

UAV Technologies

ENGINEERING INTELLIGENCE STANDARD

EIS-003

Multi-Temporal Change Detection and Monitoring Standard

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Public-use notice. EIS-003 is an original UAV Technologies company standard governing multi-temporal change detection and monitoring used in Engineering Intelligence products. It is not a government, ISO, CEOS, OGC, or other consensus standard and does not represent third-party certification or accreditation.

Document Control

Revision	Date	Status	Description	Approval
A	16 Aug 2026	Public Release	Initial public release. Formalizes change-state terminology, baseline construction, two-date and time-series analysis, persistence, magnitude, spatial coherence, anomaly detection, false-change controls, monitoring alerts, attribution limits, and technical review.	UAV Technologies

Contents

1. Purpose
2. Scope and Relationship to EIS-001 and EIS-002
3. Core Change-Analysis Principles
4. Terms and Definitions
5. Change Evidence Maturity Model
6. Engineering Objective and Change Definition
7. Baseline and Reference-State Requirements
8. Two-Date Change Analysis
9. Time-Series and Persistent-Change Analysis
10. Seasonal, Phenological, Hydrologic, and Operational Controls
11. Change Magnitude and Direction
12. Spatial Coherence and Analytical Units
13. Thresholds, Anomalies, and Statistical Controls
14. False-Change and Artifact Controls
15. Cross-Sensor and Cross-Product Change Analysis
16. Corroboration and Causal Attribution
17. Monitoring Programs and Alert Logic
18. Change Confidence and Reporting
19. Quality Assurance and Technical Review
20. Documentation, Reproducibility, and Release
21. Exceptions and Deviations
22. Continuous Improvement
- Appendix A - Change Detection Record
- Appendix B - Change Evidence Decision Guide
- Appendix C - Monitoring Alert Record
- Appendix D - Default Control Objectives

1. Purpose

EIS-003 establishes the minimum methodology UAV Technologies uses to detect, quantify, validate, monitor, and report change across multiple observations. Its purpose is to prevent a measured difference between dates from being overstated as a persistent, abnormal, operationally significant, or causally attributed change without sufficient evidence.

The standard provides a controlled progression from observation of a difference to increasingly mature change findings, while preserving traceability to source data, analytical methods, uncertainty, alternative explanations, and corroborating evidence.

2. Scope and Relationship to EIS-001 and EIS-002

EIS-003 applies when an Engineering Intelligence product compares two or more observations through time, including satellite, aerial, UAV, geospatial, environmental, infrastructure, industrial, agricultural, coastal, aerospace, transportation, disaster-response, or other technical monitoring applications.

EIS-001 governs the overall Engineering Intelligence process and reporting methodology. EIS-002 governs acceptance of Earth Observation evidence. Data used for EO change analysis under EIS-003 shall satisfy EIS-002 for the intended analytical purpose or shall be explicitly restricted to the quality class and limitations assigned under EIS-002.

Application neutrality. EIS-003 defines controls for defensible change analysis rather than prescribing one algorithm. Pairwise differencing, index trajectories, trend analysis, break detection, statistical anomaly methods, classification change, object-based comparison, and other technically justified methods may be used.

3. Core Change-Analysis Principles

- A difference is not automatically a change. Measurement noise, registration error, illumination, atmospheric effects, seasonality, phenology, tide, operational state, and processing differences can produce apparent change.
- Two-date analysis establishes a comparison between two states. Persistence or abnormality generally requires additional temporal evidence or independent corroboration.
- Baseline matters. Change shall be interpreted relative to an appropriate reference state, historical distribution, expected seasonal condition, or defined engineering threshold.
- Magnitude and significance are different. A statistically unusual change may have little operational consequence, while a modest change may be operationally important.
- Spatial pattern matters. Coherent field-, asset-, corridor-, watershed-, or region-scale change carries different evidentiary meaning than isolated pixels.
- Persistence strengthens evidence. Repeated observations that sustain or evolve a signal can distinguish durable change from transient variability.
- Attribution requires more than detection. Identifying that change occurred does not by itself establish why it occurred.
- Monitoring logic shall be transparent. Alert thresholds, persistence rules, escalation criteria, and reset conditions shall be defined before or documented with operational use.

4. Terms and Definitions

Term	Definition
Measured difference	A numerical, categorical, geometric, or observable difference between two accepted observations.
Candidate change	A measured difference that exceeds the defined analytical/noise criterion and warrants evaluation as possible real-world change.
Corroborated change	A candidate change supported by independent evidence, multiple measurements, or complementary indicators sufficient to reduce key artifact explanations.
Persistent change	A change signal that remains, evolves consistently, or is repeatedly detected across a defined persistence interval or sequence of observations.
Attributed change	A change for which a specific cause or mechanism is supported by sufficient independent evidence.
Baseline	The reference condition against which subsequent observations are evaluated.
Anomaly	A departure from an expected or reference distribution, model, seasonal state, or engineering threshold.
Change magnitude	The size or intensity of a change according to a defined metric.
Change direction	The sign, trajectory, class transition, or physical direction of the measured change.
Spatial coherence	The degree to which a change signal forms a geographically or structurally meaningful pattern rather than isolated noise.
Persistence interval	The defined number of observations or elapsed time over which a candidate change must remain detectable to satisfy a persistence rule.
Alert	A monitoring output indicating that defined detection, confidence, persistence, and/or consequence criteria have been met.

5. Change Evidence Maturity Model

Material change findings shall be described at the highest maturity level actually supported by the evidence. Progression is not automatic; a finding may remain at any level.

Level	Minimum evidentiary meaning	Permitted conclusion
1 - Detected Difference	Accepted observations differ by a documented metric or state.	A difference was measured/observed between specified dates.
2 - Candidate Change	Difference exceeds the applicable noise/artifact criterion and is spatially/technically plausible.	The signal warrants treatment as possible real-world change.
3 - Corroborated Change	Independent evidence, complementary indicators, or additional observations support the change and reduce major artifact explanations.	Change is supported within the defined scope.
4 - Persistent Change	Change persists or evolves consistently across the defined temporal rule/baseline.	A sustained or recurring change condition is supported.
5 - Attributed Change	Independent evidence establishes or strongly supports a specific mechanism/cause at the stated scale.	Change may be attributed to the supported mechanism, with confidence and limits stated.

Critical rule. No report shall use a higher change-evidence label merely because the observed difference is large. Magnitude does not substitute for corroboration, persistence, or causal evidence.

6. Engineering Objective and Change Definition

Before analysis, the project shall define what constitutes relevant change for the customer's decision. The definition should identify the object or analytical unit, variable or state, expected scale, temporal horizon, consequence, and acceptable false-positive/false-negative balance.

- Define the AOI and analytical units before interpreting results where practicable.
- Identify whether the objective is detection, quantification, trend monitoring, prioritization, verification, or attribution.
- Define the minimum change of engineering interest when the customer decision requires one.
- Identify known cyclical, seasonal, operational, or environmental variations that should not be treated as abnormal change.
- Identify whether absence of change is itself a material finding and what detection limit applies.

7. Baseline and Reference-State Requirements

The baseline shall be technically appropriate to the change question. A baseline may be a single accepted reference observation, a seasonal composite, historical distribution, modeled expectation, pre-event condition, customer-defined nominal state, or other justified reference.

Baseline type	Suitable use	Primary caution
Single-date reference	Rapid pairwise comparison, pre/post event, known reference state	Cannot by itself characterize normal variability.
Matched historical dates	Seasonal/phenological comparison	Interannual variability may remain.
Multi-year seasonal baseline	Agriculture, vegetation, hydrology, recurring operations	Requires sufficient accepted observations and stable processing.
Rolling baseline	Operational monitoring where current normal evolves	Baseline drift can conceal gradual change if not controlled.
Engineering threshold/reference	Asset state, regulatory/operational limit, customer-defined condition	Threshold validity and units must be documented.
Model-predicted state	Time-series anomaly/break detection	Model assumptions, residual error, and training period must be evaluated.

- Baseline dates and inclusion/exclusion rules shall be documented.
- Known disturbed or abnormal periods should not silently enter a 'normal' baseline.
- Baseline sample size shall be sufficient for the analytical claim; where it is limited, confidence shall reflect that limitation.
- Changes in sensor, processing baseline, collection geometry, or source product within the baseline shall be controlled or disclosed.

8. Two-Date Change Analysis

Two-date comparison is permitted when both observations are accepted for the intended use and comparability controls are satisfied. It is particularly useful for pre/post event analysis, rapid screening, and measuring state differences.

- Report the dates and exact metric or state being compared.
- Use common valid coverage for pixel-level statistics unless another method is justified.
- Evaluate registration, masking, resolution, temporal comparability, and processing differences before differencing.
- Do not describe a two-date difference as persistent unless persistence is independently established.
- Do not describe a two-date difference as abnormal unless a baseline, threshold, or corroborating evidence establishes expected behavior.
- Do not infer cause solely from the direction or magnitude of a two-date spectral or geometric difference.

9. Time-Series and Persistent-Change Analysis

Where the decision requires persistence, trend, recurrence, anomaly, or change timing, the analysis should use a time series sufficient to characterize expected variability and the candidate change.

Time-series methods may include seasonal composites, rolling statistics, robust trends, trajectory analysis, breakpoint detection, harmonic/phenological models, control charts, or other justified approaches. USGS operational land-change work demonstrates the value of using repeated high-quality observations to model seasonality and trends and to identify observations that diverge from expected behavior; EIS-003 adopts that general principle without prescribing the USGS algorithm.

- Document observation frequency, gaps, and minimum valid-observation requirements.
- Distinguish gradual trend from abrupt break when the distinction affects the decision.
- Define the persistence rule before operational alerting when practicable.
- After a confirmed structural break, determine whether a new baseline/model is required rather than indefinitely comparing to a superseded state.
- Do not allow dense temporal sampling to create false confidence when the underlying observations share the same systematic bias.

10. Seasonal, Phenological, Hydrologic, and Operational Controls

Temporal context shall be evaluated whenever natural or operational cycles can mimic change.

Application context	Controls to consider
Agriculture / vegetation	Crop calendar, planting/harvest, phenology, irrigation timing, rainfall, temperature, field management.
Wetlands / coast	Tide, water level, rainfall, storm surge, turbidity, seasonal vegetation, shoreline dynamics.
Infrastructure / construction	Work schedule, temporary staging, shadows, traffic/vehicle presence, maintenance state.
Industrial / aerospace sites	Operating status, temporary equipment, parked assets, mission/production cycle, lighting/shadow.
Disaster response	Pre-event comparability, event timing, emergency operations, debris removal, recovery activity.
Snow / high latitude	Snow/ice state, sun angle, seasonal illumination, freeze/thaw.

A fixed calendar tolerance shall not substitute for application-specific comparability. The analyst shall explain why dates are comparable enough for the intended claim.

11. Change Magnitude and Direction

- Change metrics shall identify units or dimensionless index and sign convention.
- Absolute change and relative/percent change shall not be interchanged without explanation.
- Percent change shall not be used when the denominator is near zero or otherwise makes the metric unstable without appropriate handling.
- Report robust statistics (for example median and interquartile range) when outliers or non-normal distributions make simple means misleading.
- Where thresholds classify magnitude (minor/moderate/strong, etc.), the threshold basis shall be documented.
- Operational significance shall be assessed separately from numerical magnitude.

12. Spatial Coherence and Analytical Units

Change shall be evaluated at a spatial scale appropriate to the decision. Pixel-level detections may be aggregated into parcels, fields, assets, corridors, watersheds, shoreline segments, facilities, or other meaningful analytical units.

- Isolated single-pixel change should normally receive lower evidentiary weight unless the sensor and target support object-level detection.
- Boundary pixels shall be treated cautiously because mixed pixels and small registration errors can create artificial edge change.
- Area statistics shall use an appropriate projection/geodesic method and shall exclude invalid pixels according to EIS-002.
- Spatial clustering, adjacency, or neighborhood rules may be used to suppress noise or identify coherent change when documented.
- Aggregation shall not conceal materially different conditions within the analytical unit.

13. Thresholds, Anomalies, and Statistical Controls

Thresholds shall be selected to match the analytical objective and shall not be represented as universal physical truths unless independently established.

Threshold basis	Required documentation
Engineering/customer-defined	Decision basis, units, authority, and applicability.
Empirical/project-derived	Reference dataset, derivation method, sample size, and validation.
Statistical	Baseline distribution/model, statistic, significance or anomaly rule, and multiple-testing implications when material.
Literature-based	Source, applicability to sensor/environment, and any adaptation.
Algorithm/provider default	Product/algorithm documentation and reason the default is appropriate.

- Statistical significance shall not be presented as operational significance.
- Large-area pixel testing can generate false positives; spatial coherence, false-discovery controls, aggregation, or other appropriate methods should be considered.
- An anomaly means departure from the selected baseline/model, not automatically damage, failure, stress, or other causal condition.
- Threshold sensitivity should be evaluated when small threshold changes materially alter the decision.

14. False-Change and Artifact Controls

Before accepting a candidate change, the analyst shall consider plausible non-change explanations.

- Misregistration and edge displacement.
- Cloud, cloud shadow, haze, aerosol, smoke, snow/ice, saturation, fill, or mask error.
- Sun-angle, terrain-shadow, bidirectional reflectance, or viewing-geometry effects.
- Water-level, tide, soil wetness, recent rainfall, turbidity, or transient surface condition.
- Seasonal or phenological state.
- Sensor, processing-level, calibration, scaling, resampling, or harmonization differences.
- Mixed pixels and resolution mismatch.
- Temporary objects, vehicles, staging, operational state, or short-duration activity.
- Classification error or threshold instability.

Material artifact hypotheses shall be documented when they cannot be reasonably excluded.

15. Cross-Sensor and Cross-Product Change Analysis

Cross-sensor change analysis is permitted when EIS-002 acceptance requirements are satisfied and the analyst addresses differences that could produce artificial change.

- Compare spectral response, spatial resolution, radiometric processing, acquisition geometry, temporal sampling, and masks.
- Use harmonized products when appropriate, but retain documentation of the harmonization method.
- Do not treat resampling to a common pixel size as proof of equivalent spatial information.
- Where systematic sensor bias is material, estimate/correct it or restrict the claim.
- Cross-product categorical change shall account for differences in class definitions and classification methodology.

16. Corroboration and Causal Attribution

Change detection and causal attribution are separate analytical steps. Corroborating evidence should be selected according to the hypothesized mechanism and may include field observations, engineering records, weather/hydrology, maintenance/operations records, crop information, permits, higher-resolution imagery, customer data, or authoritative public sources.

Evidence state	Permitted language
Change detected; cause untested	Change occurred / candidate change detected; cause unresolved.
Change + mechanism-consistent indicators	Change is consistent with [mechanism]; alternatives remain.
Change + independent corroboration	Evidence supports [mechanism] as a likely/major explanatory factor, with confidence stated.
Mechanism directly established at relevant scale	Change attributed to [cause], with supporting basis and limits stated.

Scale discipline. Regional evidence can support a regional driver without proving that the same driver caused every parcel-, asset-, or pixel-level anomaly. Attribution shall not be transferred across scales without supporting evidence.

17. Monitoring Programs and Alert Logic

Recurring monitoring shall define the logic by which new observations become alerts. The monitoring plan should identify cadence, baseline, valid-data requirements, detection threshold, persistence rule, severity, confidence, escalation, reset, and handling of missing observations.

Alert state	Minimum meaning	Typical action
Watch	A candidate change exceeds a screening threshold but persistence/corroboration is limited.	Retain for next observation; review context.
Advisory	Change is corroborated or repeats and may warrant customer attention.	Analyst review; targeted corroboration.
Action	Persistent/high-confidence change meets defined consequence or customer threshold.	Recommend inspection, operational review, or other specified action.
Data Hold	Required data quality/coverage is insufficient to evaluate the condition.	No change conclusion; reacquire or use alternate source.

- Alert severity and confidence shall be reported separately when both are used.
- Missing or rejected observations shall not be silently interpreted as 'no change.'
- Alert reset/closure criteria shall be defined for recurring monitoring.
- Repeated alerts from the same unresolved condition should be consolidated or tracked to avoid artificial event counts.
- Monitoring systems shall preserve the evidence and logic that generated each material alert.

18. Change Confidence and Reporting

Confidence shall follow EIS-001 and shall be assigned to the specific change claim being made. When necessary, confidence in detection, persistence, and attribution shall be reported separately.

Claim component	Example confidence question
Detection	How strongly does the evidence support that a real difference/change exists rather than artifact?
Magnitude	How reliable is the reported size/intensity of change?
Persistence	How strongly do repeated observations support a sustained/recurring condition?
Attribution	How strongly does independent evidence support the stated cause/mechanism?
Operational significance	How strongly does evidence support the consequence or priority assigned to the change?

Reports should state the change maturity level, metric, dates/baseline, confidence, material limitations, and recommended next action for significant findings.

19. Quality Assurance and Technical Review

- Verify all source observations were accepted for the intended use under EIS-002.
- Recheck registration, common valid coverage, masks, scaling, and derived calculations.
- Verify baseline construction and temporal inclusion/exclusion rules.
- Challenge whether seasonal, operational, hydrologic, atmospheric, or sensor effects could explain the result.
- Check threshold basis and sensitivity where material.
- Verify persistence claims are supported by the defined observation rule.
- Verify causal language does not exceed corroborating evidence.
- Confirm maps and figures distinguish no-data/invalid areas from no-change areas.
- Confirm alert severity, confidence, and recommended action are internally consistent.
- Reperform or independently sample material calculations when practicable.

20. Documentation, Reproducibility, and Release

Material change analyses shall preserve sufficient records for a qualified reviewer to reconstruct the decision path from accepted observations to released finding.

- Source datasets and acceptance dispositions.
- AOI/analytical-unit geometry.
- Baseline definition and included observations.
- Preprocessing, masking, registration, resampling, and common-valid-area rules.
- Change metric/formula, thresholds, model, or algorithm version.
- Statistics and aggregation method.
- Persistence and alert logic when applicable.
- Corroborating sources and attribution rationale.
- Change maturity level, confidence, limitations, and reviewer disposition.

Released products shall identify revision/date and distinguish analytical no-data, invalid-data, below-threshold, and no-change states where those distinctions affect interpretation.

21. Exceptions and Deviations

Project-specific deviations from EIS-003 are permitted when technically justified by the engineering objective, sensor/product characteristics, customer requirements, emergency conditions, or available evidence. The deviation shall identify the affected control, rationale, resulting limitation, and approval/disposition. A deviation does not authorize unsupported persistence or causal claims.

22. Continuous Improvement

UAV Technologies shall review EIS-003 using lessons learned from monitoring programs, false-positive/false-negative performance, customer feedback, technical-review findings, new EO capabilities, and advances in time-series analysis. Default thresholds and alert logic may be refined when validation supports improved decision performance.

Appendix A - Change Detection Record

Field	Requirement / guidance
Change ID	Controlled project identifier.
Engineering objective	Decision question supported by the change analysis.
AOI / analytical unit	Polygon, asset, field, corridor, parcel, watershed, etc.
Source observations	Dataset IDs, dates, EIS-002 disposition.
Baseline	Reference date(s), historical period, model, or engineering threshold.
Change metric	Formula/class transition/geometry/model residual/etc.
Measured difference	Value, direction, area, distribution, or class transition.
Artifact controls	Registration, masks, seasonal/operational factors evaluated.
Maturity level	Detected Difference / Candidate / Corroborated / Persistent / Attributed.
Confidence	Detection and, when applicable, persistence/attribution confidence.
Alternative explanations	Material unresolved hypotheses.
Corroboration	Independent supporting or contradicting evidence.
Recommended action	Monitor, inspect, review records, collect data, no action, etc.
Reviewer disposition	Review complete; comments resolved.

Appendix B - Change Evidence Decision Guide

Detected Difference: Can the analyst reproduce a difference between accepted observations using a documented metric?

Candidate Change: Does the difference exceed expected noise/artifact and form a technically plausible signal?

Corroborated Change: Do additional observations or independent evidence reduce the major false-change explanations?

Persistent Change: Does the signal satisfy the defined temporal persistence/recurrence rule or demonstrate a sustained trajectory?

Attributed Change: Does independent evidence support the proposed cause at the same spatial and temporal scale as the reported change?

Appendix C - Monitoring Alert Record

Field	Minimum content
Alert ID / date	Unique identifier and generation time.
AOI / asset	Affected analytical unit.
Alert state	Watch / Advisory / Action / Data Hold, or customer-defined equivalent.
Trigger	Metric, threshold, persistence rule, or model condition.
Magnitude / extent	Measured value and affected area/units.
Confidence	Detection and relevant persistence/attribution confidence.
Evidence window	Observation dates supporting the alert.
Data quality	Valid coverage and any EIS-002 limitations.
Context / corroboration	Relevant environmental, operational, or customer evidence.
Recommended action	Specified next step.
Status / closure	Open, escalated, resolved, reset, or superseded.

Appendix D - Default Control Objectives

Control	Default objective	Qualification
Two-date result	Report as measured difference/candidate change unless stronger evidence exists.	A pre/post event with direct independent evidence may support higher maturity.
Persistence	Require repeated accepted observations or an appropriate time-series model.	Number/cadence depends on process being monitored.
Common valid area	Use common accepted pixels/units for pairwise quantitative statistics.	Alternative sampling methods require justification.
Registration	Meet EIS-002 objectives appropriate to feature/change scale.	Edge-dominated results require heightened review.
Baseline	Use enough observations to characterize expected variability when claiming anomaly.	No universal minimum count; document limitation when sparse.
Thresholds	Document basis and sensitivity when decision-relevant.	Do not imply universal physical meaning.
No-data	Keep distinct from no-change.	Rejected/missing observation cannot close an alert.
Attribution	Require independent mechanism-relevant evidence.	Magnitude/persistence alone do not establish cause.

Informative Technical Basis

EIS-003 is an original UAV Technologies standard. Its controls are informed by established remote-sensing change-analysis principles and operational examples in which repeated, quality-controlled observations are used to characterize expected behavior and detect departures from that behavior. USGS LCMAP, for example, applies time-series modeling to Landsat Analysis Ready Data and produces change timing, magnitude, stability, and model-quality products. EIS-003 does not adopt or require the LCMAP/CCDC algorithm; it uses that work as an informative example of disciplined time-series change monitoring.

- U.S. Geological Survey, Land Change Monitoring, Assessment, and Projection (LCMAP) Science Products.
- U.S. Geological Survey, Continuous Change Detection and Classification (CCDC) product and algorithm documentation.
- Zhu, Z. and Woodcock, C.E. (2014), Continuous change detection and classification of land cover using all available Landsat data, Remote Sensing of Environment.
- UAV Technologies EIS-001, Engineering Observation, Analysis, and Reporting Methodology.
- UAV Technologies EIS-002, Earth Observation Data Quality and Acceptance Standard.

Customer transparency. Publication of EIS-003 allows customers to understand how UAV Technologies distinguishes a simple observed difference from corroborated, persistent, and causally attributed change in proposals, monitoring programs, case studies, and Engineering Intelligence reports.