



Sentinel AI™

SHM for Petroleum Refineries using AI-Driven Wireless Monitoring

PRODUCT SPECIFICATION

Reduce Risk of Structural Failures with Automated SHM

StructureIQ's AI-driven SHM Service

Petroleum refineries operate under relentless and compounding structural demands — thermal cycling across process units, chemical corrosion in high-exposure zones, high-pressure vibrations from rotating equipment, and seismic loads that periodic manual inspection routinely misses. For operators managing aging processing infrastructure, the consequences of undetected structural deterioration are severe: unplanned shutdowns cost an estimated \$15 million to \$50 million per event in lost production and emergency repairs, while environmental and safety incidents in high-density processing zones carry consequences that extend well beyond direct financial loss.

StructureIQ deploys wireless Xnode sensors across every critical refinery structure — distillation columns, coker units, pipe racks, flare stacks, and process equipment support frames — delivering continuous, real-time structural condition intelligence through Sentinel AI, its secure cloud-based SaaS dashboard. The result is earlier warning, more targeted inspection, and the operational confidence that comes from knowing the structural condition of your assets at all times — not just at the last turnaround.

Sentinel AI™



Highlights

- **Continuous Structural Performance Monitoring** — Always-on measurement of structural response across critical units under real operating loads.
- **AI-Enabled Fatigue & Anomaly Detection** — Automated identification of thermal-cycling fatigue, vibration-induced degradation, and stiffness changes that periodic turnaround inspections cannot reliably capture between cycles.
- **Real-Time Event Notification** — Immediate engineering insight following seismic activity, pressure surge events, flaring excursions, or overload conditions in high-density processing zones.
- **Shutdown Cost Avoidance** — Data-driven early warning that shifts maintenance from reactive emergency response to planned intervention, targeting the \$15M–\$50M cost exposure of an unplanned refinery shutdown.
- **Rapid Post-Event Assessment** — Accelerate return-to-operations decisions following process upsets, weather events, or equipment incidents with objective structural performance data rather than conservative precautionary shutdowns.

PRODUCT SPECIFICATION: StructureIQ AI powered SHM Service

Onshore petrochemical refineries operate under extreme structural stress. Thermal cycling, chemical corrosion, high-pressure vibrations, and seismic loads all degrade asset integrity in ways that manual, periodic inspections often miss. For legacy refineries, undetected deterioration leads to catastrophic consequences: unplanned shutdowns, environmental hazards, and severe safety risks to personnel in high-density processing zones.

Continuous Structural Health Monitoring (SHM) provides refinery operators with a real-time, high-fidelity view of structural health across every critical asset—from distillation columns and coker units to aging pipe racks and flare stacks. By moving beyond "point-in-time" manual checks, StructureIQ enables: Predictive Maintenance, Targeted Inspections, Life Extension, and Rapid Recovery.

The result is increased uptime, lower O&M costs, and the operational confidence that comes from total structural visibility.

1.) **Pipe Rack & Structural Trestle** — fatigue detection, thermal expansion monitoring, life extension decisions on high-load corridor infrastructure

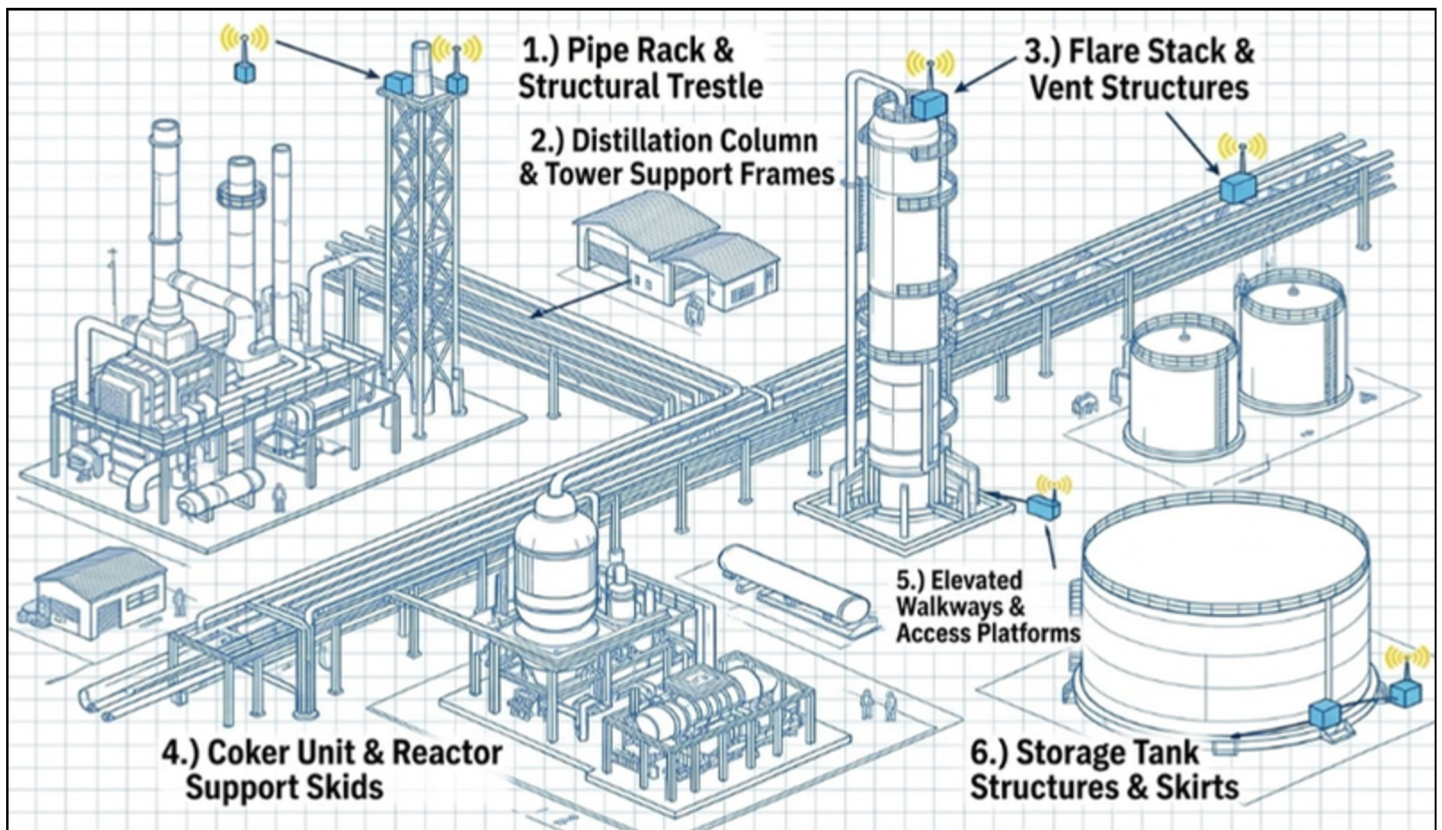
2.) **Distillation Column & Tower Support Frames** — safeguarding structural integrity under process load variations and brownfield equipment additions

3.) **Flare Stack & Vent Structures** — vortex-induced vibration and resonance alerting on inaccessible elevated structures

4.) **Coker Unit & Reactor Support Skids** — separating structural resonance from process equipment vibration as the root cause of persistent anomalies

5.) **Elevated Walkways & Access Platforms** — differential settlement monitoring across multi-unit processing complexes

6.) **Storage Tank Structures & Skirts** — continuous tilt and settlement monitoring to detect foundation movement before it becomes a containment risk



PRODUCT SPECIFICATION: StructureIQ AI powered SHM Service

Sentinel AI - SaaS Architecture

Xnode Wireless Smart Sensors

StructureIQ's wireless smart sensors provide real-time structural health monitoring by precisely measuring vibration and tilt. These ruggedized devices utilize onboard edge AI to filter raw data, identifying critical events. Data is transmitted via low-power protocols to a wireless gateway, eliminating the need for invasive and costly cabling across infrastructure.

Gateway and Cellular data

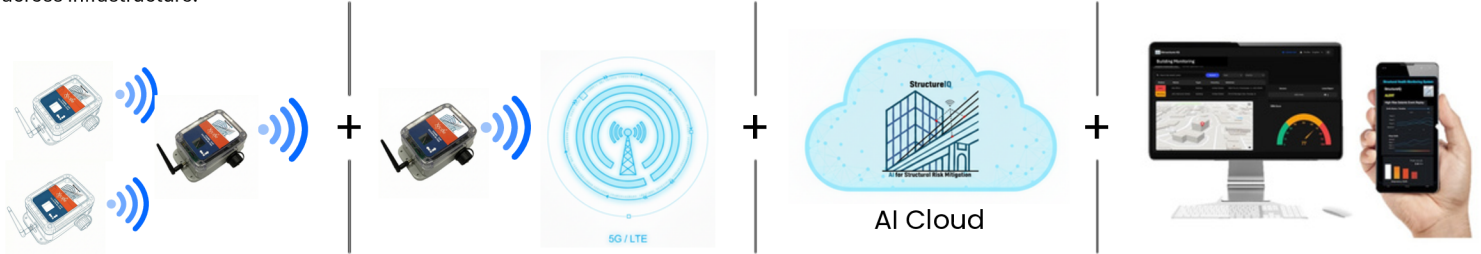
The StructureIQ Gateway acts as a secure bridge, collecting high-precision vibration and tilt data from wireless sensors via low-power protocols. After local verification and edge buffering, the gateway utilizes an encrypted 4G LTE/5G cellular uplink to transmit data through a private APN, ensuring cybersecurity.

AI Cloud & SHM Data Analysis

In the StructureIQ Data Cloud, AI algorithms de-serialize and normalize this time-series data. The engine then performs automated feature extraction to distinguish routine environmental noise from critical structural anomalies.

SHM data SaaS delivery

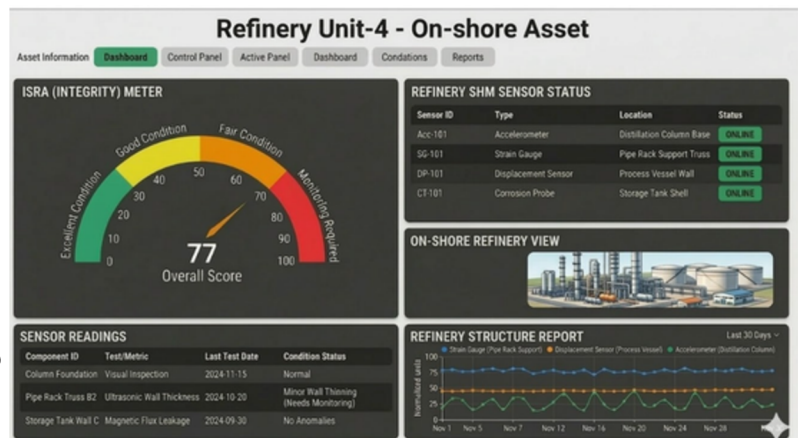
These insights generate real-time risk profiles and alerts, which are delivered directly to the secure SaaS dashboard for engineering and insurance assessment.



Core Capabilities

- Wireless smart sensor deployment – Rapid installation with minimal disruption
- Automated anomaly detection – Identifies deviations from established baselines
- Post-event structural assessment – Faster safety and occupancy decisions
- Secure cloud-based dashboard – Remote visibility anytime
- Secure SaaS delivery (no client IT infrastructure required)
- Scalable from single building to enterprise portfolio
- Subscription-based SaaS service model

Asset Dashboard



Sensor configurations shown are illustrative of monitored parameters; actual deployment specifications are tailored to each facility.

What Gets Monitored

- Vibration (Acceleration), Temperature
- Tilt – Settlement, drift, structural movement
- Impact Detection – Vehicle strikes
- Long-Term Trends – Deterioration and performance shifts

SaaS Features

- Real-time alerts (SMS, email, dashboard)
- Automated event reports
- Structural health scoring
- Multi-asset portfolio dashboard

Engineering dashboard



Management overview

