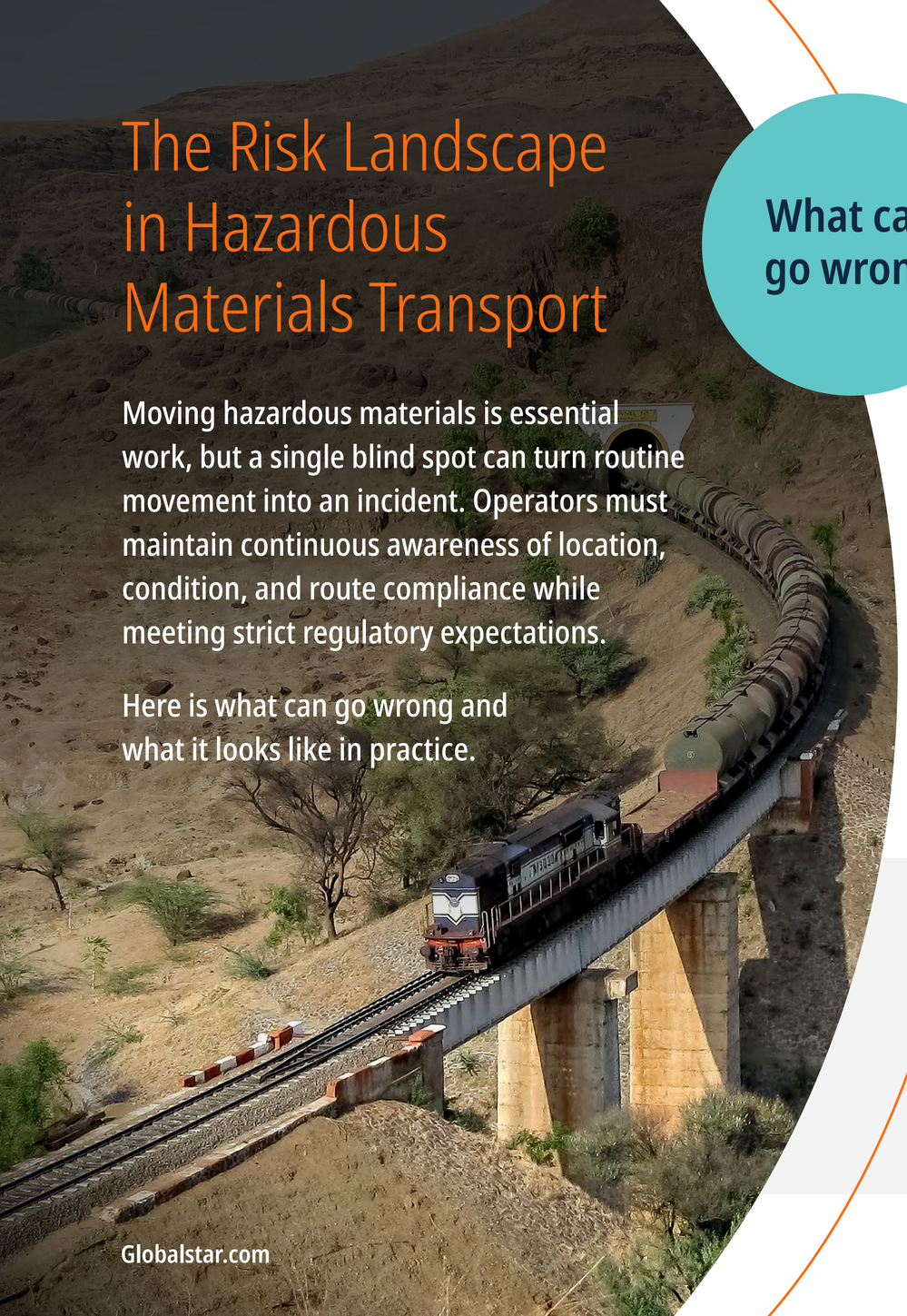
Globalstar™

EBOOK

Delivering Safe, Secure Transport for Hazardous Material through Satellite Connectivity

Transporting hazardous materials is both essential and high-risk. Rail tank cars, ISO tank containers, and highway tankers move flammable, toxic, corrosive, and pressurized cargo through cities, ports, and remote corridors. The work sits under strict national and international rules that expect operators to maintain positive control, accurate records, and timely incident response.

Digital solutions now dovetail with these obligations. Sensor-equipped assets, two-way IoT devices, geofencing, and event engines turn raw telemetry into actionable exceptions. Satellite connectivity keeps the data flowing across blind spots, borders, and outages so decision makers can see conditions, confirm location, and act quickly.



The Risk Landscape in Hazardous Materials Transport

Moving hazardous materials is essential work, but a single blind spot can turn routine movement into an incident. Operators must maintain continuous awareness of location, condition, and route compliance while meeting strict regulatory expectations.

Here is what can go wrong and what it looks like in practice.

What can go wrong

Condition excursions

Pressure rise or drop, temperature out of range, unexpected venting, vibration or shock, tilt or rollover

Loss of control

Route deviation, unauthorized stops, prolonged dwell in unsecured areas, door or hatch open outside authorized zones, tamper events

Coverage and continuity gaps

Tunnels, rural corridors, ports, yards, and cross-border handoffs where cellular is unreliable; outages during storms, power loss, or cyber incidents

Data and process gaps

Missing proofs of arrival and departure, incomplete custody records, delayed exception handling, stale device configurations

Regulatory exposure

Inability to produce audit-ready logs, delayed notifications, incomplete incident reports

Safety and environmental impact

Late detection of leaks or pressure events that increase risk to crews, communities, and the environment

Taken together, these risks show that hazardous materials transport needs more than basic track and trace. Operators need condition-aware sensing, policy-driven alerts, clear audit trails, and resilient connectivity that holds up across blind spots, borders, and outages. With this risk map in hand, the next chapter can focus on how modern IoT and satellite connectivity come together to build a monitoring stack that prevents incidents, speeds response, and satisfies regulators.

What Advanced Monitoring Really Means: From Basic Tracking to Intelligent Visibility

For years, hazardous materials transport relied on simple track-and-trace systems — periodic GPS pings showing where a tank car or container had last checked in. This was enough to confirm location for billing or scheduling, but not enough to manage real risk. If a valve leaked, if temperature climbed, or if a wagon took a wrong siding, those systems stayed silent. Operators might not learn of an incident until hours later, when a customer calls or a safety alarm sounds on-site.

As shipments grew larger, routes longer, and regulations tighter, this passive approach could no longer meet expectations. Stakeholders now need to know not just where an asset is, but what is happening to it — and to be alerted the instant a threshold is crossed. That shift has created the demand for advanced monitoring: a combination of intelligent sensing, edge logic, and resilient connectivity that transforms raw data into actionable information.

Sensing and Edge Logic

Modern IoT devices go far beyond location. Sensors record pressure, temperature, shock, tilt, vibration, and door or hatch status to detect conditions that signal potential danger. Instead of reporting everything all the time, these devices apply on-board rules that determine what constitutes an exception.

For example, a sensor might be configured to transmit only when internal pressure rises two percent above the safe band or when a hatch opens outside an authorized geofence. This edge logic minimizes data noise while ensuring that critical alerts are sent instantly. Over-the-air configuration allows operators to adjust thresholds and reporting intervals remotely: vital when regulations, routes, or environmental conditions change.

Once these intelligent devices capture meaningful events, the next challenge is to move the data quickly and securely to where it can be acted upon.

Data Flows

Advanced monitoring depends on reliable, two-way communication between assets and control systems. Devices send event-driven messages when an exception occurs, supported by periodic heartbeat pings that confirm system health even when nothing is wrong.

Using a combination of cellular and satellite links, data is transmitted to a secure cloud environment. There, it is normalized and shared through APIs with enterprise systems such as Transport Management (TMS), Warehouse Management (WMS), Enterprise Resource Planning (ERP), and safety or incident-response platforms.

This seamless data flow ensures that every stakeholder, from fleet operations to compliance and emergency response, sees the same verified picture in real time.

When information moves reliably, operators gain a unified view of the entire fleet, enabling faster and more coordinated decision-making.

Operator View

At the control center, advanced monitoring becomes tangible. Operators see a live fleet map displaying each rail car, tank, or trailer, with color-coded geofences marking yards, terminals, and corridors. Dashboards highlight exceptions such as route deviations, prolonged dwell times, or unsafe temperature trends. Each alert links to a response playbook that defines who is notified, what actions are taken, and how results are recorded.

The interface doesn't just display data, it orchestrates workflows. Security can be dispatched to a geofence, maintenance can schedule an inspection, and compliance can export audit logs automatically. The result is continuous situational awareness and documented accountability across the operation.

Advanced monitoring marks the evolution from static tracking to condition-aware, exception-driven management. It integrates modern IoT sensing, on-device intelligence, secure data exchange, and intuitive dashboards into one system of action. These advances deliver earlier detection, faster response, and stronger compliance than legacy methods ever could.

Why Satellite Matters in Hazardous Materials Operations

As advanced monitoring systems became standard in hazardous materials transport, one limitation quickly stood out: connectivity. No matter how sophisticated the sensors or dashboards, they're only as reliable as their ability to communicate. Traditional cellular networks perform well along populated corridors, but they fade fast in the places where hazardous materials often travel, such as remote pipelines, rural rail lines, inland terminals, border crossings, and industrial zones built far from cities.

That's why satellite connectivity has shifted from a convenient backup to a critical enabler. For operations that can't afford blind spots, it's the link that keeps the data flowing when other networks can't.

Coverage and Reach

Hazardous material shipments move through some of the least connected environments in the world: deserts, mountains, dense forests, open seas, and cross-border regions with inconsistent infrastructure. Satellite fills these gaps by providing uninterrupted coverage across entire territories and oceans, ensuring that data continues to transmit no matter where assets travel.

Even when shipments pass through short cellular dead zones, tunnels, rail yards, or port facilities, satellite provides store-and-forward resilience, buffering data until a clear path reopens. This level of persistence transforms monitoring from a “best effort” service into an always-on safety system.

But coverage alone isn’t the full story; in emergencies, the true measure of value is resilience.

Resilience in Critical Moments

When something goes wrong, a derailment, spill, or extreme weather event, terrestrial networks are often among the first to fail. Power outages, damaged towers, and overloaded infrastructure can sever cellular connectivity precisely when responders need it most.

Satellite connectivity remains immune to these local failures. It keeps transmitting alerts and telemetry during natural disasters, infrastructure failures, or cyberattacks that might disable other networks. Operators continue to receive condition data, GPS coordinates, and distress messages, enabling faster and better-informed responses.

For hazardous materials, where minutes can define outcomes, this resilience isn’t just an advantage; it’s a life-safety feature.

Beyond reliability, satellite also reinforces one of the industry’s most pressing needs: control and security.

Control and Security

Transporting dangerous goods involves sensitive information: cargo contents, routes, schedules, and security protocols. This data must stay protected from interception and misuse. Satellite networks built for industrial IoT and enterprise applications provide end-to-end encryption, private device identities, and controlled access to keep data confined to authorized systems.

Unlike public networks, satellite connections don't depend on third-party roaming agreements or congested consumer infrastructure. This gives operators consistent governance and data sovereignty, especially across borders or jurisdictions where compliance standards differ.

By pairing private 5G or on-prem systems with satellite backhaul, companies can maintain local data control while still benefiting from global reach and redundancy. This hybrid approach combines security with scale.

And as fleets expand and regulations evolve, satellite's scalability ensures the system grows as fast as the operation itself.

Scalability and Efficiency

Once deployed, satellite IoT can scale from a small pilot to a full global fleet with no dependency on terrestrial buildout. Devices can be provisioned remotely, configurations pushed over the air, and alerts routed directly into existing workflows.

This scalability makes it ideal for fleets operating across thousands of tank cars, containers, or trailers. The same infrastructure can support different cargo types, geographic regions, and regulatory frameworks without rebuilding the network each time. The result is long-term efficiency and predictable operating costs, which is a key advantage in a highly regulated, capital-intensive sector.

In hazardous materials transport, connectivity equals safety. Satellite ensures that the visibility and intelligence gained from IoT monitoring aren't lost in the very moments they're needed most. It fills the gaps, withstands the shocks, and extends the reach of modern logistics far beyond the limits of terrestrial networks.

By combining advanced sensing, edge logic, and satellite-backed communication, operators achieve a continuous stream of trustworthy data — from refinery to terminal, from loading dock to final destination. In the next section, we'll look at how real-world deployments are already proving this model in the field.

How Advanced Solutions Leverage IoT for Safer Hazmat Transport

Modern hazardous materials monitoring isn't a single technology; it's a stack. Each layer of that stack plays a role in turning field data into real-time operational awareness.

1

Hardware: Intelligent, purpose-built devices

- Rugged, intrinsically safe sensors measure pressure, temperature, shock, tilt, and door status
- Compact satellite- or hybrid-enabled transmitters work without dependence on local power or cellular coverage
- Edge processors on the device apply logic rules, sending alerts only when conditions deviate from safe ranges, reducing data noise and airtime costs

2

Software: Event-driven insight and automation

- Cloud platforms collect and normalize incoming data into standardized dashboards and KPIs
- Geofences and event policies trigger automatic workflows, alerts to security, maintenance, or emergency response teams
- APIs link seamlessly into enterprise systems such as TMS, ERP, or incident management software to ensure one version of truth

3

Connectivity: Always-on communication from anywhere

- Dual-path communication uses cellular when it's strong and satellite when it's not, ensuring that alerts are never stranded
- Two-way messaging supports configuration updates, firmware refreshes, and acknowledgement signals for verified delivery
- Encrypted, authenticated links maintain data integrity and security, meeting regulatory and insurer expectations

Together, these layers create a living digital ecosystem — one that senses, thinks, and communicates on its own. The result is continuous visibility, faster incident response, and the confidence that every shipment remains within safety and compliance thresholds, anywhere on Earth.

Case Studies from the Field

Advanced monitoring of hazardous materials isn't a theory anymore; it's working in the field today. Across Europe and the Americas, major petrochemical producers and logistics providers are using IoT-enabled, satellite-connected systems to keep constant watch over rail tank cars, ISO tank containers, and road tankers. These solutions combine three critical layers:

Hardware

Intrinsically safe sensors and tracking units mounted on assets, measuring pressure, temperature, shock, and location

Software

Cloud-based platforms that aggregate, visualize, and alert on exceptions in real time

Connectivity

Resilient satellite networks that ensure the data moves continuously, even where cellular cannot

The result is a new level of control for operators handling explosive, flammable, or corrosive cargo. They can detect anomalies within minutes, verify the safety of a shipment across borders, and document every movement for regulators and insurers alike.

Nowhere is this transformation clearer than in the partnerships Globalstar has helped build with leading industrial companies across Europe.

Keeping Hazardous Cargo Visible: Globalstar and Ovinto

Globalstar has worked closely with Ovinto, a leading European IoT and software provider specializing in rail and tank container monitoring. Together, they have deployed advanced monitoring solutions for some of the world's largest chemical manufacturers, most notably INEOS Oxide, to improve the safety and efficiency of hazardous goods transport.

These solutions rely on the Globalstar low-Earth orbit (LEO) satellite network, which delivers real-time or near-real-time data from remote and mobile assets, unaffected by the blind spots and reliability issues of terrestrial networks. Each monitored asset, typically a rail tank car or tank container, is equipped with an Ovinto Sat device, a purpose-built IoT unit certified for ATEX Zone 1 (explosive environments).

The system continuously collects and transmits:

- GPS location and route adherence
- Internal pressure and temperature
- Shock, tilt, and vibration events
- Door or hatch opening outside of designated geofences

When an exception occurs, alerts are automatically routed to the operator's control center, triggering established safety workflows and enabling rapid intervention.

INEOS Oxide: Satellite IoT for Hazardous Gas Transport

One of the most notable examples comes from INEOS Oxide, a division of INEOS responsible for the production and transport of ethylene oxide, a highly flammable and reactive chemical used in many industrial processes.

INEOS equipped hundreds of its rail tank cars and tank containers with Ovinto Sat devices powered by Globalstar connectivity. These units provide continuous data on cargo condition and movement across the company's extensive European rail network.

The system gives INEOS complete visibility of each tank car's journey, from the moment it leaves the plant to final delivery, while automatically flagging temperature fluctuations, pressure changes, or impacts that could indicate a safety issue.

According to company reports, this deployment has:

- Enhanced safety compliance by ensuring regulatory conditions are met across multiple countries
- Reduced manual inspection needs, saving significant operational time
- Enabled faster response to any potential hazard or deviation from the planned route
- Strengthened customer confidence through validated, data-backed transparency

This isn't an isolated case. Globalstar's satellite IoT ecosystem continues to expand into other sectors of dangerous goods transport, where continuous connectivity is equally vital.

Enabling Safe, Clean Energy and Chemical Transport

As industries transition toward lower-carbon energy sources, new risks and transport requirements are emerging. Globalstar's collaboration with Ovinto now supports the movement of potentially explosive gases and clean-energy feedstocks, where the same principles of visibility and reliability apply.

These deployments highlight how satellite IoT scales across cargo types and industries, from petrochemicals and ammonia to hydrogen and other next-generation fuels. Each use case benefits from the same foundation: ruggedized IoT hardware, intelligent software, and a resilient satellite link that ensures continuity under all conditions.

The outcome is a connected ecosystem where fleet managers, safety officers, and regulators operate from a single version of the truth supported by verified, real-time data rather than periodic reports.

Across deployments, operators report tangible results:

- Fewer safety incidents due to early detection of pressure or temperature anomalies
- Faster resolution times through automated alert routing and response workflows
- Reduced operational costs by eliminating manual reporting and reducing asset downtime
- Improved compliance through automated, timestamped audit trails accessible to inspectors and insurers
- Higher customer trust via transparent, verifiable shipment data

These outcomes demonstrate how satellite IoT has evolved from a niche technology into a core operational tool for the global hazardous materials supply chain.

The success of programs like INEOS Oxide's satellite monitoring initiative illustrates the full potential of IoT-driven, satellite-enabled visibility in the most demanding transport environments. By connecting every asset, automating data collection, and maintaining resilience across regions and networks, satellite IoT is not just supporting hazardous materials transport; it's redefining what safety and accountability look like in the modern era.

In the next section, we'll quantify these results and explore the key performance indicators (KPIs) that operators can use to measure value and build a business case for large-scale deployment.

Key Takeaways

from Globalstar Deployments

Real-world validation of satellite IoT in hazardous transport

Always-on visibility

Continuous monitoring across cross-border rail and road networks, even in rural or infrastructure-poor regions

Safety first

Early detection of anomalies, pressure rise, temperature change, impact, or route deviation, enables faster, more precise intervention

Regulatory readiness

Automated data logging provides an auditable trail for safety authorities and insurers

Operational efficiency

Remote configuration, reduced manual inspection, and automated reporting lower total cost of ownership

Proven scale

Hundreds of tank cars and containers equipped, generating consistent, reliable data across international corridors

Trusted partners

Deployments executed through collaboration between Globalstar's satellite network and Ovinto's IoT platform, with customers such as INEOS Oxide leading adoption

In every deployment, the combination of certified hardware, intelligent software, and Globalstar satellite connectivity delivers a single goal: safe, secure, and uninterrupted transport of hazardous materials worldwide.

Safety, Visibility, and Compliance with Always-On Connectivity

Hazardous materials transport will always carry inherent risk—but technology now makes that risk manageable, measurable, and often preventable. The combination of IoT-enabled sensing, intelligent software, and resilient satellite connectivity has redefined what's possible for operators who handle dangerous goods.

By moving beyond basic tracking toward continuous, condition-aware visibility, transporters gain the ability to detect issues early, act decisively, and demonstrate compliance with confidence. Satellite connectivity ensures that no corridor, no border, and no emergency ever leaves an operator blind to what's happening in the field.

From petrochemical producers and clean-energy innovators to logistics providers and regulators, the value proposition is the same: safer operations, stronger accountability, and uninterrupted awareness from origin to destination.

For more information, reach out to our team of experts.

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