



AF-TR-9800-001

Quantitative Methods and Worked Calculations

Space / Aviation / Defense

FIRST EDITION

AF 9800 SUPPORTING DOCUMENT

Document identity and use

FIRST EDITION MANUSCRIPT - Prepared for Aerospace Federation review

Field	Controlled identity
Document	AF-TR-9800-001 - Quantitative Methods and Worked Calculations
Parent standard	AF 9800 - Aerospace Maintenance & Personnel Competence
Edition / language	FIRST EDITION / English master text
Family	Companions
Primary source anchors	7, 11, 15-18, 21, 33, 35; informative Annex O
Suggested local owner	Maintenance / competence / assurance specialist
Authority	Publisher approval and effective date are not assigned. Local use requires authorized adoption and completed parameters.

Use with the main standard

This document implements the identified AF 9800 clauses and annexes. Read the complete applicable requirements in the main standard. The source anchors are navigation references; a template does not replace technical judgement, evidence, permission or eligible approval.

AF-ML-9800-001 lists the complete supporting set. AF-CM-9800-001 maps the main clauses and annexes to working documents. AF-TP-9800-001 establishes the common local parameter baseline; add the relevant discipline profiles.

Record control

Identify the object, configuration, record owner and dates. Reference attachments by stable identifier and version. Keep superseded evidence and decisions traceable. Use the approved local retention, access and authentication arrangements. No technical limit, numerical limit, interval or acceptance value is assigned by a blank template.

Implementation model: Translate the stated responsibilities and controls into the actual organization. Informative examples remain explanatory; use approved programme-specific values for operational decisions.

1 Use of quantitative examples

All values and cases in this companion are synthetic. They explain assumptions, calculations and limitations; they are not system limits, product evidence or mandatory default parameters. Select and approve the actual model and values before relying on a calculation.

2 Worked calculations

Status: Informative. All values are synthetic teaching examples, not operational limits, mandated intervals or evidence of actual performance.

0.1 Concurrent maintenance limits

Assume an illustrative task has 120 operating hours remaining, 45 cycles remaining and 12 calendar days remaining. Forecast use is 6 hours and 3 cycles per day. The calculations use constant utilization only for planning; actual exposure still controls.

Hours-based forecast = $120 / 6 = 20$ days

Cycles-based forecast = $45 / 3 = 15$ days

Planning due point = $\min(20, 15, 12) = 12$ days

The calendar limit controls this forecast. Increased utilization can make another limit controlling sooner. A planned date does not extend any limit, and the organization must use the actual approved time origins and counting rules.

0.2 Skill-based production capacity

Eight staff each have 7 scheduled hours; a justified planning factor of 0.75 represents productive availability after identified non-production duties. Demand is 30 hours of execution, 10 of preparation and 6 of restoration. Separately, an inspection skill requires 8 hours but has only 6 available.

General capacity = $8 \times 7 \times 0.75 = 42$ staff-hours

General demand = $30 + 10 + 6 = 46$ staff-hours

General shortfall = $46 - 42 = 4$ staff-hours

Inspection shortfall = $8 - 6 = 2$ inspector-hours

Both constraints require resolution. Extra general labour cannot fill an authorization-specific inspection gap. The availability factor is an example assumption, not a prescribed efficiency target or permission to remove breaks.

0.3 Practical-training coverage

A learning plan requires 20 distinct task outcomes. Eighteen have valid evidence; the other two are critical outcomes. Repeated performance of already-covered tasks does not add new outcomes to the numerator.

Coverage = $18 / 20 \times 100 = 90$ percent

Coverage measures evidence completeness, not overall competence. The missing critical outcomes keep the affected completion decision on HOLD. Weighting or rounding the percentage cannot make them demonstrated. The reviewer must also examine evidence quality, assistance and representative conditions.

0.4 Aggregate assessment versus critical criteria

An illustrative assessment gives 95 points out of 100, but the candidate fails the predetermined critical criterion to stop when instructions conflict. The scheme requires every critical criterion to pass, in addition to its locally set aggregate rule.

Aggregate result = $95 / 100 \times 100 = 95$ percent

Critical criteria passed = $3 / 4 = 75$ percent

The affected competence decision is FAIL despite the high aggregate result. Remediation and reassessment must address the failed behaviour and connected judgement. No universal numerical pass mark is established here.

0.5 Recency counting with task relevance

For illustration only, a local rule requires four qualifying activities within a 180-day look-back period for one task family. Records are 10, 30, 90 and 120 days old. All are within the time window, but only three belong to the required family; one is unrelated.

In-window records = 4

Relevant qualifying records = 3; required = 4

Evidence shortfall = 4 - 3 = 1 activity

The role is not current under this synthetic rule. The response follows the actual approved lapse/return process; adding an unsupported activity or changing its date cannot restore currency. Other obligations may require a different basis entirely.

0.6 Measurement uncertainty and acceptance

Suppose a synthetic dimensional requirement is 10.00 +/- 0.20 mm. A result is 10.14 mm with expanded uncertainty $U = 0.08$ mm. The locally selected conservative decision rule requires the entire stated uncertainty interval to lie within the specification interval.

Specification interval = [9.80, 10.20] mm

Result interval = [10.14 - 0.08, 10.14 + 0.08]

Result interval = [10.06, 10.22] mm

The central value lies inside the specification, but the interval crosses the upper limit. Under this illustrative rule, acceptance is not demonstrated and remains HOLD pending an eligible resolution. This is not proof that the physical dimension is necessarily nonconforming. State the uncertainty basis and approved decision rule before measuring.

0.7 Retrospective tooling impact

An out-of-tolerance tool has 42 candidate work-package uses since its last established acceptable state. Traceable technical screening excludes 26 uses because the affected range/function was not used. Sixteen remain potentially affected. Rechecks find 8 acceptable, 5 unacceptable and 3 pending.

Potentially affected = 42 - 26 = 16 packages

Reconciled disposition = 8 + 5 + 3 = 16

The five unacceptable results require correction and affected-release review; the three pending cases remain HOLD. The 26 exclusions need individual technical rationale. An arithmetically balanced list does not establish the quality of the screening or rechecks.

0.8 Event rate and time-between-event estimate

Three defined events occurred over 12,000 comparable asset-hours. Assume complete reporting and a homogeneous population for this descriptive calculation. The reciprocal exposure estimate is meaningful only for the defined event and population.

Event rate = $3 / 12,000 \times 1,000 = 0.25$ per 1,000 h

Exposure per event = $12,000 / 3 = 4,000$ h

These are point estimates, not guaranteed intervals between failures for an individual asset. Examine uncertainty, failure modes, censoring, age and operating context before any programme decision. The result alone cannot authorize interval escalation.

0.9 Zero events and an upper statistical bound

Assume zero events in 6,000 independent, comparable exposure hours and a constant-rate Poisson model. A one-sided 95 percent upper rate bound solves $\exp(-\text{rate} \times \text{exposure}) = 0.05$. The confidence statement depends on the model and complete observation.

$$\text{Upper rate} = -\ln(0.05) / 6,000$$

$$\text{Upper rate} = 0.0004992887 \text{ events per hour}$$

$$\text{Upper rate} = 0.4993 \text{ events per 1,000 hours}$$

Zero observed events does not establish zero risk. Dependence, under-reporting or changing hazard rates can invalidate this simple model. This calculation illustrates uncertainty and supplies no mandatory reliability acceptance threshold.

O.10 On-time completion and missing records

Of 80 packages with known status, 72 were completed within the approved planning target. Five additional eligible packages have unknown completion status. Reporting only the known subset can overstate the complete population's demonstrated performance.

$$\text{Known-subset rate} = 72 / 80 \times 100 = 90 \text{ percent}$$

$$\text{Full eligible population} = 80 + 5 = 85$$

$$\text{Demonstrated on-time share} = 72 / 85 = 84.71 \text{ percent}$$

Report the 5 unknown cases separately; do not label them late without evidence or silently exclude them. A delivery metric does not establish technical quality or release validity. Define denominator rules before comparing periods.

O.11 Simulator comparison and critical mismatch

A simulator validation compares 40 predetermined scenario outcomes with the accepted reference. Thirty-nine agree, but the mismatch concerns a critical warning cue needed for the intended assessment.

$$\text{Overall agreement} = 39 / 40 \times 100 = 97.5 \text{ percent}$$

The high overall agreement does not validate the affected critical competency. Restrict that use, investigate the mismatch and demonstrate correction. Scenario selection, fidelity and observation quality matter; the percentage alone is not a complete validation argument.

O.12 Recurring-defect improvement

A comparable task population has 8 recurring defects in 2,000 work orders before an intervention and 3 in 1,500 afterwards. Assume consistent definitions, complete reporting and comparable work mix for the descriptive comparison.

$$\text{Before} = 8 / 2,000 \times 1,000 = 4 \text{ per 1,000 orders}$$

$$\text{After} = 3 / 1,500 \times 1,000 = 2 \text{ per 1,000 orders}$$

$$\text{Observed relative reduction} = (4 - 2) / 4 = 50 \text{ percent}$$

The observed rate fell, but small counts and changed conditions may explain some difference. Establish suitable uncertainty and causal evidence before claiming sustained effectiveness. Continue monitoring the relevant failure mechanism rather than declaring success from a single percentage.