Continuous Physical Assurance

The Missing Layer in Global Infrastructure Finance

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Infrastructure assets that cannot demonstrate continuous physical health will carry a risk premium. Infrastructure assets that can will price that certainty into every financial instrument that references them. This paper introduces the framework, the methodology, and the mechanism that makes this possible for the first time.

Executive Summary

The infrastructure finance system operates on an assumption it has never verified: that the physical assets underlying $4.2 trillion in institutional allocation perform as modeled, reported, and claimed. This assumption is asserted by operators and fund managers, passed upstream through the capital stack as fact, and embedded into every financial covenant, ESG disclosure, and PPP payment mechanism that depends on it. It is never independently confirmed. It is never continuously monitored. It has always been taken on trust.

The cost of this trust is now measurable. Infrastructure distress rates have risen 148% in 43 months, reaching 11.98% in January 2026. $875 billion of infrastructure debt matures in 2026 alone, each refinancing requiring a physical condition report that the existing episodic advisory model cannot produce at the required volume or currency. ESG disclosure frameworks are tightening from voluntary review to personally-liable attestation under ISSA 5000, the new international sustainability assurance standard approved by the IAASB in 2025. 140 UK PFI contracts require independent physical handback surveys before 2030. In each case, the same structural failure appears: the mechanism designed to confirm physical performance is either episodic, self-reported, or both.

This paper introduces the framework, the methodology, and the mechanism that makes this possible for the first time — and extends an invitation to the industry to shape what the standard becomes. Continuous Physical Assurance (CPA) — the independent, physics-verified data layer connecting what infrastructure assets actually do to the financial, legal, and regulatory frameworks that depend on them doing it. CPA is produced continuously, not episodically. It is derived from physics — not models, not inference, not self-declaration. One data engine serves lenders, insurers, equity investors, ESG practitioners, governments, and secondaries buyers simultaneously, producing institution-grade output in the format each audience requires.

CPA introduces two instruments that have not previously existed in infrastructure finance.

The **Operational Health Index (OHI)** is a methodology, an independent measure of infrastructure physical health on a scale of 0 to 100, derived from physics, updated every four seconds, and immutable once asserted. The OHI Methodology v0.1 is introduced in this paper and maintained by 6SenseGlobal, LLC. The Plumb & Veracity Institute — the independent standards body that will ultimately govern the OHI Standard — is the institutional destination toward which this practice is being built. VERA, operated by 6SenseGlobal LLC (6SG), is the first OHI methodology-certified platform. The patent protects the method. FRAND licensing governs the methodology. The distinction is legally precise and institutionally critical.

The **Capital Trigger** is a binary financial mechanism — ACTIVE or SUSPENDED — derived directly from the OHI and governing bond disbursement, covenant compliance, availability payments, and insurance contingencies automatically, without human judgment and without delay. The capital trigger does for infrastructure finance what the circuit breaker did for equity markets: it connects a physical reality to a financial mechanism in real time. It is the first physics-linked financial instrument.

CPA operates within the frameworks institutions already depend on — ISSA 5000, ISO 55001, ISO 22372:2025, SFDR PAI, GRESB, UN/CEFACT, and the existing LIE/LTA conventions of infrastructure lending. No new regulatory framework is required. The frameworks now demand exactly what CPA provides. A real-time, continuously-updated, asset-specific binary trigger governing covenant compliance, bond disbursement, availability payment release, and insurance contingencies simultaneously — derived from a standardized physical, operational health index — does not exist in infrastructure finance.

This paper names the category, defines the methodology, describes the mechanism, and extends an invitation to participate in shaping the practice before others define it without you.

Intended Audience

This paper is not addressed to technology buyers. It is addressed to the institutions that carry the risk, the regulatory exposure, and the mandate to close the verification gap it describes. Five audiences share that mandate — each with its own language for the same structural problem.

Infrastructure Debt Participants
Lenders, credit committees, debt fund managers, and Lenders' Technical Advisor firms for whom the interval between LTA reports represents unmonitored physical risk. The Capital Trigger mechanism introduced in this paper is written into loan documentation. The Verification Report replaces the point-in-time LIE Report with a continuously-produced, physics-verified monitoring record.

ESG and Sustainability Practitioners
Chief Sustainability Officers, fund ESG teams, sustainability assurance auditors, and practitioners working under ISSA 5000, SFDR PAI, and GRESB frameworks for whom the shift from voluntary disclosure review to personally-liable physical attestation creates an evidential gap that self-reported annual data cannot close. The Certification Report is designed for this audience.

Governments and PPP Authorities
Contracting authorities, PPP monitoring units, treasury and finance ministries, development finance institutions, and bodies such as the National Infrastructure and Service Transformation Authority (NISTA) whose oversight mandates require independent physical verification of asset performance that operator self-reporting cannot provide. The Assurance Report is designed for this audience.

Infrastructure Equity Investors and Secondaries
Fund managers, LP oversight teams, asset management professionals, and secondaries buyers for whom the physical condition of an asset at the time of acquisition, re-rating, or reporting cycle is currently unknown, estimated, or taken on trust from a counterparty with a direct interest in a favourable result.

Insurers and Reinsurers
Infrastructure asset insurers, parametric insurance underwriters, and reinsurers for whom physical asset health is a direct input to risk pricing, contingency activation, and claims assessment — and for whom that input is currently derived from the same episodic, self-reported data that governs lending decisions. The Capital Trigger's ACTIVE and SUSPENDED states map directly to insurance contingency mechanisms. Continuous physics-verified monitoring changes what infrastructure insurance can know, when it can know it, and how it can respond.

Standards Bodies, Regulators, and Academic Institutions
The IAASB, GRESB, ISO working groups, UN/CEFACT, and research institutions engaged in the development of infrastructure disclosure and assurance frameworks. The OHI Methodology is presented as a practitioner contribution to a standard-setting process that requires exactly this kind of empirical, physics-grounded starting point. Participation in shaping what becomes the standard is the purpose of this paper's invitation.

> If you are responsible for the physical veracity of assets you own, lend against, insure, report on, or oversee — this paper is for you. If you are responsible for the frameworks that govern how that veracity is established — this paper is also for you.

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I

The Unverified Assumption

The global infrastructure finance system rests on a single assumption that has never been tested: that infrastructure assets perform as modeled, as reported, and as claimed. Every covenant ratio, every SFDR disclosure, every PPP availability payment, every secondary transaction, every insurance premium is priced against this assumption. The assumption is never verified. It is asserted — by the operator, the fund manager, the developer — and then passed upstream through the capital stack as fact.

The financial system has constructed $4.2 trillion of institutional real asset allocation on an evidential layer that does not exist. Not because the industry is negligent. Because the means to verify physical performance continuously, at institution-grade output quality, and at the cost structure required for systematic adoption, did not exist until now.

Infrastructure distress rates have risen 148% over 43 months. They stand at 11.98% as of January 2026 and are projected to reach 15% by December 2026. $875 billion of infrastructure debt is maturing in 2026 alone. ESG disclosure frameworks are tightening from voluntary review to personal-liability-attached attestation. Governments with long-term PPP commitments have launched new oversight authorities whose mandates explicitly require independent physical verification of asset performance. Every force is moving in the same direction.

> *Infrastructure assets that can demonstrate continuous physical health will price that certainty into every financial instrument that references them. Those that cannot will carry a risk premium that compounds with every passing reporting cycle.*

The gap is not a gap in technology. It is a gap in institutional practice. This paper introduces the framework that closes it.

II

The Substrate Problem

Infrastructure is the substrate of every financial, legal, and regulatory framework in the world. Roads, bridges, energy assets, water systems, data centers, and transport networks are not simply assets on a balance sheet. They are the physical layer on which every transaction, every compliance obligation, every sovereign commitment is premised. When the substrate degrades, everything built on top of it is compromised — not eventually, but immediately and structurally.

Every bond, every covenant, insurance premium, every SFDR disclosure, every PPP payment assumes that infrastructure performs. None of them verify it continuously. This paper introduces the framework that changes that.

Three existing processes attempt to address this, and each fails in a structurally identical way.

The Episodic Technical Report

The Lenders' Independent Engineer Report — the LIE Report or Lenders' Technical Advisor Report — has been the primary mechanism for physical condition verification in infrastructure finance for decades. The process is: trigger event, commissioning, scope definition, site visit, draft, response, final report. Duration: twelve to twenty weeks. Output: a point-in-time snapshot of an asset that has been changing continuously since the previous report. The snapshot is then used to make financial decisions for the next twelve to twenty-four months.

The Self-Reported ESG Score

GRESB — the primary ESG benchmark for real assets — operates on an annual cycle. The fund manager self-reports physical performance data. GRESB scores and ranks. LPs receive the score and log it as evidence of physical condition. The score reflects performance at a single point in the previous year. Between annual cycles, the asset may perform entirely differently. The score persists. The gap between score and physical reality is alive and growing every day of the twelve-month cycle. No one sees it. No one reports it. Everyone acts as if it does not exist.

The Operator Self-Declaration

In Public-Private Partnership contracts, the PFI Co — the operator — self-reports its own compliance with the output specification. The authority that awarded the contract and makes the availability payment receives a declaration from the entity whose payment depends on that declaration being satisfactory. There is no structural mechanism for independent continuous verification. The payment mechanism and the reporting mechanism are operated by the same party.

III

The Category: Continuous Physical Assurance

Continuous Physical Assurance is the independent, physics-verified data layer connecting what infrastructure assets actually do to the financial, legal, and regulatory frameworks that depend on them doing it — produced continuously, not episodically.

This is not a new software product. It is not a digital twin. It is not an ESG consulting service. It is not a lenders' technical report delivered faster. It is a new category of institutional practice — the systematic, independent, physics-verified confirmation that the physical world matches the financial and regulatory world's assumptions about it, updated in real time, and available as institution-grade output to every stakeholder that depends on those assumptions.

Five Founding Principles

— **Physics primacy.** Physical observation precedes financial assertion — not the reverse. The condition of the asset determines the status of the covenant, the score, and the payment. The financial instrument does not determine the condition of the asset.

— **Continuous production.** Assurance is a state, not an event. The evidential record is live and current. The twelve-week gap and the twelve-month cycle are structural failures of process, not unavoidable properties of the task.

— **Independence.** The producer of the physical evidence cannot be the operator of the asset. The assurance value of any data produced by the entity whose revenue depends on its outcome is zero.

— **Multi-framework output.** One data engine serves financial, regulatory, and governmental audiences simultaneously. The data does not change. The reporting lens changes with the audience.

— **Audit trail integrity.** Every assertion is timestamped, attributable, and reproducible. Any assertion that cannot be traced to a specific physical observation at a specific time by a specific method is not an assertion. It is an opinion.

> *Continuous Physical Assurance is not a product. It is an institutional practice that the infrastructure finance system has been building toward for thirty years without a name for it.*

Adjacent categories exist and are well established. Asset Integrity Management serves oil, gas, nuclear, and heavy industrial — producing engineering output for engineers. Independent Technical Assurance serves project finance — episodically. ESG Sustainability Assurance serves disclosure review — for reported data. Physical Climate Risk Assessment serves exposure modeling — for modeled projections. None of them produce what CPA produces: continuous, physics-verified, institution-grade evidence of physical performance across the financial, regulatory, and governmental frameworks simultaneously.

IV

The Problem in Five Dimensions

The same structural failure — physical performance assumed but never continuously verified — presents differently across five distinct institutional contexts. Each has its own language, its own cost, and its own regulatory exposure. Each is resolved by the same data engine.

1. Infrastructure Debt — The Covenant Gap

The infrastructure debt market carries $168 billion in AUM and is growing at 14.4% annually. Every loan in that market is governed by financial covenants — DSCR, LTV, coverage ratios — that are lagging financial indicators measured quarterly. What those covenants do not measure is the physical condition of the asset that produces the cash flow they reference. By the time a financial covenant signals distress, the physical degradation that caused it has been accumulating, undetected, for months or years. $875 billion of infrastructure debt is maturing in 2026. Every refinancing event triggers a technical report requirement. The advisory model that services this demand — twelve to twenty weeks per engagement — cannot service the volume. A continuous physical monitoring capability is not an upgrade to the LIE Report. It is the only viable response to the maturity wall.

2. ESG and LP Oversight — The Attestation Gap

SFDR's Principal Adverse Impact indicators require physical performance disclosure. ISSA 5000 — the new international sustainability assurance standard approved by the IAASB in 2025 — extends assurance scope explicitly to include physical information in sustainability reporting. GRESB's 2025 standards changes address verification and assurance of infrastructure data directly. The frameworks are moving from voluntary disclosure review to required physical attestation. The personal liability attaching to ESG sign-off is increasing with every revision cycle. The data available to sign off against has not changed. It is still self-reported. It is still annual. It is still unverified. The exposure that attaches to a Chief Sustainability Officer or an audit partner who provides an assurance opinion on self-reported, unverified physical data under ISSA 5000 is the commercial engine that drives CPA adoption in this market.

3. PPP and Government — The Verification Gap

There are 665 operational PFI contracts in the United Kingdom representing £50 billion in capital investment and £136 billion in committed unitary charges to 2052. The operator self-reports compliance with the output specification. The authority that makes the payment receives a declaration from the entity receiving the payment. NISTA — the National Infrastructure and Service Transformation Authority, launched April 2025 — has an explicit mandate to improve oversight of this system. CPA provides the independent, continuous verification of output specification compliance that makes government oversight of PPP performance possible rather than nominal.

4. Infrastructure Secondaries — The Inheritance Gap

The infrastructure secondaries market is one of the fastest-growing segments of the asset class. Every secondary transaction involves a buyer inheriting the physical risk of an asset without the benefit of the original underwriting due diligence that established the asset's physical baseline. The instrument available to close this gap is a site visit report that may be three years old, produced by the vendor's adviser, reflecting a physical state that has since changed. A rapid CPA assertion cycle — producing a current, independent, physics-verified physical condition report — is available at a fee that is a rounding error on secondary transaction costs. The risk it addresses is not a rounding error.

5. PFI Handback — The Condition Gap

140 PFI contracts are expiring before 2030. Every one of them triggers a contractual requirement for an independent handback condition survey — the physical assessment that determines whether the asset is returned to the authority in the condition specified by the contract and whether remedial works obligations are triggered. This is the most mechanical, non-discretionary, contractually mandated demand for physical condition verification in the UK infrastructure market. Approximately 28 surveys per year represent near-term, certain demand with no dependency on product adoption decisions. The authority requires it. The contract requires it. The operator cannot provide it. CPA delivers it.

V

Why Physics Is the Answer

The infrastructure assurance market has already tried the alternatives. Models have been built. Algorithms have been trained. AI has been applied. Each of them has produced the same category of output: a better estimate of what might be happening, derived from data that someone else already reported.

The fundamental problem with estimates, models, and AI-derived outputs in an assurance context is that they inherit the uncertainty of their inputs. A model trained on self-reported data produces a better model of self-reported data. It does not produce ground truth. An AI system that synthesizes asset management reports produces a summary of what was reported. It does not verify what was reported. These tools have value in their domains. They do not have assurance value in the legal, regulatory, and financial sense that infrastructure institutions require.

> *No AI. No inference. No model. No assumption. Physics only. The condition of the asset is observed, not estimated. The observation is timestamped, attributed, and immutable.*

Physics operates without assumption. A structural load is either within tolerance or it is not. A pressure differential is either within specification or it is not. A thermal reading either matches the expected profile or it does not. The physical world does not negotiate with financial models. It performs or it does not. The assurance value of a physics-derived observation is categorically different from the assurance value of a model output, an AI inference, or a self-declaration, because it has a different epistemological status: it is a measurement, not a conclusion.

The Convergence That Makes This Possible Now

Four forces have converged to make Continuous Physical Assurance economically viable and institutionally necessary simultaneously.

Regulatory. SFDR 2.0 was proposed in November 2025. ISSA 5000 was approved in 2025. GRESB's 2025 standards changes explicitly address verification and assurance of infrastructure data. The direction of travel is unambiguous: from disclosure review to physical attestation. This is not a trend. It is a regulated endpoint.

Financial. $875 billion of infrastructure debt matures in 2026. The distress rate stands at 11.98% and is rising. The secondaries market is growing. The covenant monitoring gap is compounding. The financial system needs a physical intelligence layer that is faster, more current, and more continuous than the episodic advisory model can provide.

Technological. The physical monitoring infrastructure — satellite, sensor, data transmission, computation — now exists at a cost and scale that makes institution-grade continuous monitoring economically viable across an infrastructure portfolio for the first time. The digital twin market is $35.82 billion growing at 31.1% CAGR, precisely because this infrastructure is being built globally.

Political. Governments with long-term infrastructure commitments — PFI handbacks, Vision 2030, energy transition programs — require independent physical verification of asset performance that does not depend on operator self-reporting. NISTA is the most concrete institutional signal. It will not be the last.

VI

The OHI Methodology

Continuous Physical Assurance requires a unit of measure. Without a standardized, independently defined measure of physical health, CPA produces useful data but not comparable, certifiable, or financially linkable outputs. The Operational Health Index — OHI — is that measure.

THE OPERATIONAL HEALTH INDEX

- A number. Zero to one hundred.
- Derived from physics. Not from models, estimates, or declarations.
- Updated every four seconds during active monitoring.
- Immutable once asserted. The record cannot be altered after the fact.
- Designed to be certifiable by an independent body against a published standard.
- Linked to financial mechanisms, including the Capital Trigger.

The OHI Methodology v0.1 presented in this paper is a first rigorous definition — built from first principles by 6SenseGlobal and offered to the industry as the starting point for a collaborative standard-setting process, not as a conclusion of one. The distinction is deliberate.

A methodology becomes a standard when the industry that depends on it has tested it, challenged it, contributed to it, and elected to adopt it. That process takes time, requires institutional participation, and produces something more durable than any single organization's vision of what the right answer should be. 6SenseGlobal has built the methodology and the first implementation of it. What the OHI becomes as a standard is properly a function of who uses it, what they find, what they require, and what the independent governance process determines. This paper initiates that process. It does not conclude it.

> The OHI Methodology is not a finished standard asserted as complete. It is a rigorous starting point, offered to the infrastructure finance community with an explicit invitation to shape what it becomes.

The OHI is a measure, not a model. The number it produces, the assurance properties it carries, and the financial mechanisms it governs are defined in this paper. How the OHI is computed — the algorithm, the sensor specifications, the data processing methodology, and the assertion protocols — is the subject of OHI Methodology v0.1 and its successors. The method is protected under Patent Pending Application #19/576,486. The methodology will be published under FRAND licensing terms — Fair, Reasonable, and Non-Discriminatory — ensuring that any implementation meeting the standard requirements may participate in the certification framework.

The OHI is an infrastructure asset's credit score. A credit score does not reveal the algorithm by which it is calculated. It reveals the number, the interpretation framework, and the financial consequences of the number's position. The OHI operates on the same principle: the output is public, transparent, and financially actionable. The computation is protected, versioned, and open to industry review as the standard evolves. The goal is not a proprietary specification owned by one company.

The goal is a standard that the infrastructure finance system can trust because the industry helped build it.

VII

The Capital Trigger

The capital trigger is the most significant innovation introduced in this paper. It is not a feature of a platform. It is a new category of financial instrument.

Infrastructure finance has always sought to connect physical performance to financial flows. Covenant ratios attempt this with financial indicators. ESG scores attempt this with reported metrics. Both are lagging, indirect, and subject to human judgment and delay. The capital trigger is none of these things.

THE CAPITAL TRIGGER: DEFINITION

A binary state — ACTIVE or SUSPENDED — derived directly from physics via the OHI.
Updated in real time. Determined without human judgment.

When ACTIVE, it governs:

- Bond disbursement
- Covenant compliance status
- Availability payment release
- Insurance contingency activation

When SUSPENDED, each of these mechanisms responds automatically and immediately — without waiting for a quarterly report, a credit committee meeting, or a site visit.

The closest analogy in financial markets is the circuit breaker — the mechanism that halts equity trading when price movement exceeds a defined threshold. The circuit breaker does not require a committee decision, a risk assessment, or a human judgment. It reads a measured state and responds automatically. It was introduced because the financial system recognized that human judgment, under time pressure and information asymmetry, produces worse outcomes than a pre-defined, automatic response to a measured condition.

The mechanism is contractual pre-commitment: the OHI threshold, the binary states, and the financial consequence of each state are defined in the instrument itself, referencing the OHI data feed by name, such that the consequence executes on the measured state rather than on a human assessment of it.

> *The capital trigger does for infrastructure what the circuit breaker did for equity markets: it connects a physical reality to a financial mechanism automatically and without human judgment or delay.*

The capital trigger has not existed before because the prerequisite did not exist: a continuous, independent, physics-verified measure of physical performance that updates faster than the financial

mechanism it governs. The OHI is that measure. VERA is the first implementation of a system that produces it.

The capital trigger is not a risk score. Risk scores are probabilistic. The capital trigger is deterministic. It reads a physical state and translates it into a binary financial condition. The financial institution does not need to interpret it. The legal document does not need to define what a risk score means in operational terms. The capital trigger is already in binary terms: the condition that governs the financial mechanism is either met or it is not.

VIII

The Institutional Value of a Standardized Operational Health Index - Seven Properties

The OHI is institutionally valuable because it is physics-derived. That is the foundation. But physics alone does not explain the value of a *standardized* measure — and the standardization is as important as the physics. The infrastructure finance system does not lack data. It lacks a single, consistent, independently produced measure of physical condition that is comparable across asset types, geographies, operators, and reporting cycles. The OHI is that measure. Understanding why a scalar matters as much as what it measures is the institutional argument this section makes.

Comparability — The Case for a Single Number
Raw sensor data from a highway bridge in Ontario cannot be compared to raw sensor data from a water treatment facility in Abu Dhabi or a biologics manufacturing suite in North Carolina. The asset types are different, the sensor configurations are different, the physics parameters are different, and the operator reporting conventions are entirely incompatible. An institution holding all three in its portfolio currently has three unrelated data sets and no common language for the physical condition of any of them.

The OHI resolves this. One methodology. One scale. One number for every asset, regardless of class, geography, or operator. The institutional value of comparability is not abstract — it is what makes portfolio-level risk intelligence possible for the first time. A lender monitoring fifteen infrastructure projects across five jurisdictions can, for the first time, read the physical condition of its entire portfolio in a single view and rank assets by OHI trend rather than by which LTA report arrived most recently. The credit score analogy is precise: its value to institutions is not the algorithm, it is the comparability the algorithm enables.

Independence — The Value That Self-Reporting Cannot Provide
An operational health assessment produced by the asset operator has zero assurance value in any institutional context. This is not a criticism of operators — it is a structural observation about how assurance works. Assurance derives from independence. The financial system already understands this: it is why credit rating agencies exist rather than borrower self-ratings, why independent auditors are required rather than management sign-off alone, why the Lenders' Technical Advisor is engaged rather than the developer's own engineer. The OHI applies this principle to physical condition monitoring — continuously, not episodically.

The independence of the OHI is structural, not procedural. VERA, operated by 6SenseGlobal, produces the OHI from physics observed independently of the operator. The operator does not control the sensors, does not access the assertion chain before it is recorded, and cannot alter the record after it is immutable. This is not a stronger version of the existing episodic LIE Report process — it is a categorically different evidential basis. The assurance value of a continuously-produced, independently-observed OHI record is of a different order from any condition assessment the operator produces about itself.

Financial Linkage — From Measure to Mechanism
Most physical condition data produces a report. The OHI produces a trigger. This distinction is the single most significant institutional property of the measure, and it is unique to the OHI among all existing physical condition assessment frameworks.

Via the Capital Trigger — defined in the following section — the OHI governs bond disbursement, covenant compliance status, availability payment release, and insurance contingency activation, automatically and without human judgment. No physical condition measure has previously been defined in terms that make it directly operable as a financial mechanism. DSCR and LTV are financial ratios that proxy for physical condition — lagging, indirect, and subject to the delay of the reporting cycle. The OHI is the physical condition, expressed as a number that the financial instrument reads directly. The gap

between physical reality and financial response, which has always been measured in reporting cycles, collapses to the cadence of the assertion — four seconds.

Liability Protection — The Defensible Record

The liability landscape for infrastructure disclosure is changing in one direction. ISSA 5000, approved by the IAASB in 2025, extends assurance scope to physical performance data and attaches personal liability to the sign-off. SFDR's proposed revisions tighten the physical disclosure obligations on regulated funds. GRESB's 2025 standards changes address verification and assurance of the data underlying annual scores. In each case, the person who signs the disclosure — the Chief Sustainability Officer, the audit partner, the fund manager — is increasingly exposed to the quality of the evidence behind what they sign.

Self-reported, annually-produced, operator-attested physical performance data is not a defensible evidential basis for that sign-off. It is the basis currently in use across the industry. The OHI — immutable once asserted, traceable to a specific physical observation at a specific time by a specific method, produced independently of the entity being reported on — is the only continuously-produced physical condition record that provides a defensible basis for ISSA 5000 assurance engagements, SFDR PAI disclosures, and the evolving personal liability obligations that attach to infrastructure physical performance attestation.

Portfolio Intelligence — What Standardization Makes Possible at Scale

The final institutional value of the OHI is visible only at portfolio scale — and it is the value that the infrastructure finance system has had no means to access until now. A standardized, continuously-produced, physics-derived operational health score across every asset in a portfolio creates a risk intelligence layer that episodic, format-inconsistent, point-in-time condition reports cannot produce regardless of their frequency.

WHAT PORTFOLIO-LEVEL OHI INTELLIGENCE ENABLES

— Rank assets by OHI trend, not by recency of the last report
— Identify early-stage deterioration across a portfolio before it reaches covenant thresholds
— Aggregate physical condition data for ESG portfolio reporting with a single consistent methodology
— Benchmark asset physical performance across operators, geographies, and asset classes
— Produce a current, defensible physical condition profile for every asset at any point in the reporting cycle
— Provide secondary buyers with a physics-verified condition baseline before a transaction closes

The first five institutional values of a standardized Operational Health Index address what the measure produces — comparability, independence, financial linkage, liability protection, and portfolio intelligence. The sixth and seventh address what the measure changes: the quality of capital allocation decisions, and the timing intelligence with which every institutional decision is made. These two properties are distinct. Capital discipline governs how much to spend and where. Decision intelligence governs when to act. Together, they close the gap between a measure that informs and a measure that transforms.

Capital Discipline — From Calendar-Based to Condition-Based Allocation

Capital expenditure in infrastructure is governed by two forces: the calendar and the crisis. Assets are replaced, upgraded, or overhauled on schedule — or after a deterioration event compels it. Neither mechanism is condition-based. An asset running at OHI 91 and trending stable has no evidence-based argument to defer its scheduled overhaul. An asset sliding from OHI 74 to 66 over sixty days has no

mechanism to accelerate its capital allocation before the decline crosses a covenant or compliance threshold. The OHI provides both — simultaneously, and continuously.

The capital discipline value of a standardized, continuously-produced OHI operates in three modes.

Deferred CapEx with evidence. An OHI record sustained in the HEALTHY state — trending stable, independently produced — is the first evidence-based basis for extending an asset's useful life beyond its scheduled replacement interval. The deferral is not an operator decision; it is a physics-justified one. On a single major infrastructure asset, a justified deferral is worth tens of millions. The cost of the OHI record that justifies it is a fraction of that. Without the OHI record, the deferral is a risk. With it, the deferral is a defensible capital decision.

Accelerated CapEx with early warning. The WATCH state fires at OHI below 70 — before a deterioration event reaches a compliance threshold, a covenant breach, or a forced-maintenance event. It converts reactive capital mobilization into planned capital deployment. The cost differential between reactive and planned CapEx in infrastructure environments is consistently two to four times. The WATCH state is not a warning label. It is a capital planning signal — the earliest signal in the asset's history that has been physics-verified rather than operator-reported.

Commissioning baseline integrity. A facility or asset monitored from commissioning opens with a physics-verified day-zero condition record. Every subsequent capital decision — renovation, expansion, replacement — is traceable to a verified starting point. Without a commissioning baseline, starting conditions are estimated. Estimated starting points compound into contested capital decisions across the asset's life. Physics-verified starting points do not. The commissioning record is not administrative; it is the foundation of every capital decision that follows.

Decision Intelligence — The Physics-Informed Timing Signal

The OHI answers two questions: what is the condition of this asset, and when is the right moment to act? The score answers the first. The trend — the rate and direction of change across continuous assertion cycles — answers the second. The trend is where the decision intelligence resides.

Infrastructure decisions are consequentially time-sensitive. A refinancing executed at OHI 84 and trending stable captures a different risk premium than the same transaction executed at OHI 79 and declining. An asset disposition timed to a sustained HEALTHY state produces a different transaction outcome than one executed after a WATCH state has appeared on the OHI record. An insurance renewal negotiated with a ninety-day continuous OHI record in the HEALTHY state reaches a different result than one supported by a point-in-time inspection report nine months old. The timing of the decision is as consequential as the decision itself — and timing, until the OHI, has never had a physics-informed signal to optimize around.

The decision intelligence value of the OHI operates across four institutional contexts.

In capital markets. The OHI trend defines the optimal window for refinancing, covenant renegotiation, and secondary market execution. Institutions that time these transactions to physics rather than to schedule are operating with information their counterparties do not have. The OHI trend is not a forecast — it is a current, verified condition signal. Acting within the window it defines is not speculation; it is evidence-informed execution.

In insurance and risk transfer. The OHI record determines when a risk profile has improved sufficiently to support a premium review, when a deterioration trend warrants proactive disclosure, and when the evidential basis for a coverage renegotiation is most favorable. Premium decisions timed to continuous condition evidence consistently outperform those timed to annual inspection cycles. The difference is not marginal — it is the difference between negotiating from evidence and negotiating from assumption.

In regulatory and compliance engagement. The OHI trend provides advance visibility into when a compliance event is approaching — before it arrives. Proactive regulatory engagement initiated while the OHI is in the WATCH state is structurally different from remediation initiated after a breach. It is the difference between a managed compliance narrative and a reactive one. Every regulatory authority across every jurisdiction responds differently to an operator who arrives before the threshold than to one who arrives after it.

In asset management. The OHI trend determines when to hold, when to invest, and when to exit. A declining OHI trend on a portfolio asset that has not yet breached a market-visible threshold creates an information asymmetry that an owner with continuous condition data can manage — and a buyer without it cannot price. The physics-informed timing advantage is a decision intelligence asset that exists only if the OHI exists. It is not derivable from financial ratios, operator reports, or episodic inspections. It is available only through continuous, independent, physics-verified condition monitoring.

WHAT DECISION INTELLIGENCE ENABLES

- Refinancing and capital raise timed to OHI trend, not to the maturity schedule
- Insurance premium renegotiation anchored to continuous, independent condition evidence
- Asset disposition and acquisition timed to physics, not to calendar or operator assertion
- Regulatory engagement initiated before breach, not compelled by it
- Maintenance scheduling aligned to actual deterioration rate, not assumed service intervals
- Transaction due diligence anchored to a verified continuous condition record

The seven institutional values of a standardized Operational Health Index, taken together, constitute the evidential and decision-support infrastructure that the infrastructure finance, GMP manufacturing, and ESG compliance systems have required — and have had no means to access — until the OHI.

#	Value	What It Changes
I	Comparability	One Number, any asset, any geography - portfolio-level risk intelligence becomes possible
II	Independence	Physics-verified, operator-independent record - assurance value that self-reporting cannot produce
III	Financial Linkage	From measure to mechanism - the OHI governs bond disbursement, covenants, and availability payments directly
IV	Liability Protection	Immutable, independently-produced record - the defensible evidential basis for ISSA 5000, SFDR, and GRESB sign-off
V	Portfolio Intelligence	Standardized, continuous, comparable data across every asset - a risk intelligence layer that episodic reporting cannot produce

#	Value	What It Changes
VI	Capital Discipline	Condition-based CapEx allocation - defer with evidence, accelerate with early warning, commission with a verified baseline
VII	Decision Intelligence	Physics-informed timing signal - the right moment to refinance, insure, disclose, dispose, or engage regulators

None of these capabilities are available to any infrastructure institution today, at any price, through any existing methodology. They are not available because the standardized, continuous, independent data layer they require does not exist — not because the institutions lack the appetite for them. The OHI is not a better version of what exists. It is the prerequisite for an entirely new class of infrastructure risk intelligence that the industry has assumed it could not have.

The score tells you where the asset stands. The trend tells you when to act. For the first time, both are physics-verified, independently produced, and continuously available — across any asset, any geography, any regulatory framework, and any institutional decision that depends on knowing what infrastructure actually does.

IX

The Standards Architecture

Continuous Physical Assurance does not require new regulatory frameworks. It operates within, and enables compliance with, the frameworks that institutional infrastructure investors and regulators already depend on. The architecture is simple.

ISSA 5000 — Sustainability Assurance

The International standard on Sustainability Assurance, approved by the IAASB in 2025, replaces ISAE 3000 as the primary standard for assurance engagements on sustainability information. ISSA 5000 explicitly extends assurance scope to include physical performance data — not just reported disclosures. The CPA Certification Report is designed to be the primary input for ISSA 5000 assurance engagements on infrastructure assets. No other method produces physics-verified physical performance data in a form that is ISSA 5000 assurance-ready.

ISO 55001 — Asset Management

ISO 55001 is the international standard for asset management systems. It requires systematic, evidence-based monitoring of asset condition as a core operating requirement. The OHI, updated every four seconds and maintained as an immutable record, is the evidence layer that ISO 55001-certified asset management systems assume exists but that no previous technology has delivered continuously. CPA is the practical implementation of the ISO 55001 monitoring requirement.

ISO 22372:2025 — Infrastructure Resilience

ISO 22372:2025, published by ISO/TC 292 in November 2025, establishes guidelines for infrastructure resilience across all infrastructure types and sectors. The standard explicitly requires the collection of physical evidence (§6.2.2), continuous monitoring and reporting of infrastructure resilience performance (§6.7, Principle P6A3: Monitor and Report), the adoption of condition-based maintenance informed by observed physical condition (§6.9.2, Principle P2A11), and the inspection of assets following disruptive incidents (§6.9.3, Principle P2A13). These are not aspirational principles — they are operational requirements that the standard's own introduction acknowledges most current infrastructure approaches do not fulfill. The OHI is the physics-verified evidence layer that makes ISO 22372 operational rather than declarative. The Methodology defines what must be done. It does not define the mechanism by which it is done. CPA aligns directly with ISO 22372's operational requirements — and may represent the first implementation that not only satisfies the standard's physical evidence and reporting obligations, but connects that evidence to financial mechanisms. Where ISO 22372 calls for physical evidence to inform resilience governance, the OHI provides it. Where ISO 22372 calls for monitoring and reporting, the CPA report suite delivers it. Where ISO 22372 is silent — on how physical evidence connects to financing — the Capital Trigger completes the chain. CPA does not claim to have contributed to ISO 22372. It claims to be what ISO 22372 has been waiting for.

SFDR / Principal Adverse Impact

SFDR’s PAI indicators require disclosure of physical performance data for infrastructure assets held by regulated funds. The data available to meet this requirement is currently self-reported, annual, and unverified. The CPA Certification Report provides physics-verified physical performance data in a format that maps directly to SFDR PAI disclosure requirements, making the disclosure defensible in a regulatory examination context.

GRESB / Infrastructure Benchmark

GRESB's 2025 infrastructure standards changes explicitly address verification and assurance of the data that funds report. The annual self-reporting cycle that currently generates GRESB scores creates a twelve-month living gap between score and physical reality. CPA closes that gap to near-zero by providing continuous, verified physical performance data that generates GRESB-formatted outputs at any point in the reporting cycle.

UN/CEFACT - Cross-Border Data Standardization

The United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT) develops the international data exchange standards that govern how structured information moves between institutions, jurisdictions, and regulatory regimes. The OHI, as a standardized performance output that must be readable by lenders in Singapore, regulators in Brussels, and contracting authorities in Riyadh, operates within the data exchange architecture that UN/CEFACT governs. The membership model is designed to bring 6SG into UN/CEFACT's Buy-Ship-Pay and supply chain data frameworks as an institutional participant — establishing the OHI data schema as a recognized standard within the UN/CEFACT reference data model. This is the mechanism by which CPA outputs become admissible across jurisdictions without requiring bilateral recognition agreements between each pair of institutions. The connection between ISO 22372's UNDRR lineage and UN/CEFACT's trade facilitation mandate is the institutional pathway through which P&V enters the UN standards system.

LIE / LTA — Lenders' Technical Advisory

The CPA Verification Report does not replace the LIE Report convention. It upgrades the methodology that produces it. The output format is familiar to every credit committee that has reviewed a technical report. The data underlying it is current rather than historical, continuous rather than episodic, and physics-verified rather than site-visit-attested. The institutional adoption barrier is low. The output format is already trusted. The methodology behind it is what changes.

X

Plumb & Veracity

Plumb & Veracity is the vision for an independent standards body for the Operational Health Index — the institution whose sole purpose would be to define, publish, maintain, and certify compliance with the OHI Standard. That institution does not yet exist as a standalone body. What exists today is the function it will ultimately perform, carried within 6SenseGlobal, LLC while the practice, the client base, and the institutional momentum that justifies an independent body are built.

This is the honest version of the architecture. The three-entity structure described below — 6SenseGlobal, VERA, and Plumb & Veracity — is the design toward which the practice is being built. The design is sound. The sequencing is intentional.

THE INSTITUTIONAL ANALOGY — THE DESTINATION

ISO publishes ISO 9001. ISO does not manufacture products. Third-party auditors certify that products meet ISO 9001. The manufacturer implements it.

Plumb & Veracity — when established — publishes the OHI Standard. P&V does not operate sensors. P&V-certified engineers verify that implementations meet the standard. VERA implements it. Until P&V is established as an independent institution, the standards and certification functions it will ultimately govern reside within 6SenseGlobal, LLC.

Plumb & Veracity is conceived in the tradition of institutions whose authority derives from the rigor of their standards and the independence of their process — ISO for standards rigor, CERN for peer-collaborative structure, the Financial Times and The Economist for editorial independence and institutional trust. One standard. One mandate. Nothing else. The Institute comes into existence when the engagements, relationships, and institutional credibility that an independent body requires have been established through the practice itself.

Four Roles — What P&V Will Do

— **Standards Publisher.** Publishes and maintains the OHI Standard — the full methodology document that this paper introduces but does not disclose. Version control through peer review. Permanent public archive of all versions.

— **Certifying Authority.** Issues OHI Certification to assets and platforms that meet the standard requirements. VERA is the first platform positioned for this certification. Maintains a public register of certified implementations. Revokes certification when standards are not met.

— **Membership Body.** Admits institutional members: lenders, insurers, governments, development finance institutions, academic institutions, and standards peers. Members participate in standard development and revision — the mechanism by which the OHI Methodology becomes an industry standard rather than a single organization's specification.

— **Training and Academy.** Trains and certifies independent engineers to review and interpret OHI-certified assertion data. Credentials recognized by credit committees, regulatory bodies, and contracting authorities.

The Current State: Function Within 6SenseGlobal

Until P&V is established as an independent institution, the standards development, certification, and methodology governance functions described above are carried within 6SenseGlobal, LLC. The OHI Methodology is maintained and versioned by 6SenseGlobal. Pilot engagements are scoped and delivered by 6SenseGlobal. The methodology is refined through those engagements. When clients, institutional relationships, and practice maturity make the case for a standalone body, the Plumb & Veracity Institute is the form it takes.

FRAND Licensing

The OHI Standard will be published under FRAND terms: Fair, Reasonable, and Non-Discriminatory licensing. Any platform that meets the standard requirements can be certified. FRAND is what makes a standard a standard. Without it, the OHI Methodology is a proprietary specification. With it, it is an industry standard. The patent protects the method. FRAND licenses the standard. 6SenseGlobal's competitive advantage is not exclusivity of the standard — it is priority of implementation, depth of institutional relationships, and the authority that comes from having built the category.

The Three-Entity Structure — The Architecture

The intended design is three entities, three roles, none conflated. The current state is that those roles are being built from within a single entity and will be separated as the practice matures.

The Structural Separation

Three entities. Three roles. None conflated.

THE THREE-ENTITY STRUCTURE

6SG — The commercial entity. Owns the VERA platform. Owns the patent. Generates revenue. Currently carries the standards and certification functions that P&V will ultimately own. Victor Rieber, Founder.

VERA — The platform. Implements the OHI Methodology. Delivers Verification, Certification, and Assurance Reports. Operated by 6SenseGlobal.

Plumb & Veracity Institute — The standards body. Defines and publishes the OHI Standard. Certifies implementations. Commercially independent of 6SenseGlobal. The destination toward which the current practice is being built. Founded by Victor Rieber. Governed independently when established.

A lender trusting the Verification Report trusts the methodology behind the OHI — not any single platform's implementation of it. The platform is the instrument. The methodology is the measure. The certifying body is the guarantor. All three must exist — in sequence — for the system to carry the institutional trust the infrastructure finance market requires.

XI

The Path Forward

Continuous Physical Assurance is not a product launch. It is a category that the infrastructure finance system is building toward whether or not it has a name for it yet. Every regulatory framework, every maturity event, every secondary transaction, and every ESG disclosure obligation is creating demand for it. The question is not whether this category will exist. It is who will define it.

For Lenders and Debt Funds

The CPA Verification Report replaces the episodic LIE Report methodology. Five to ten business days versus twelve to twenty weeks. Current data versus a historical snapshot. OHI-linked covenant monitoring versus quarterly financial ratios as lagging indicators. The Capital Trigger integrated into loan documentation as a binary covenant condition governed by physics.

For Equity Investors and ESG-Committed Funds

The CPA Certification Report provides physics-verified inputs for GRESB reporting, SFDR PAI disclosure, and ISSA 5000 sustainability assurance engagements. The gap between GRESB score and physical reality closes to near-zero. Personal liability attaching to ESG sign-off is addressed by a defensible evidential record. The LP Dashboard provides continuous, verified physical performance visibility across the portfolio between reporting cycles.

For Governments and PPP Authorities

The CPA Assurance Report replaces operator self-reporting with independent physical verification. Availability payment mechanisms are governed by the Capital Trigger rather than operator declaration. Handback condition surveys are produced from continuous assertion data rather than point-in-time site visits. NISTA's oversight mandate is fulfilled by a mechanism that exists independently of the operator it oversees.

For Infrastructure Secondaries

The rapid CPA assertion cycle replaces the three-year-old site visit. Current, independent, physics-verified physical condition data is available at a cost that is a rounding error on secondary transaction costs. The physical risk the buyer inherits is visible before the transaction closes.

Standards Bodies and Regulatory Alignment

The IAASB, GRESB, the IFRS Foundation, and ISO are the organizations whose framework evolution determines the rate at which CPA becomes standard practice. The groundwork is already present in ISSA 5000. The next step is guidance specific to infrastructure physical condition data. 6SG's membership model is the mechanism by which 6SG enters those standards processes as an institutional participant.

XII

The Call to Action

The institutions that define the methodology of Continuous Physical Assurance, shape its framework, and adopt its practice earliest will have more influence over how it works — and more protection from the risks it addresses — than those that wait for the category to be defined by others.

We are convening a working group of lenders, insurers, equity investors, ESG practitioners, PPP authorities, and independent engineers to develop the first practitioner framework for CPA in infrastructure. The working group will:

- Review OHI Methodology v0.1 and provide technical and institutional feedback that shapes the standard
- Participate in the development of the Capital Trigger loan documentation template
- Contribute to 6SG's founding membership and governance structure
- Receive advance access to VERA platform certification and pilot engagement terms

If you are responsible for the physical veracity of assets you own, lend against, insure, report on, or oversee — this conversation is for you.

Contact: Victor at 6SenseGlobal, LLC · victor@6sg.tv

APPENDIX

References and Sources

All market data, regulatory citations, and standards references are sourced from publicly available institutional and governmental publications. Where a figure derives from proprietary data providers, the source organization is identified. Citations follow a modified Chicago author-date format.

A — MARKET AND FINANCIAL DATA

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D — INTELLECTUAL PROPERTY

United States Patent and Trademark Office (filed 2024). Patent Pending Application #19/576,486. Methods, systems, and processes for continuous physics-verified infrastructure asset operational health monitoring and financial mechanism linkage. Applicant: 6SenseGlobal, LLC.

The methods, algorithms, and processes underlying the Operational Health Index (OHI) and the VERA platform are protected under Patent Pending Application #19/576,486. The OHI Methodology v0.1 will be published and initially maintained by 6SenseGlobal, LLC. The OHI Standard will be published by the Plumb & Veracity Institute upon its establishment as an independent body. The data schema and interface specifications referenced in this paper do not constitute disclosure of the underlying methodology.

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