STRUCTURAL INTELLIGENCE BRIEF

Transportation & Warehousing

NAICS 48-49 — CISA Critical Infrastructure Sector

THINNESS	PERMISSION	MANAGEMENT	ABSENCE
VULNERABLE	STRAINED	VULNERABLE	VULNERABLE

S.J. Bridger
Four Frequencies Framework

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sjbridger.com/intelligence/transportation-warehousing/

Executive Summary

Transportation and warehousing is structurally configured to accelerate the consequences of the disruptions it exists to absorb. Six Class I railroads control 94% of freight revenue. Top 25 LTL carriers hold 91% of market share. Over 10,000 motor carriers exited in H1 2024. Over 80% of 567,000 active interstate carriers remain unrated by FMCSA. Injury rate 4.5/100 FTE—2x national. Fatality rate 13.6/100K—3.9x national. Driver turnover averages 93% at large carriers with shortage projected at 82,000. Average driver age risen to 47, with 62% Gen X or Boomer and only 20% under 35. East Palestine demonstrated this interaction: a bearing overheat alert existed in the monitoring system, but the single analyst staffing the ATC desk was managing alarms from multiple trains simultaneously.

Three of the four frequencies score VULNERABLE. This is the only Tier 1 sector with three Vulnerable frequencies.

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Sector Structural Profile

Transportation and warehousing encompasses air, rail, truck, water, and pipeline transportation plus warehousing and storage. The Department of Transportation serves as the Sector Risk Management Agency under CISA's critical infrastructure framework. Disruption propagates through every supply chain. The sector employs approximately 6.8 million workers across 300,000+ establishments. What happens at rail, trucking, and aviation hubs immediately affects manufacturing, retail, construction, and healthcare—everything with a physical supply chain.

Multi-Modal Consolidation

Rail

Six Class I railroads control 94% of freight revenue—concentrated from 40+ carriers pre-1980. Herfindahl-Hirschman Index exceeds 2,200, above the DOJ structural merger threshold of 2,500. Only two of the six railroads report revenue adequacy in 2024. The structural condition: a network that carries 40% of American freight revenue concentrated in a handful of carriers, each carrying compensatory load from the others with zero redundancy.

Trucking

91.5% of carriers operate 10 or fewer trucks. This looks like structural diversity until you measure consolidation at the Less-Than-Truckload (LTL) tier, where top 25 carriers hold 91% of market share. Yellow Corporation's bankruptcy removed $5 billion in capacity and 30,000 jobs from the market in 2024. Over 10,000 motor carriers exited in H1 2024. The structural consequence: the system trades individual small-carrier volatility for large-carrier concentration risk.

Airlines

The Big Four carriers (American, Delta, United, Southwest) control 73%+ of passenger capacity. Herfindahl-Hirschman Index ranges 2,000-2,100. National market looks moderately concentrated. Route-level thinness is severe—specific origin-destination pairs often have only one or two carriers, creating genuine network fragility when weather, staffing, or mechanical issues strike.

Four Frequency Assessment

Thinness: Structural Slack and Concentration

VULNERABLE — Where structural slack has eroded below recoverable thresholds.

Multi-modal consolidation has concentrated critical capacity. Rail: six carriers handling 94% of freight revenue with HHI 2,200+. LTL trucking: top 25 carriers holding 91% of market share. Yellow's exit removed $5 billion in capacity with no redundant carrier network to absorb the load. Over 10,000 carrier exits in H1 2024 compress available options further. Airlines: Big Four holding 73%+ with route-level thinness far worse. The structural condition: the system concentrates critical capacity in a small number of carriers. When one is disrupted, the system has no buffer.

Permission: Authority and Oversight

STRAINED — Authority fragmented across regulators with enforcement constraints.

Over 80% of 567,000 active interstate carriers remain unrated by FMCSA. The agency lacks direct civil penalty authority—must refer enforcement to District Court, creating delay between detection and consequence. OSHA splits its inspection resources 50/50 between complaint-driven and planned inspections. Warehousing operates under a National Emphasis Program (NEP) with limited audit capacity. Regulatory fragmentation splits authority across DOT, FMCSA, FRA, FAA, PHMSA, and NTSB. The structural condition: oversight is distributed and underfunded relative to the sector's scale.

Management: Safety Information and Response

VULNERABLE — Where safety performance is acute and information systems do not translate to action.

SOII injury rate (NAICS 48-49): 4.5/100 FTE—2x the all-industry average of 2.1. Couriers specifically report 9.2/100 FTE. Fatality rate in transportation occupations: 13.6/100K FTE—3.9x the national rate. Large trucks involved in 5,375 fatal crashes in 2023. Truck fatality rate per vehicle-mile-traveled has risen to 1.76 despite fewer absolute crashes. East Palestine: information present in system but not acted upon. Single ATC analyst managing alarms from multiple trains. The structural condition: safety hazards are visible in the data but information does not reliably produce action.

Absence: Knowledge and Operator Continuity

VULNERABLE — Where critical functions degrade through knowledge departure and supply constraints.

93% annual turnover at large truckload carriers. Driver shortage projected at 60,000-82,000. Average driver age risen from 42 (1995) to 47 (2024). 62% are Gen X or Boomer, only 20% under 35. Class I railroad staffing declined 28% (2011-2021). 16,000 pilot retirements in the past 5 years. Pilot shortage peaked at 24,000 in 2026. The structural condition: the pipeline cannot replace departing operators faster than they leave. Institutional knowledge exits with them.

Federal Data Evidence Base

This assessment draws on 14 federal data metrics from DOT, FMCSA, BLS, OSHA, EPA, and NTSB sources. The metrics below provide measurement points for the structural conditions described in the Four Frequency Assessment above.

Source	Metric	Current Value	Structural Signal
STB	Class I railroads (freight revenue %)	6 carriers, 94%	HHI 2,200+ (highly concentrated)
STB	Revenue-adequate Class I railroads	2 of 6 (2024)	Structural financial stress
FMCSA	Active interstate carriers	~567,000	80%+ unrated by agency
FMCSA	Carrier exits (H1 2024)	10,000+	Accelerating consolidation
FMCSA	LTL carrier concentration	Top 25 = 91% market share	Thinness VULNERABLE
FMCSA	Large truck fatal crashes (2023)	5,375 (8.4% decrease YoY)	Rate per VMT rising
BLS	SOII injury rate (NAICS 48-49)	4.5/100 FTE	2x all-industry average
BLS	Fatality rate (transport occupations)	13.6/100K FTE	3.9x national average

ATA	Large carrier turnover (annual avg)	92.7-93%	Structural knowledge departure
ATA	Driver shortage projection	60,000-82,000	Pipeline structurally constrained
ATRI	Average truck driver age (2024)	47 years	Up from 42 (1995)
OSHA	Inspection split (planned vs complaint)	50.5% unprogrammed	Complaint-driven normalized
BTS	Sector employment (Sept 2025)	6.79M across 300,000+ establishments	Highly dispersed base

Sources: DOT/FMCSA, Surface Transportation Board (STB), BLS (QCEW, JOLTS, SOII, CFOI), OSHA, EPA ECHO, NTSB RIR-24-05, American Trucking Associations (ATA), American Transportation Research Institute (ATRI), Bureau of Transportation Statistics (BTS).

Structural Risk Scenarios

The Four Frequencies assessment reveals structural patterns, not event predictions. These scenarios describe how the measured conditions interact under stress. Whether a specific organization experiences them depends on its internal structural profile.

Scenario 1: Capacity Concentration Cascade

Stress event: Major carrier failure or service disruption at one of six Class I railroads. Structural condition: 94% freight revenue concentration means stress transmits across supply chains immediately. Remaining carriers cannot absorb displaced freight. Thinness VULNERABLE means no buffer carriers exist to reroute traffic. Outcome: Supply chains across agriculture, manufacturing, retail propagate disruption within days.

Scenario 2: Safety Information Architecture Failure

Stress event: Rapid-onset safety condition requiring immediate response. Structural condition: Management VULNERABLE. Single-analyst monitoring paradigm from East Palestine replicates at other carriers. Information present in systems but workforce thinned through Absence (28% railroad staffing decline, 93% driver turnover) cannot process signals at required speed. Outcome: Physical, irreversible—derailment, crash, or release.

Scenario 3: Workforce Departure Threshold

Stress event: Demand surge coinciding with seasonal retirement wave. Structural condition: Absence VULNERABLE. 93% turnover means institutional knowledge never accumulates. 82,000 shortage means no surge capacity. 62% approaching retirement means pipeline cannot replace departures. Pilot shortage peaks at 24,000. Outcome: Capacity constrained not by equipment or infrastructure but by the absence of

qualified operators.

Each scenario describes a pattern measurable in sector data today. Whether a specific organization experiences it depends on its internal structural profile.

The Diagnostic Gap

This brief assesses structural conditions visible from federal data and public sources. The Four Frequencies framework measures 20 dimensions. Twelve are assessable from public data. Eight require diagnostic access to an organization's internal structural patterns through behavioral intelligence from raters inside the organization.

What Public Data Reveals (12 Dimensions)

The 12 public dimensions capture sector-level structural conditions: consolidation velocity, carrier concentration, safety performance rates, workforce turnover and shortage projections, regulatory fragmentation, and inspection capacity. These are the dimensions scored in this brief. They describe the structural environment that every organization in transportation and warehousing inhabits.

What Requires Diagnostic Access (8 Dimensions)

Safety Protocol Substitution Readiness

Whether critical safety functions continue when a key operator, inspector, or certified specialist is absent. Federal data shows injury and fatality rates. It cannot map whether your specific organization's protocols replace departing expertise.

Rerouting Decision Velocity

How fast the organization redirects freight, passengers, or services when a planned route becomes unavailable. Consolidation data shows carrier concentration. It cannot measure whether your organization can execute rerouting within the speed the disruption requires.

Knowledge Continuity Through Turnover

Whether departing drivers, operators, and dispatchers transfer route knowledge and equipment familiarity before leaving. 93% turnover means this rarely happens at the sector level. It cannot assess whether your organization actively protects this knowledge.

Safety Override Pattern Integrity

Whether safety protocols hold when schedule pressure, fuel costs, or revenue targets create incentive to bypass them. Federal data shows fatality rates rising per VMT. It cannot measure whether your organization's culture sustains compliance when external pressure mounts.

Monitoring System Channel Integrity

Whether safety alerts move from monitoring systems to operators to decision-makers without degradation. East Palestine measured this gap at one carrier. It cannot assess whether your monitoring systems retain fidelity under the load your organization carries.

Escalation Architecture Under Pressure

Whether safety concerns from drivers, engineers, and dispatchers actually reach management with sufficient force to change operations. Turnover and concentration data reveal nothing about this. It cannot assess whether dissent reaches decision-makers at your organization.

Compensatory Load Distribution

Which informal relationships and trust networks are currently absorbing structural weight that formal systems have failed to carry. Federal data reveals sector-level patterns. It cannot identify which relationships are critical in your organization.

Adaptive Structural Capacity

How the organization's structure responds under sustained pressure, not just acute crisis. The scenarios above describe sector-level patterns. Only internal measurement reveals how your specific structure adapts.

> *The gap between what is publicly visible and what is structurally real is where organizational risk lives. The brief tells you the weather. The diagnostic tells you whether your equipment can hold.*

Methodology

The Four Frequencies framework measures structural resilience across four dimensions: Thinness (depth of critical capacity), Permission (distribution of decision authority), Management (leadership and operational effectiveness), and Absence (gaps in critical functions and their consequences). Each frequency is assessed across five dimensions, for a total of twenty structural measurements.

Sector-level assessments draw on federal data mapped to the twelve publicly-measurable dimensions. Organization-level diagnostics add behavioral intelligence from internal raters to score all twenty dimensions. The combination produces the Structural Resilience Index (SRI), a composite score calibrated to a six-band severity scale.

Severity terminology: RESILIENT (structural depth across all frequencies), STABLE (adequate structural capacity with minor gaps), STRAINED (measurable structural pressure in one or more frequencies), VULNERABLE (significant structural gaps with compounding risk), FRAGILE (structural conditions that amplify disruption), CRITICAL (structural failure in progress or imminent).

What This Means for Your Organization

This brief describes the structural environment your organization operates inside. Whether these sector-level conditions are amplified or mitigated within your specific organization depends on your internal structural profile.

The Four Frequencies diagnostic measures all 20 dimensions for a single organization, producing a 40-page structural analysis with the Structural Resilience Index.

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About S.J. Bridger

S.J. Bridger is a structural resilience diagnostics practice. We analyze the structural conditions that determine whether organizations hold together when key people leave, when systems fail, and when the relationships that carried institutional knowledge disappear. The Four Frequencies framework was developed through forensic analysis of organizational failures across multiple sectors and refined through diagnostic engagements that measure what traditional assessments miss.

Structural Intelligence Briefs are published assessments of sector-level conditions. They are updated quarterly as federal data sources release new information. The Transportation & Warehousing brief is the third in a series covering all 16 CISA critical infrastructure sectors.