; Table 6-12; Fig.6-18; failure row FM-PWR-07; PT-4.12.
Evidence / reviewer note	Objective evidence: [drawing/test/status]. The FMEA states [claim]. Cross-check shows [fact]. Inference/assumption: [clearly labelled]. Conclusion: [why outcome follows].
Gap / concern summary	The FMEA [missing/incorrect/unverified element] for [system/configuration]. Consequently [technical uncertainty or vulnerability] remains against [criterion/source basis].

8.2 Common evidence mistakes

- Giving credit because a system appears in the contents list.
- Treating a generic component FMEA as proof of vessel-level integration and common-cause analysis.
- Citing an unexecuted trials procedure as validation.
- Using current drawings with an older FMEA without reconciling revisions and modifications.
- Accepting a simulated result without recording the model, assumptions, configuration, acceptance criteria and independent validation basis.
- Treating an alarm as adequate detection without confirming source, independence, annunciation, operator response and timing.
- Treating a manual recovery action as a compensating provision without time, access, conditions, competence and safe-execution evidence.

9. Weighting, finding classification and score

9.1 Weighting philosophy

Weighting	Weight	Meaning
Critical	1.00	Potential to exceed WCFDI, invalidate the redundancy concept, defeat single-fault tolerance or materially challenge Class integrity.
Major	0.75	Potential to equal WCFDI, cause the defined worst-case loss or materially weaken fault tolerance/recovery.
Minor	0.50	Technical completeness, verification or linkage weakness not alone expected to equal WCFDI, but capable of reducing assurance or combining with other weaknesses.
Documentation	0.10	Document control, presentation, cross-reference or administrative completeness with no direct technical consequence where the underlying basis is sound.

Do not reweight to improve the result

Weighting belongs to the criterion design and provides consistent prioritisation. If vessel-specific evidence shows a different consequence, describe it in the gap and DP/WCFDI consequence; escalate through technical review rather than altering the weight ad hoc.

9.2 Automatic finding classification

Weighting	Not covered / UTV	Partially covered	Sufficient + concern	Sufficient; no concern
Critical	Major Finding	Major Finding	Minor Finding	None
Major	Major Finding	Minor Finding	Observation	None
Minor	Minor Finding	Observation	Opportunity	None
Documentation	Observation	Opportunity	Opportunity	None

Not assessed, Not applicable and blank outcomes calculate to None, and so does every row with Relevant = No. A Sufficiently covered row with text in Gap / concern summary creates a finding, allowing residual concerns to remain visible without changing the technical coverage result.

9.3 Weighted coverage score

Formula

Weighted coverage score = Σ(weight × assessment factor) ÷ Σ(weight), for Relevant = Yes rows assessed as Sufficiently covered, Partially covered, Not covered or Unable to verify. Not applicable, Not assessed and blank rows are excluded. Unable to verify has factor 0.

- The score is a coverage/prioritisation indicator—not a Class, Flag, contractual or safety pass/fail decision.
- Completion includes every defined reviewed outcome, including justified Not applicable. Technical coverage includes only Sufficiently covered, Partially covered, Not covered and Unable to verify; Not applicable, Not assessed, blank and invalid values are excluded. No applicable scored items gives a displayed zero, not a technical pass.
- A high score can coexist with a single Major Finding that threatens the redundancy concept or WCFDI.
- Sufficiently covered with a recorded concern retains factor 1.0, so findings must always be read alongside the score.
- A large UTV population can depress the score and, more importantly, indicates an assurance limitation requiring evidence or explicit issue disclosure.

10. Technical challenge by workstream

The embedded criteria are the authoritative checklist. The prompts below are an aide-mémoire for reviewing the analysis as a coherent system; they do not replace the row-level questions.

10.1 DP FMEA — methodology, scope and documentation

- Controlled identity, revision history, author/reviewer/approver and change scope.
- Explicit systems boundary, exclusions and failure types; vessel-level integration of vendor/subsystem FMEAs.
- Declared methodology and analysis granularity suitable for the vessel's redundancy concept and industrial mission.
- Full configuration set, redundancy groups, WCFDI, actual WCF, post-failure capability and stated limitations.
- Common points, cross-connections, hidden failures, fail-safe states, dependencies, detection, compensating provisions and recovery.
- Traceable failure-mode tables with local/system/DP effects, validation references and conclusions consistent with the detailed analysis.
- Action register, trials linkage, modifications/revalidation and closure of prior findings without loss of audit trail.

10.2 DP System Design

Domain	Challenge prompts
Vessel / redundancy particulars	Class notation; redundancy groups; WCFDI/WCF; approved modes; post-failure capability; physical/logical boundaries; industrial mission interfaces.
Power generation / energy	Prime movers, generators, excitation/governors, ESS/fuel cells, fuel/air/cooling/lube/start services, controls/protection, load acceptance and common dependencies.
Distribution / protection	AC/DC topology, ties/converters, grounding, fault levels, selectivity, protection settings/coordination, arc/earth faults, fault ride-through, blackout and recovery.

Domain	Challenge prompts
Thrusters / drives	Mechanical/electrical/control failures, drive/DC-link effects, cooling/lube/seals, pitch/azimuth, runaway or unintended thrust, feedback, local/remote control and emergency stop.
DP control / networks	Controllers, IJS, operator stations, PMS/VMS interfaces, networks/switches, software/firmware baselines, failure detection, time synchronisation, segregation and safe state.
PRS / environmental sensors	Independence, diversity, common infrastructure, correction/data links, power/network dependencies, plausibility checks, weighting/rejection and misleading data.
Auxiliaries	Cooling, ventilation, seawater/freshwater, hydraulics, compressed air, fuel, lubrication, valve power/control, cross-connections, reserve capacity and restoration.
Safety / segregation	Fire/flood zones, cable and pipe routing, penetrations, co-routes, F&G/ESD actions, hazardous areas, ventilation shutdown, remote stops and post-casualty control/indication.

10.3 DP Operations

- Industrial mission and consequence of loss of position; capability, time to terminate and proximity/exposure assumptions.
- ASOG/CAM/TAM/WSOG consistency with FMEA-approved configurations, WCFDI and post-failure capability.
- Configuration control, inhibited/defeated alarms or protections, maintenance states and degraded modes.
- Operator detection, immediate response, recovery sequence, communications, manning/competence and decision authority.
- Planned maintenance, periodic proving, annual trials, modification/revalidation triggers and incident learning.

10.4 Specialist workstreams

Workstream	System-level assurance questions
BESS / Hybrid	Role in redundancy/WCFDI; SOC/energy margin; BMS/EMS/PMS interactions; protection/isolation; thermal runaway, ventilation and F&G; black start/ride-through; auxiliaries; converters; safe degradation; test and Class evidence.
Future Fuels	Fuel-specific hazards; containment, preparation and supply; ventilation/detection; purge/inerting; ESD; hazardous areas; common auxiliaries; loss/changeover effect on DP; safe state; operating restrictions; fire/explosion validation.
Common / Closed Bus	Fault containment; selective protection; bus-tie/control dependencies; short-circuit/earth-fault response; transient stability and fault ride-through; blackout prevention/recovery; simulations, hardware/software tests, inspections and configuration control; JDP01 assurance logic.
DC Power	DC zones/sections; converters and energy sources; fault-current characterisation; high-speed protection/selectivity; grounding/insulation monitoring; DC-link/arc faults; isolation/reconfiguration; stability/FRT; stored energy; black start/recovery; model and test validation.
Cyber E26 / E27	Applicability and Class implementation; asset/system inventory; zones/conduits; access and network segregation; secure configuration; patch/update and supplier lifecycle; backup/restore; logging/time sync; incident response; DP safe state; E26 ship integration and E27 equipment evidence.
Fuel Cell	Fuel and balance-of-plant dependencies; ventilation/detection/purge; shutdown and safe state; water/thermal control; converters/DC bus; load response/start/stop; shared auxiliaries; fire/explosion; isolation, recovery and integrated validation.

Specialist limit

Where specialist competence is required—for example DC fault studies, battery thermal propagation, alternative-fuel hazardous-area design, protection coordination or cyber product compliance—record the need for competent specialist verification. Do not convert unfamiliarity into an unsupported conclusion.

11. Step 5 — FINDINGS REGISTER and closure pathway

5

Move from assessment to accountable close-out

The Gap Analysis defines the deficiency; the Findings Register carries consequence, action, ownership, status, evidence and independent acceptance.

11.1 How findings appear

The Findings Register is linked by immutable Criterion ID. Filter Track? to Yes. Its stored Finding ID and Criterion ID must not be edited. Assessment data are looked up by Criterion ID; editable action and closure fields stay with those keys. The sheet is protected: only columns L to S accept entries and sorting is disabled. Cell A5 shows the live count of tracked findings; choose Data > Reapply to show new findings. Prior action records remain traceable when assessment or applicability changes.

Columns	Control
A–K	Stored identity and linked assessment: Finding ID and Criterion ID are immutable keys; Track?, workstream/topic, classification, weighting, result, locator, evidence note and gap are calculated. A to K are locked.
L–S	Practitioner closure workflow: DP/WCFDI consequence, recommendation/pathway, owner, target date, status, closure evidence/acceptance, closure reviewer and closure review date.

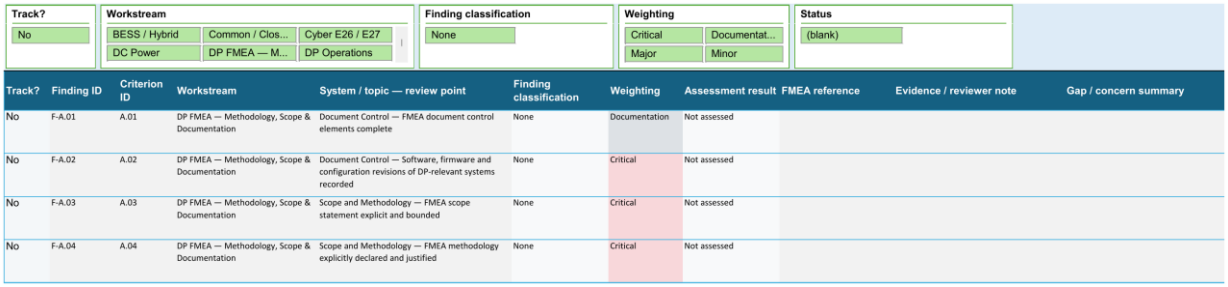


Figure 12 - FINDINGS REGISTER worksheet view: five slicers, stored identity and linked assessment fields.

Figure 13 — FINDINGS REGISTER right side: consequence, action, owner, status and independent closure evidence.

11.2 Write a defensible finding

Element	Required content
Objective evidence	Exact FMEA locator and the controlled evidence reviewed, including revision/status and relevant configuration.
Criterion	Criterion ID and adopted source basis, with exact clause where verified and needed.

Element	Required content
Gap	What is absent, incorrect, internally inconsistent, unverified or inadequately analysed.
Propagation / consequence	How the weakness could affect redundancy, station keeping, WCFDI/WCF, detection, recovery or operational decision-making.
Recommendation	A measurable action that removes the uncertainty or vulnerability and identifies the acceptance evidence.
Control	Owner, target date, status and dependencies, including MOC/Class/Flag/client interfaces where applicable.

11.3 Closure stages

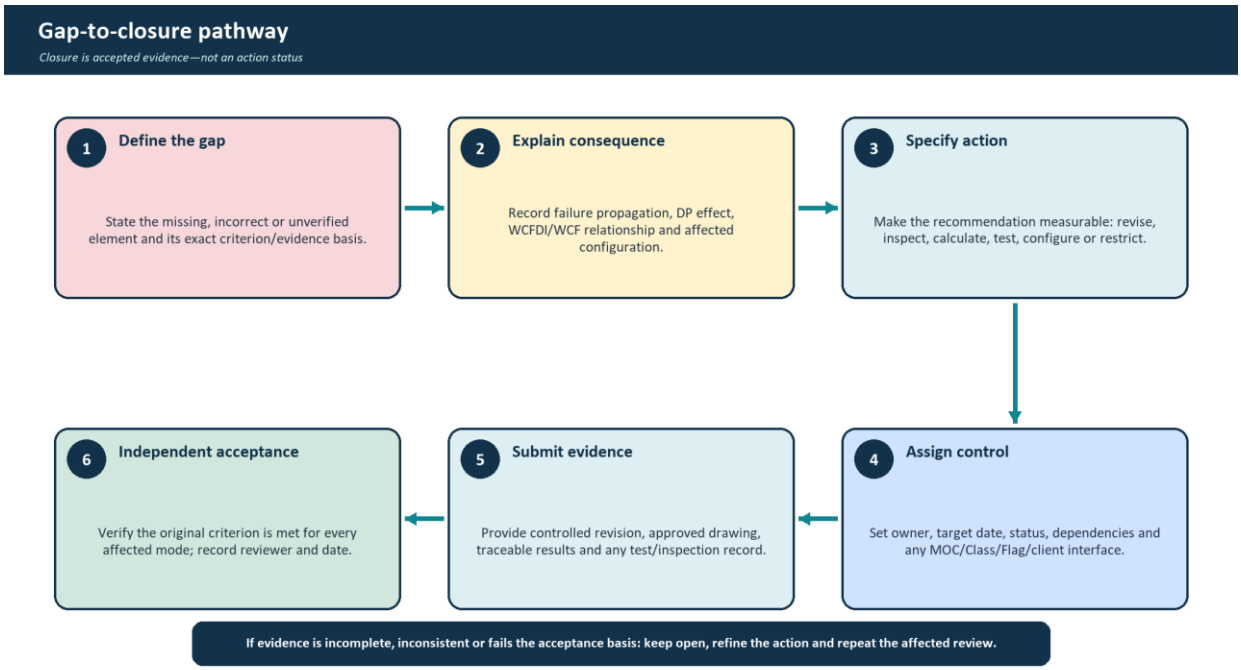


Figure 14 — Gap-to-closure pathway: accepted evidence is the final gate.

Status	Use
Open	Finding accepted for action; no adequate closure evidence yet.
In progress	Corrective work is under way; closure basis not yet complete.
Awaiting evidence	Action is claimed complete or materially progressed, but the controlled evidence required for review has not been supplied.
Ready for review	The owner has submitted the identified closure evidence for independent assessment.
Closed	Independent review confirms the original criterion for every affected configuration. Record closure evidence, reviewer and a valid, non-future Excel date. Closed enters the dashboard closed count only when those fields are complete; the workbook checks field completeness, not the truth or authority of acceptance.
Not required	Record the justified no-action disposition and its acceptance. Not required does not earn closed-finding credit. While the relevant criterion still generates a finding, it remains outstanding; an accepted no-action note alone does not remove that count.

Status	Use
Close only against the original basis	Re-read the original Criterion ID, assessment, evidence note, gap and DP/WCFDI consequence. Confirm the new evidence removes the stated deficiency for every affected mode. If the design or operating basis changed, verify MOC, FMEA revision, proving/revalidation, Class/Flag/client interface and operational document alignment as applicable.

11.4 Hypothetical worked example — cable-route separation

Scenario

A DP3 FMEA states that redundant DP control power cables are routed separately, but it gives only a generic narrative and no controlled routing drawing, fire/flood-zone mapping or inspection evidence. This example is illustrative and does not assert facts about any vessel.

Field	Illustrative entry
Assessment result	Unable to verify — the claimed separation cannot be judged from the supplied evidence.
FMEA reference	FMEA §8.3, p.211, paragraph ‘Cable segregation’.
Evidence / reviewer note	Objective evidence: narrative claim only; cable schedule/route drawing not provided. The compartment/fire-boundary basis and penetrations are not traceable. Conclusion: separation of the two DP redundancy groups cannot be verified.
Gap / concern	The FMEA does not substantiate physical separation of the redundant control-power cable routes against the DP3 fire/flood casualty basis.
DP / WCFDI consequence	A common route, penetration or casualty space could affect both redundancy groups and potentially exceed the declared fire/flood WCFDI; actual exposure remains unknown pending evidence.
Pathway to closure	Provide approved/as-built cable route schedule and compartment/fire-boundary drawings; reconcile penetrations and shared spaces; perform targeted onboard inspection; revise the FMEA propagation analysis; test or revalidate affected functions where the confirmed arrangement or modification requires it.
Acceptance	Independent reviewer verifies controlled evidence, as-built condition, revised FMEA and any required test/MOC/Class disposition; then records closure reviewer/date.

12. Step 6 — interpret the DASHBOARD

6

Use metrics as a decision aid

Read scope, progress, coverage, material findings, limitations and closure together. The dashboard summarises; it does not decide.

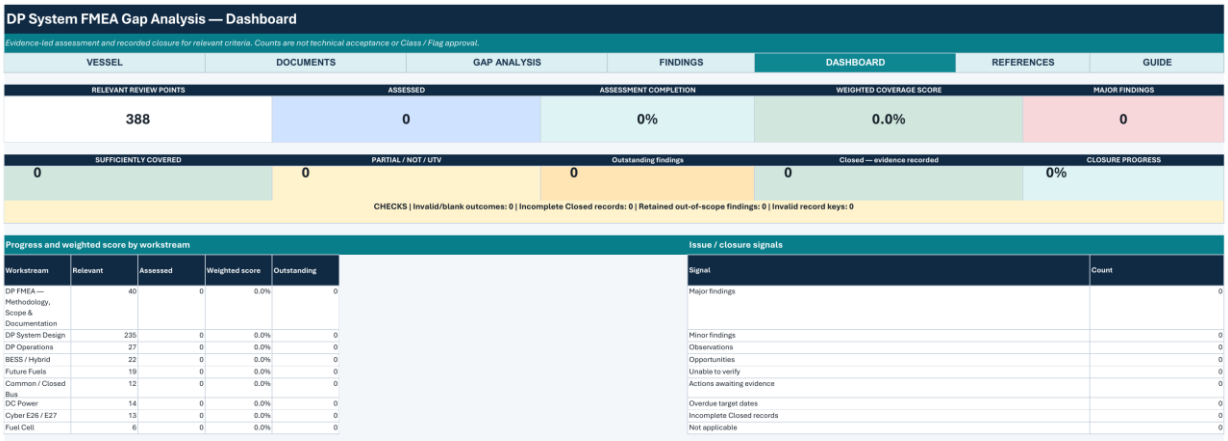


Figure 15 — DASHBOARD top: scope, progress, coverage, findings and workstream/closure signals.

12.1 Read metrics in this order

Figure 16 — Dashboard reading order and three non-negotiable interpretation rules.

Metric / signal	Correct interpretation	Challenge question
Relevant review points	The scope generated by vessel selectors and applicability rules.	Do the selectors and assessment scope represent every required configuration?
Assessed / completion	Defined reviewed outcomes, including justified Not applicable, count as assessed. Blanks and invalid results do not.	Are all relevant rows genuinely judged, and are NA decisions justified?
Weighted coverage	Risk-weighted technical coverage among scored outcomes.	Which material gaps, UTV items or concerns sit behind the aggregate?
Major findings	Highest-priority deficiencies generated by the weighting/result logic.	Does any one finding challenge WCFDI, redundancy, safe recovery or issue readiness?
Result mix / chart	Distribution of sufficient, partial, not covered, UTV, NA and not assessed outcomes.	Is the population dominated by unassessed or UTV rows?
Workstream score	Coverage and open findings by technical area.	Are specialist or core domains incomplete or disproportionately weak?

Metric / signal	Correct interpretation	Challenge question
Closure signals	Relevant-scope open/closed and closure-quality indicators; retained out-of-scope history is separate.	Are findings actually accepted, or merely administratively advanced?

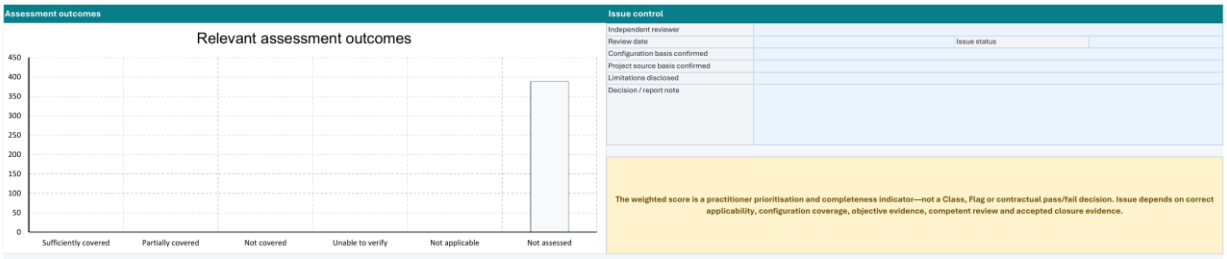


Figure 17 — DASHBOARD lower area: assessment-outcome chart and issue-control gate.

12.2 Issue-control fields

- Independent reviewer and review date: identify the competent person who challenged the assessment, not merely the file editor.
- Issue status: Draft; Ready for independent review; Issued internally; or Not issued.
- Configuration basis confirmed: Yes only when the selected configuration/WCFDI scope is supported by controlled evidence.
- Project source basis confirmed: Yes only when the governing editions/applicability are recorded and verified.
- Limitations disclosed: Yes only when UTV, unavailable documents, exclusions, assumptions and unresolved authority decisions are visible in the issued report.
- Decision/report note: concise overall opinion, material exceptions, use limitations and required next action; never state Class/Flag approval unless issued by that authority.

Release interpretation

Do not issue an unconditional positive conclusion solely because completion is 100% or the score is high. Release depends on material findings, UTV/limitations, correct applicability, evidence quality, competent review and accepted closure.

13. Review strategy: comprehensive without becoming cumbersome

13.1 Use filters as a work queue

Pass	Suggested filters	Purpose
1 — Basis	Relevant = Yes; Workstream = DP FMEA Methodology	Confirm scope, references, WCFDI, configuration and document/trials linkage before detailed system credit.
2 — High consequence	Relevant = Yes; Weighting = Critical, then Major	Identify potential redundancy/WCFDI blockers early.
3 — System blocks	Workstream/System topic	Review coherent evidence packs: power, distribution, thrusters, control, PRS/sensors, auxiliaries, segregation.
4 — Specialist	BESS/Hybrid; Future Fuels; Closed Bus; DC; Cyber; Fuel Cell	Use only applicable specialist workstreams and obtain competent support where needed.
5 — Exceptions	Result = Partial, Not covered or UTV; and Finding classification	Complete evidence, gap wording and findings consistency.

Pass	Suggested filters	Purpose
6 — Closure	FINDINGS: Track? = Yes; status/owner/date filters	Manage actions and independently accept closure.
7 — Issue	Dashboard signals + residual Not assessed/NA/UTV	Reconcile totals, limitations and issue readiness.

13.2 Sampling is not silent exclusion

A comprehensive gap analysis requires a decision for every relevant criterion. Efficient review comes from reusing controlled evidence across related criteria and reviewing systems in blocks—not from leaving rows unassessed or bulk-awarding credit. Where one evidence item supports several criteria, each row should still state the relevant locator and why it is sufficient.

13.3 Pause points

- Pause when the vessel configuration, WCFDI or applicable rule edition is unclear; resolve the basis before continuing the affected domain.
- Pause when evidence conflicts across the FMEA, drawings, trials or operating procedures; record the conflict and obtain disposition.
- Pause before concluding on specialist engineering outside the reviewer's competence; obtain qualified technical review.
- Pause before changing status to Closed; inspect the actual closure evidence against the original criterion.

14. Quality assurance and independent issue gate

14.1 Practitioner self-check

Gate	Release question
1 — Identity and scope	Are vessel/FMEA identity, class/notation, configuration, industrial mission, WCFDI/WCF and assessment scope complete and internally consistent?
2 — Evidence register	Are all supplied/used records registered with controlled identity, status, revision and locator? Are missing documents visible?
3 — Applicability	Are selectors correct, Data > Reapply performed, Relevant = Yes filtered, and every NA decision technically justified?
4 — Sources	Are governing editions/clauses verified against controlled project sources, with non-governing current comparators labelled?
5 — Assessment completeness	Is every relevant criterion assessed with exact FMEA locator and sufficient objective evidence/reasoning?
6 — Technical integrity	Do material rows follow the full propagation chain and reconcile with WCFDI, configuration and validation evidence?
7 — Findings	Does every finding contain evidence, criterion, gap, consequence and measurable closure route? Are classification and wording consistent?
8 — Closure	Are Closed findings supported by controlled evidence, independent acceptance, reviewer/date and any necessary MOC/FMEA/trials/Class alignment?
9 — Dashboard	Do scope, completion, score, findings, UTV, workstream and closure counts reconcile with filtered tables?
10 — Issue	Are limitations disclosed, decision wording calibrated to authority, independent review recorded and export filters checked?

14.2 Independent-review challenge

- Select a risk-based sample across all workstreams, including every Major Finding and material UTV item.
- Reperform the applicability decision and evidence trace for sampled criteria.
- Challenge Sufficiently covered rows that carry concerns and all Critical-weighted rows assessed without strong evidence.
- Reconcile the actual configuration table/one-line with the FMEA narrative, trials and operational documents.
- Check that one common deficiency is not inconsistently classified across multiple criteria, and that separate deficiencies have not been merged into an uncloseable action.
- Verify closure evidence independently; do not accept the owner's status as the assurance conclusion.

14.3 Common errors and corrective action

Error	Corrective action
Wrong rows visible after selector change	Choose Data > Reapply; re-filter Relevant = Yes; confirm selectors and avoid manual edits to relevance.
All criteria left visible	Complete selectors. To confirm is intentionally conservative; resolve actual vessel data before excluding workstreams.
FMEA locator absent	Add section/page/table/row/test identity. A reviewer note without a locator is not reproducible.
Evidence note repeats the FMEA	Add the independent cross-check, evidence status, assumptions and why the result follows.
UTV used as a convenient gap	State the exact missing evidence and obtain it. Convert to Partial/Not covered only when evidence supports that conclusion.
NA used to improve completion/score	Reperform vessel/configuration applicability and record a technical justification.
Gap closed by revised wording alone	Confirm whether design, configuration, tests, operating documents and Class/MOC disposition are also required.
High score described as approval	Report score as an indicator; disclose Major Findings, UTV, limitations and authority boundaries.

15. Reporting and export

Use the DASHBOARD Report and Export Centre after the assessment and issue checks are complete. The workbook contains Office-native instructions and configured print areas/repeating headings.

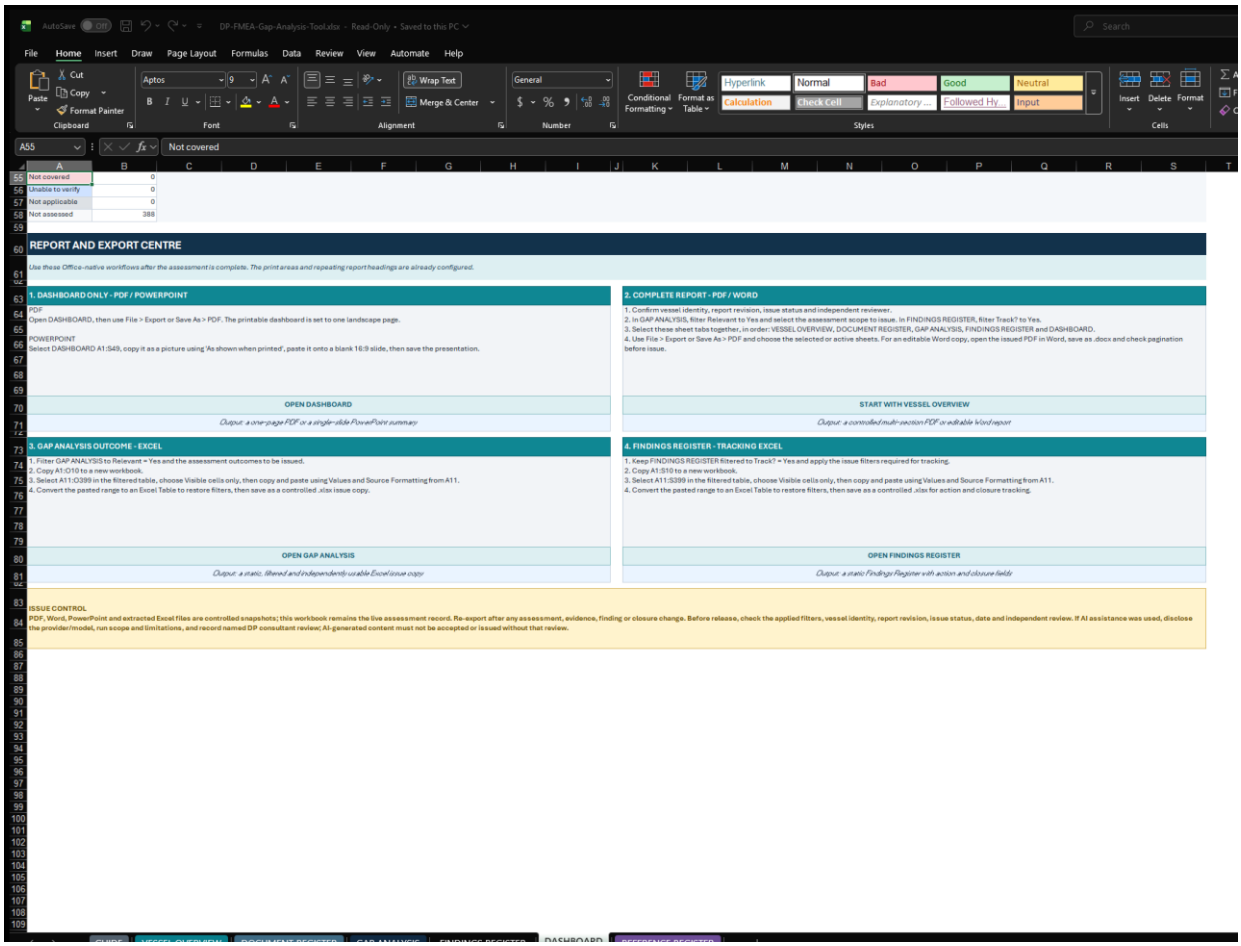


Figure 18 — REPORT AND EXPORT CENTRE: four controlled output workflows.

Output	Workflow	Issue control
Dashboard only — PDF / PowerPoint	PDF: open DASHBOARD and use File > Export or Save As > PDF. PowerPoint: select DASHBOARD A1:S49, copy as picture 'As shown when printed', paste to a blank 16:9 slide, save.	One-page/one-slide summary; it must be accompanied by appropriate limitations and report reference where issued externally.
Complete report — PDF / Word	Confirm issue controls; filter GAP ANALYSIS Relevant = Yes and issued outcomes; filter FINDINGS Track? = Yes; select VESSEL OVERVIEW, DOCUMENT REGISTER, GAP ANALYSIS, FINDINGS REGISTER and DASHBOARD in that order; export selected/active sheets. For editable Word, open issued PDF in Word and check pagination.	Check vessel identity, revision, filters, independent reviewer, limitations and final pagination.
Gap Analysis outcome — Excel	Filter issued GAP ANALYSIS rows; copy A1:O10 to a new workbook; select filtered A11:O399, Visible cells only, and paste Values and Source Formatting from A11; convert the pasted range to a Table and save as controlled .xlsx.	Static snapshot: include file/report reference, filter basis, revision/date and preserve Criterion IDs.
Findings Register — tracking Excel	Keep FINDINGS Track? = Yes and apply the required issue filters; copy A1:S10; select filtered A11:S399, Visible cells only, and paste Values and Source Formatting from A11; convert the pasted range to a Table and save as controlled .xlsx.	Static tracker: retain Finding ID/Criterion ID, action/closure fields and issue identity; reconcile changes back to the live record.

Controlled snapshot rule

The live workbook remains the assessment record. Re-export after any change to vessel basis, evidence, assessment, finding or closure. Before release, check applied filters, vessel/report identity, issue status, date and independent review.

Appendix A — Field aide-mémoire

A.1 Before opening the FMEA

- Controlled working copy and report identity confirmed.
- Vessel, Class/notation, DP2/DP3, bus mode, AC/DC, specialist systems and industrial mission confirmed or set To confirm.
- Redundancy groups, WCFDI/WCF, post-failure capability and configuration table recorded.
- Document and source registers populated; missing evidence visible.
- Data > Reapply; Relevant = Yes.

A.2 For every criterion

Ask	Record
Does it apply to this vessel and mode?	Applicability basis; if NA, technical justification.
Where is it analysed?	Exact FMEA section/page/table/row/test.
What proves the claim?	Controlled evidence identity/status/revision and cross-check.
What is the propagation?	Failure → dependencies → surviving system → DP effect → WCFDI/WCF.
Is the evidence enough to judge?	If no: UTV and exact missing evidence.
How complete is the analysis?	Sufficient / Partial / Not covered with concise reasoning.
Is there a residual concern?	Gap/concern text; verify calculated finding.

A.3 Before issue

- No relevant row left Not assessed; every NA justified; every UTV disclosed and actioned or accepted as a limitation.
- Every Major Finding and WCFDI/redundancy concern independently reviewed.
- Findings have consequence, measurable action, owner, date and status.
- Closed means accepted evidence, reviewer and date—not ‘owner says complete’.
- Dashboard scope/progress/score/findings/closure reconcile with filtered records.
- Issue controls complete; output type, filters, date, revision and limitations checked.

Appendix B — Recommended wording patterns

Purpose	Pattern
Evidence note	Objective evidence: [controlled document/test and locator]. The FMEA states [claim]. Cross-check [supports/contradicts/cannot verify] because [fact]. Assumption/inference: [label]. Result: [outcome] because [reason].

Purpose	Pattern
Gap statement	The FMEA does not [identify/analyse/substantiate/reconcile] [specific element] for [system/configuration]. Therefore [uncertainty/vulnerability] remains against [criterion/adopted basis].
DP consequence	If [initiating/common cause] occurs, [propagation] may remove/degrade [surviving functions], resulting in [DP effect]. This [equals/exceeds/cannot be compared with] the declared WCFDI because [reason].
Recommendation	[Revise/inspect/calculate/test/configure/restrict] [specific system/document/mode] to demonstrate [acceptance criterion]. Provide [controlled evidence] for [affected configurations], including [witness/Class/MOC/revalidation] as applicable.
Closure acceptance	Reviewed [evidence identity/revision/result] against [Criterion ID/original gap]. It demonstrates [acceptance basis] for [configurations]. Residual limitations: [none/list]. Accepted by [reviewer] on [date].
Overall conclusion	The assessment covers [scope/configurations] against [source basis]. [Completion/score] are indicators only. Material findings: [summary]. Unverified/limited areas: [summary]. The workbook does not confer Class/Flag/contractual approval.

Appendix C — Reference and applicability checklist

- Exact issuer, document title, revision/edition and issue date confirmed.
- Official/current status checked; project-controlled copy recorded.
- Vessel build/contract and major-conversion dates considered.
- Class society, full notation and qualifier applicability confirmed.
- Flag, statutory, contract, owner and charterer adoption basis recorded.
- Exact clause/table/figure checked before making a compliance statement.
- Current good-practice comparator labelled where not governing.
- Conflicts, deviations and authority decisions visible in the assessment.

C.1 Key official source locators

ID	Source	Official locator
S1	IMO MSC 98 summary — revised Guidelines for vessels/units with DP systems (MSC.1/Circ.1580 context)	Open official source
S2	IMCA M166 — Code of Practice on FMEA, Rev.3 May 2024	Open official source
S3	MTS TECHOP D-05 — FMEA Gap Analysis, Rev.1 January 2021	Open official source
S4	JDP01 — Unified Approach to Verification, Validation and Assurance of Single Fault Tolerance in DP Systems, Rev.1 / First Edition	Open official source
S5	IACS — E26/E27 revised applicability press release	Open official source
S6	IACS UR E26 — Cyber resilience of ships, Rev.1 November 2023	Open official source

ID	Source	Official locator
S7	IACS UR E27 — Cyber resilience of on-board systems and equipment, Rev.1 September 2023	Open official source
S8	ABS Guide for Dynamic Positioning Systems, February 2024	Open official source
S9	DNV Rules and Standards Explorer	Open official source
S10	Lloyd's Register rules portal	Open official source
S11	Bureau Veritas Rules Explorer	Open official source
S12	OCIMF DP FMEA Assurance Framework — Risk-based Guidance	Open official source

Use the REFERENCE REGISTER to identify sources, then verify the vessel-governing edition and relied-upon clauses against the controlled original. A listed title or current issuer page alone is not clause verification.

Appendix D — Glossary

Term	Meaning in this manual
CAM	Critical Activity Mode: the configuration and operating state selected for the critical DP activity.
TAM	Task Appropriate Mode: an alternative configuration judged appropriate for a defined task and risk context.
WCFDI	Worst Case Failure Design Intent: the failure/casualty the redundancy design is intended to withstand while retaining the defined DP capability.
WCF	Worst Case Failure: the most limiting analysed/actual failure outcome; reconcile any difference from WCFDI.
Objective evidence	Controlled, traceable information that directly supports or contradicts a technical claim.
Verification	Confirmation that specified requirements/design outputs have been met, by review, analysis, inspection or test as appropriate.
Validation	Confirmation, using suitable evidence, that the integrated system performs the intended function under the stated conditions/configurations.
UTV	Unable to verify: evidence is insufficient, unavailable, conflicting or uncontrolled, so the technical state cannot be judged.
Finding	A tracked gap/concern with evidence, criterion, consequence and closure pathway; classification is calculated by the workbook logic.
Accepted closure	Independent confirmation that controlled evidence satisfies the original criterion for all affected configurations, recorded with reviewer and date.

Appendix E — Abbreviations

Abbreviations used in the workbook (criteria, guidance notes, selectors and Reference Register) and in this manual. Class notations, standards and rules are named as the issuer names them; confirm the governing edition in the REFERENCE REGISTER.

Abbreviation	Meaning
A-60	SOLAS structural fire-protection division class
AC	Alternating current
AF / AN	Air forced / air natural (dry-type transformer cooling)
AI	Artificial intelligence
ASOG	Activity-specific operating guidelines
AVR	Automatic voltage regulator
BESS	Battery energy storage system
BMS	Battery management system
BOL / EOL	Beginning of life / end of life (battery state of health)
BOP	Blowout preventer
BV	Bureau Veritas
C&E	Cause and effect
C3EI2	Commonality, cross-connections, external interfaces and influences (MTS)
CAM	Critical activity mode
CAN	Controller area network (serial bus)
CCF	Common-cause failure
CMF	Common-mode failure
CPP / FPP	Controllable-pitch propeller / fixed-pitch propeller
CPU	Central processing unit
CT / VT	Current transformer / voltage transformer
DB	Distribution board
DC	Direct current
DCS	Distributed control system (for example drilling, crane or pipe-lay control)
DGNSS / GNSS / GPS	Differential global navigation satellite system / global navigation satellite system / Global Positioning System
DNS	Domain name system
DOL	Direct-on-line (motor start)
DoS	Denial of service
DP	Dynamic positioning
DP2 / DP3	DP equipment class 2 / 3
DPCS	DP control system
DPMS	Drilling power management system
DPO	DP operator
DPSI	DP system integration
DPS / DYNPOS / DP(AA) / DYNAPOS	DP class notations of ABS, DNV, Lloyd's Register and Bureau Veritas; see the vessel's Class rules for each qualifier
ECU	Engine control unit
EMC	Electromagnetic compatibility

Abbreviation	Meaning
EMS	Energy management system (ESS); engine management system (prime mover)
ESD	Emergency shutdown
ESS	Energy storage system
F&G	Fire and gas
FAT / SAT	Factory acceptance test / sea or site acceptance test
FDS	Functional design specification
FMEA	Failure modes and effects analysis
FO / LO	Fuel oil / lubricating oil
FOG / RLG	Fibre-optic gyro / ring-laser gyro
FRT	Fault ride-through
FW / SW	Fresh water / seawater
GA	General arrangement (drawing)
GCU	Gas combustion unit
HFO / MDO / MGO	Heavy fuel oil / marine diesel oil / marine gas oil
HIL	Hardware-in-the-loop (testing)
HMI	Human-machine interface
HPR	Hydroacoustic position reference
HT / LT	High-temperature / low-temperature (cooling water circuit)
HV / MV / LV	High / medium / low voltage
HVAC	Heating, ventilation and air conditioning
I/O	Input / output
IAC A-FLR	Internal arc classification of switchgear (accessibility A; front, lateral and rear)
IACS	International Association of Classification Societies
IAN	Inertial-aided navigation
IEC	International Electrotechnical Commission
IF	Intermittent fault
IGBT	Insulated-gate bipolar transistor
IGC Code	International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk
IGF Code	International Code of Safety for Ships using Gases or other Low-flashpoint Fuels
IJS	Independent joystick system
IMCA	International Marine Contractors Association
IMO	International Maritime Organization
INS	Inertial navigation system
IP	Ingress protection (enclosure rating)
IRM	Inspection, repair and maintenance (vessel activity)
ISDS	Integrated software dependent systems
ISQM	International Standard on Quality Management
IT	Unearthed (isolated) power system
JDP 01	Joint DP guidance: unified approach to the verification, validation and assurance of DP systems
LAN / VLAN / VPN	Local area network / virtual LAN / virtual private network
LBL / USBL	Long baseline / ultra-short baseline (hydroacoustic positioning)
LDS	Load-dependent start
LEL	Lower explosive limit
LFF	Low-flashpoint fuel
LLM	Large language model

Abbreviation	Meaning
LNG / LPG	Liquefied natural gas / liquefied petroleum gas
LOA	Length overall
LR	Lloyd's Register
MBT	Model-based testing
MCC	Motor control centre
MGPS	Marine growth prevention system
MOC	Management of change
MODU	Mobile offshore drilling unit
MRU	Motion reference unit
MSC	Maritime Safety Committee (IMO); MSC.1/Circ. denotes an MSC circular
MTS	Marine Technology Society (DP Committee)
NA	Not applicable
NER / NET	Neutral earthing resistor / neutral earthing transformer
NFU	Non-follow-up (control mode)
NMEA	National Marine Electronics Association (data protocol)
NTP	Network time protocol
OCIMF	Oil Companies International Marine Forum
OEL / UEL	Over-excitation limiter / under-excitation limiter
OEM	Original equipment manufacturer
OEUK	Offshore Energies UK
ONAN / ONAF	Oil natural, air natural / oil natural, air forced (transformer cooling)
OSV	Offshore support vessel
OT	Operational technology
PLC	Programmable logic controller
PMG	Permanent-magnet generator (excitation supply)
PMS	Power management system
PRD	Protective functions on which redundancy depends
PRS	Position reference system
PTO	Power take-off (shaft generator)
QCV	Quick-closing valve
RCPD	Redundancy concept philosophy document
RIO	Remote input / output
ROV	Remotely operated vehicle
RS-485	Serial communication interface standard
RTU	Remote terminal unit (Modbus RTU)
RVC	Remote valve control
SF6	Sulphur hexafluoride (switchgear insulating gas)
SFPA	Single failure propagation analysis
SIL	Safety integrity level
SIMOPS	Simultaneous operations
SME	Subject-matter expert
SMS	Safety management system
SOC / SOH	State of charge / state of health
SOLAS	International Convention for the Safety of Life at Sea
TAM	Task appropriate mode

Abbreviation	Meaning
TCV	Temperature control valve
TECHOP	MTS technical and operational guidance document
THD	Total harmonic distortion
TW	Taut wire (position reference)
UPS	Uninterruptible power supply
UR	Unified Requirement (IACS), for example UR E26 and E27
USB	Universal serial bus
UTV	Unable to verify (assessment result)
V&V	Verification and validation
V/Hz	Volts per hertz (limiter)
VFD	Variable-frequency drive
VMS	Vessel management system
W2W	Walk-to-work
WCF	Worst case failure
WCFDI	Worst case failure design intent
WSOG	Well-specific operating guidelines

Criterion ID, Finding ID and Reference ID codes

Code	Meaning
A to Q	Base-domain criteria (for example A methodology and scope, C generators, D distribution, Q operations)
CBX	Common or closed bus-tie enhanced verification add-on
DC	DC power add-on
FC	Fuel-cell add-on
CY	Cyber resilience (IACS UR E26 / E27) add-on
RU / RP / ST / OS / CP	DNV rules / recommended practice / standard / offshore standard / class programme
GN	Lloyd's Register guidance notes
NR	Bureau Veritas rule note (for example NR467)
Pt / Ch / Sec	Part / chapter / section of a set of rules
TS / TR / PAS	IEC technical specification / technical report / publicly available specification
M	IMCA marine division guidance document (for example IMCA M 166)