AM-14.01 — Qualify a material: how do we know it will really survive on Mars?

Guiding question

 MEASURED · CONVENTION · CALCULATED · LEARNING ASSUMPTION · MISSION DATA · ⚠ APPROXIMATION

Course map

The real phenomenon → Vocabulary and problem boundary → Course-specific system view → Mathematical relationship and reading the symbols → Worked calculations and interpretation

1 — The real phenomenon

A part can look perfect and still fail too early. Qualification means collecting enough evidence to decide that a material, part or process is suitable for a defined function in a defined environment.
The guiding question is: What evidence is needed before declaring that a material or part is truly suitable for its Martian use? Reasoning starts with the physical or operational function before introducing the mathematical relationship. The goal is not to accumulate terminology, but to know which quantity changes, why it changes and what becomes hazardous when it leaves its domain. For “AM-14.01 — Qualify a material: how do we know it will really survive on Mars?”, the first task here is therefore to identify the mechanism specific to this subject before searching for an equation or reference value.

2 — Vocabulary and problem boundary

In “Qualify a material: how do we know it will really survive on Mars?”, distinguish the phenomenon, available measurement, any command, the margin and the success criterion. The calculation boundary states what is included and excluded; without that boundary, a percentage, mass or time may be mathematically correct but wrong as an engineering conclusion. For “AM-14.01 — Qualify a material: how do we know it will really survive on Mars?”, the chosen boundary also states what would otherwise be double-counted or omitted from a mission budget.
failure rate, operating hours, margins, cycles, temperature, leaks, repair time and availability
common cause, slow drift, uncovered fatigue, consumed margin or a repair introducing a new defect
duration tests, reasoned accelerated cycling, FMEA/FMECA, injected faults and configuration tracking

Equation - evidence - decision

relation propre au cours

Failure to test: The reference failure is not a vague “broken component.” For “Qualify a material: how do we know it will really survive on Mars?”, test in particular common cause, slow drift, uncovered fatigue, consumed margin or a repair introducing a new defect. Diagnosis asks which symptoms appear first, which are only consequences and which action preserves the most options.

AM-14.01 — Qualify a material: how do we know it will really survive on Mars?

3 — Course-specific system view

This lesson does not reuse one generic picture for every subject. The system view follows cause → measured quantity → decision or physical response → limit for “Qualify a material: how do we know it will really survive on Mars?”. The English text remains fully equivalent while large translated illustrations are intentionally deferred until their dedicated artwork is supplied. For “AM-14.01 — Qualify a material: how do we know it will really survive on Mars?”, the system view must expose inputs, outputs, measured quantity and the consequence of drift without relying on a generic module diagram.

4 — Mathematical relationship and reading the symbols

Before substituting numbers, write the unit of every term, state whether the relationship is a physical law, approximation or project indicator, and check dimensional consistency. This is especially important here because “Qualify a material: how do we know it will really survive on Mars?” combines quantities that do not all have the same evidence status. For “AM-14.01 — Qualify a material: how do we know it will really survive on Mars?”, this relationship is chosen because of the phenomenon under study; a different dominant quantity would require a different equation or model.

5 — Worked calculations and interpretation

1. Exemple relation numérique du cours Interpretation: this result is used only after comparison with units, margin and the scenario boundary for “Qualify a material: how do we know it will really survive on Mars?”.

6 — What the formula does not contain

The relationship “relation propre au cours” does not by itself contain all of “Qualify a material: how do we know it will really survive on Mars?”. It does not automatically tell us whether a sensor is valid, a structure is aging, a resource is accessible, a command arrives in time or a secondary failure removes margin. The example relation numérique du cours therefore remains a local calculation rather than a complete architecture.

To make the model useful, explicitly add the quantities that dominate this subject: failure rate, operating hours, margins, cycles, temperature, leaks, repair time and availability. We can then ask which variation truly changes the result, which is negligible and which forces an architectural change. For “AM-14.01 — Qualify a material: how do we know it will really survive on Mars?”, this model limitation states exactly what a correct calculation still cannot establish about the real system.

Operational table

Phenomena / sections:	3 — Course-specific system view ; 4 — Mathematical relationship and reading the symbols ; 5 — Worked calculations and interpretation
Relationship to revisit:	relation propre au cours
Expected decision:	measure → compare with margin → choose nominal, degraded or stop

Check before continuing

Explain without rereading: 3 — Course-specific system view ; 4 — Mathematical relationship and reading the symbols ; 5 — Worked calculations and interpretation. State one measured quantity, one margin and one possible decision.

AM-14.01 — Qualify a material: how do we know it will really survive on Mars?

7 — Instrumentation, observability and data quality

For “Qualify a material: how do we know it will really survive on Mars?”, observability relies on failure rate, operating hours, margins, cycles, temperature, leaks, repair time and availability. Each datum has a unit, acquisition rate, uncertainty, timestamp and validity domain. A value arriving without context can be more dangerous than no measurement because it creates unjustified confidence.

Consistency is checked with at least one independent piece of information when the function is critical. A trend, physical balance or second measurement principle helps distinguish a real system change from a drifting sensor. For “AM-14.01 — Qualify a material: how do we know it will really survive on Mars?”, the selected instrumentation must distinguish a real physical change from sensor drift or a bad state estimate.

8 — Phenomenon-specific failures and recovery

The reference failure is not a vague “broken component.” For “Qualify a material: how do we know it will really survive on Mars?”, test in particular common cause, slow drift, uncovered fatigue, consumed margin or a repair introducing a new defect. Diagnosis asks which symptoms appear first, which are only consequences and which action preserves the most options.

The degraded mode must be defined before failure: minimum function, allowable duration, consumed stock, crew action, abort condition and return-to-nominal criterion. That sequence is topic-specific and cannot be replaced by one universal paragraph about redundancy. For “AM-14.01 — Qualify a material: how do we know it will really survive on Mars?”, the degraded mode is defined around the minimum function specific to this subject, with an abort threshold and a return-to-nominal condition.

9 — NASA / reference case

NASA material is used as an evidence dossier: requirements, reliability, maintainability, testing and configuration. The lesson never turns a generic failure rate into a universal truth; it shows how evidence is bounded to defined hardware, environment and duration.

The case is used only within what it actually demonstrates. Flight measurement, human-system standard, component test and architecture study are different kinds of evidence; the text therefore states what is observed, calculated, simulated or still prospective. For “AM-14.01 — Qualify a material: how do we know it will really survive on Mars?”, the cited NASA case is used as targeted evidence for this phenomenon and is never turned into one universal Mars architecture.

Operational table

Phenomena / sections:	7 — Instrumentation, observability and data quality ; 8 — Phenomenon-specific failures and recovery ; 9 — NASA / reference case
Relationship to revisit:	relation propre au cours
Expected decision:	measure → compare with margin → choose nominal, degraded or stop

Check before continuing

Explain without rereading: 7 — Instrumentation, observability and data quality ; 8 — Phenomenon-specific failures and recovery ; 9 — NASA / reference case. State one measured quantity, one margin and one possible decision.

AM-14.01 — Qualify a material: how do we know it will really survive on Mars?

10 — Architecture trade

A good solution for “Qualify a material: how do we know it will really survive on Mars?” does not maximize one metric. Compare nominal performance, mass, energy, simplicity, maintenance, crew time, common dependencies and recoverability. An option that improves relation numérique du cours can still be rejected if it makes failure detection or repair much harder.

The trade is recorded together with its assumptions. If environment data, mass or mission cadence changes, we know which conclusions must be recomputed instead of silently preserving an obsolete choice. For “AM-14.01 — Qualify a material: how do we know it will really survive on Mars?”, the trade is evaluated against the interfaces actually touched by this subject rather than a generic list of desirable qualities.

11 — Demonstration, testing and success criteria

The evidence strategy for “Qualify a material: how do we know it will really survive on Mars?” combines duration tests, reasoned accelerated cycling, FMEA/FMECA, injected faults and configuration tracking. Every test records exact hardware, software, configuration, environment, tolerances and success criterion. A successful demonstration outside the mission domain does not replace qualification inside it.

Evidence grows by levels: analytical relationship, simulation, component, subsystem, integrated system, duration and failure. This hierarchy prevents one spectacular test from being presented as validation of the whole mission. For “AM-14.01 — Qualify a material: how do we know it will really survive on Mars?”, demonstration must reproduce the constraints that make this phenomenon difficult; a spectacular test outside the mission domain is insufficient.

12 — Decision exercise

Situation: revisit “Qualify a material: how do we know it will really survive on Mars?” with a 20% increase in the most penalizing quantity from the first worked example while one measurement or backup path is unavailable.

Situation: revisit “Qualify a material: how do we know it will really survive on Mars?” with a 20% increase in the most penalizing quantity from the first worked example while one measurement or backup path is unavailable. Expected answer: recompute the relationship, identify remaining margin, check whether observability is still adequate, and decide whether degraded operation remains acceptable. Multiplying by 1.2 is not enough if the variation also changes interfaces or limits.

Operational table

Phenomena / sections:	10 — Architecture trade ; 11 — Demonstration, testing and success criteria ; 12 — Decision exercise
Relationship to revisit:	relation propre au cours
Expected decision:	measure → compare with margin → choose nominal, degraded or stop

Check before continuing

Explain without rereading: 10 — Architecture trade ; 11 — Demonstration, testing and success criteria ; 12 — Decision exercise. State one measured quantity, one margin and one possible decision.

AM-14.01 — Qualify a material: how do we know it will really survive on Mars?

13 — What to retain without over-generalizing

14 — Topic-specific primary sources

These references directly document the phenomenon, technology or human constraint addressed in this lesson. They do not by themselves define an official Mars architecture. For “AM-14.01 — Qualify a material: how do we know it will really survive on Mars?”, the bibliography is deliberately targeted to this page so that readers can trace each claim back to the relevant primary document.

Topic-specific primary sources

NASA-STD-8729.1A — Reliability and Maintainability Standard - https://standards.nasa.gov/standard/NASA/NASA-STD-87291

NASA Safety and Mission Assurance — Reliability and Maintainability - https://sma.nasa.gov/sma-disciplines/reliability-and-maintability

NASA — Systems Engineering Handbook - https://www.nasa.gov/reference/systems-engineering-handbook/

Operational table

Phenomena / sections:	13 — What to retain without over-generalizing ; 14 — Topic-specific primary sources ; Topic-specific primary sources
Relationship to revisit:	relation propre au cours
Expected decision:	measure → compare with margin → choose nominal, degraded or stop

Check before continuing

Explain without rereading: 13 — What to retain without over-generalizing ; 14 — Topic-specific primary sources ; Topic-specific primary sources. State one measured quantity, one margin and one possible decision.