

OPERATIONAL RISK DECISION SUPPORT

Safe operating capacity methodology

Technical specification, peer-review protocol and an anonymised worked example

Version	Version 1.2.1
Date	23 September 2026
Status	Clean revised issue
Publication status	Published for method transparency.
Prepared by	NorthSky Aviation Consultancy

Scope of this document

This document provides operational risk decision support. It does not constitute regulatory approval, aerodrome licensing, certification, compliance verification or an authority determination.

Contents

1	Purpose and scope.....	3
2	Required outputs.....	3
3	Roles.....	3
4	Data architecture.....	3
5	Annual-to-peak conversion.....	4
6	Circuit occupancy model.....	4
7	Control hierarchy.....	5
8	Model validation.....	5
9	Occurrence analysis.....	5
10	Runway occupancy.....	6
11	Human Factors Integration.....	6
12	Sensitivity and Monte Carlo.....	6
13	Evidence integration.....	7
14	Worked-case decision.....	7
15	Revalidation triggers.....	8
16	Reproduction protocol.....	8
17	Verification matrix.....	9
18	Version 1.2.1 change record.....	9
19	Controlled sources.....	10

1 Purpose and scope

This methodology specifies the evidence, calculations, validation tests and decision gates required to assess safe operating capacity at a smaller aerodrome without full ATS. Another competent analyst should be able to apply it using local data. The case aerodrome is a worked example, not a benchmark.

Version 1.2.1 incorporates the March 2026 assessment, August 2026 change note and supplied 10,000-row sensitivity output. Where the assessment and change note differ, the change note controls. [S1][S2][S3]

Normative language

“Shall” identifies a reproducibility requirement. “Should” identifies recommended practice. “May” identifies an option. Departures shall be documented with their effect on uncertainty.

2 Required outputs

- Defined annual management limit and any hourly/daily constraints.
- Transparent local annual-to-peak conversion.
- Circuit occupancy with primary and secondary probabilities.
- Occurrence, ROT and HFI evidence with limitations.
- Barrier assurance register and release-gate decision.
- Monitoring and revalidation plan.
- Calculation workbook reproducing every published numeric output.

3 Roles

Role	Responsibility
Operator	Owns assumptions, barriers, decision and residual risk.
Analyst	Builds calculations and provenance.
Operational users	Validate behaviour and barriers.
Independent reviewer	Recalculates and challenges.
Accountable decision-maker	Signs release gates and ALARP decision.

4 Data architecture

The movement definition shall state how departures, arrivals and touch-and-go operations are counted. The same rule shall be used for annual exposure, peak counts and occurrence rates. Every hardcoded input shall have source, date, owner, status and uncertainty. Expert judgement shall never be labelled as measured.

Gate	Requirement
Completeness	All periods and user groups covered.
Consistency	Definitions and time zones match.
Accuracy	Sample reconciled against independent records.
Currency	Procedures and barriers current.
Traceability	Every input has controlled provenance.
Fitness	Uncertainty treated proportionately and conservatively.

5 Annual-to-peak conversion

Peak hourly movements are $q = A \times s \div D \times F_d \times F_h \div H_d$. Expected simultaneous occupancy is $\lambda = q \times T \div 60$. Every term shall be retained separately. An annual-hours shortcut shall not replace the chain unless independently derived and shown equivalent.

Symbol	Definition	Case aerodrome
A	Annual movements	Scenario value
s	High-season share	0.60
D	High-season days	153
F _d	Busy-day factor	1.50
F _h	Peak-hour factor	1.15
H _d	Operating hours/day	12
T	Circuit residence time	7 min

Example: $q = 15,500 \times 0.60 \div 153 \times 1.50 \times 1.15 \div 12 = 8.738$ movements/hour. $\lambda = 8.738 \times 7 \div 60 = 1.019$. Narrative rounding may state nine and 1.02; the workbook retains precision.

6 Circuit occupancy model

Let X be simultaneous aircraft in the defined circuit system. Under a homogeneous approximation, $X \sim \text{Poisson}(\lambda)$. For Case aerodrome, $P(X \geq 3) = 1 - e^{(-\lambda)}(1 + \lambda + \lambda^2/2)$. The secondary $P(X \geq 4)$ adds the $\lambda^3/6$ term inside the bracket. Reporting both prevents “reaching three” from being confused with “exceeding three.”

The local probability boundaries are 5% and 15% for $P(X \geq 3)$. Solving gives $\lambda = 0.817691$ and 1.330637 . Dividing by the annual-to-occupancy factor produces 12,433 and 20,232 movements under the case aerodrome’s assumptions. [S2]

Annual	Peak/h	λ	$P \geq 3$	$P \geq 4$	Band
12,433	7.01	0.818	5.0%	1.0%	Boundary
15,500	8.74	1.019	8.4%	2.0%	Low yellow
18,000	10.15	1.184	11.7%	3.2%	Yellow
20,232	11.41	1.331	15.0%	4.6%	Boundary
21,000	11.84	1.381	16.2%	5.2%	Red
22,000	12.40	1.447	17.8%	5.9%	Red

7 Control hierarchy

The analyst shall distinguish physical maximum, model risk criterion and management control. They may share a number but are not interchangeable.

Control	Case aerodrome treatment	Consequence
OCC planned-pattern cap	Two simultaneous lessons; self-imposed for CAA risk appetite.	Barrier input, not capacity proof.
Total-circuit rare event	Three or more total aircraft, $P(X \geq 3)$.	Primary annual banding event.
Four or more	$P(X \geq 4)$.	Secondary diagnostic.

If a controlled procedure limits total aircraft to two, redefine and rerun the model. Before external use, formally confirm whether “two” applies to planned pattern lessons or all aircraft in the circuit. [S2]

8 Model validation

The analyst shall compare observed counts and occupancy with the expected distribution. Minimum diagnostics are variance-to-mean ratio, observed versus predicted tail frequency, schedule waves and zero-count frequency. Over-dispersion or bunching requires stratification, empirical modelling or a negative-binomial alternative. Poisson is conservative only where its assumptions remain adequate.

9 Occurrence analysis

Occurrence evidence shall separate total reports, serious airspace events and relevant precursors; normalise by exposure; and document changes in reporting culture and barrier state. Three annual observations shall not be regressed into a safe number.

Year	Movements	Reports	Serious airspace
2023	21,000	41	8
2024	16,500	33	5
2025 estimate	15,500	28 projected	0 reported in source period

The controlled 2023 value is eight. A zero in 2025 is encouraging but statistically weak. Event-rate acceptance thresholds are local governance choices and shall not be presented as universal standards. [S2]

10 Runway occupancy

1. Define start and runway-vacated end points.
2. Stratify by direction, operation, aircraft and backtrack.
3. Measure enough observations to describe centre and upper tail.
4. Add an explicit buffer.
5. Calculate theoretical rate as $3,600 \div \text{MinSep}$.
6. Compare with observed peaks; do not treat as approval.

Case	MinSep	Theoretical rate
RWY 05 school aircraft	85 s	42.4 $\approx$ 42/h
RWY 23 school aircraft	245 s	14.7 $\approx$ 15/h

RWY 23 is conservative due to backtrack. At the assessed nine movements per peak hour, runway throughput exceeds demand, subject to measurement validation. [S2]

11 Human Factors Integration

HFI shall test scenarios rather than infer workload from annual totals. It shall address simultaneous traffic, unknown/non-radio traffic, radio demand, task phase, recovery and barrier performance.

Variable	Green	Yellow	Red
Simultaneous aircraft	≤ 3	4	≥ 5
Unknown aircraft	0–1	2	≥ 3
Messages/aircraft	5–8	9–12	≥ 13
Events/1,000	< 1.5	1.5–2.0	> 2.0

The corrected 2025 score is 0.5, not 0.6. It is a local decision aid, not a validated psychometric instrument. The 2+1 scenario remains an independent trigger. [S2]

12 Sensitivity and Monte Carlo

First vary one parameter at a time. A Monte Carlo specification shall disclose input distributions, bounds, correlations, seed, software/version and output equation.

Statistic	Supplied output
Iterations	10,000
Mean	16,206
Median	15,507
Standard deviation	4,494
2.5th percentile	9,525
97.5th percentile	27,104
Minimum/maximum	6,464 / 56,628

These statistics are reproducible from capacity_adj. The generating process is not: sampled inputs, distributions, correlations, seed and code are absent. The workbook marks this gate OPEN. [S3]

13 Evidence integration

The four methods shall not be averaged. The following gates apply.

Gate	Pass condition	If failed
Data	Definitions and reconciliation complete	No numeric conclusion.
Circuit	Assumptions tested; band accepted	More data, constrain peaks or change model.
Occurrence	No unexplained adverse signal	Investigate before increase.
ROT	Conservative throughput above demand	Constrain configuration.
HFI	No unresolved red scenario	Strengthen controls/reduce exposure.
Barriers	Owners, standards and evidence current	Claimed capacity unsupported.
Governance	Signed ALARP decision	No release.

14 Worked-case decision

The corrected circuit model places 15,500 in low yellow. Release therefore depends on verified PPR, OCC scheduling, circuit controls, monitoring and escalation. A proposal above 20,232 is red under current assumptions; 22,000 is not supported by this operating concept. [S2]

15 Revalidation triggers

- Change in circuit or OCC rule.
- Peak demand above model input or repeated bunching.
- Material circuit-time change.
- Repeated primary-event occupancy or red HFI scenario.
- Increase in serious airspace occurrences.
- Change in ATS, airspace, PPR, radio, infrastructure or user mix.
- Forecast above 15,500 or approach to 20,232.
- Barrier failure or annual review.

16 Reproduction protocol

1. Confirm version and sources.
2. Populate inputs with provenance.
3. Close data-quality gates.
4. Reconcile annual and peak records.
5. Validate annual-to-peak chain against observations.
6. Confirm event definition.
7. Recalculate probabilities and thresholds.
8. Import occurrence, ROT and HFI evidence.
9. Recalculate Monte Carlo outputs; do not claim generation reproducibility until complete.
10. Complete decision log, independent review and approval.

17 Verification matrix

ID	Item	Status
V-01	Seasonal chain	CLOSED – reproduced
V-02	Primary event	CLOSED – $P(X \geq 3)$
V-03	Secondary event	CLOSED – $P(X \geq 4)$
V-04	Green/yellow threshold	CLOSED – 12,433
V-05	Yellow/red threshold	CLOSED – 20,232
V-06	15,500 classification	CLOSED – low yellow
V-07	2023 serious events	CLOSED – eight
V-08	ROT values	CLOSED – 42/15
V-09	HFI score	CLOSED – 0.5
V-10	Two-aircraft interpretation	CLOSED as management control; currency check required
V-11	Monte Carlo output stats	CLOSED – recalculated
V-12	Monte Carlo generation	OPEN – protocol absent
V-13	Empirical Poisson fit	OPEN – time-stamped occupancy required
V-14	Barrier effectiveness/audit	OPEN – active work items

18 Version 1.2.1 change record

Update	Response
Way B removed	Way A only
Notation clarified	Primary/secondary tails separate
Thresholds corrected	12,433/20,232
15,500 reclassified	Low-yellow ALARP
ROT/HFI/occurrences harmonised	Consistent values
Clustering caveat strengthened	Validation and alternatives added
Monte Carlo supplied	Output imported; generation open
Anonymisation and v1.2.1 corrections	Aerodrome identity, ICAO code and case-specific source references removed for publication. $P(X \geq 4)$ at 12,433 corrected to 1.0%. Peak/h at 20,232 corrected to 11.41. $P(X \geq 4)$ wording clarified. Publication status line added.

19 Controlled sources

ID	Source
S1	Assessment of safe movements at the case aerodrome, v1.2, 29 March 2026 (confidential client report; aerodrome identity withheld for publication).
S2	Change note v1.3, 24 August 2026; prevails over S1 where inconsistent.
S3	Monte Carlo sensitivity CSV, 10,000 capacity_adj outputs.
S4	Operational Concept for the case aerodrome, v1.0 (confidential client document; anonymised for publication).
S5	Risk Analysis for the case aerodrome, v1.0 (confidential client document; anonymised for publication).
S6	Internal Audit for the case aerodrome, 2025 v1.2 (confidential client document; anonymised for publication).
S7	Occurrence investigation report held by the client (reference withheld to preserve anonymisation).
S8	Published AIP aerodrome entry for the case aerodrome (reference withheld to preserve anonymisation); current issue to be verified locally.
S9	Regulatory correspondence held by the client (case references withheld to preserve anonymisation; matter since resolved).
S10	NorthSky Safe Movement Numbers screening tool v0.9; advisory screening only.