VBTS Hourglass Bulk Delivery System:

Technical Product Overview

System Overview and Value Proposition

The VBTS Hourglass Bulk Delivery System represents a purpose-engineered solution to persistent operational inefficiencies in dry bulk material transport. Unlike traditional pneumatic tank trailers that require drivers to remain on-site for 40–60 minutes per delivery while operating truck-mounted blowers, or modular container systems that depend on incomplete gravity discharge, the Hourglass architecture decouples transportation from material transfer through a split-cell design and site-based automation. This approach eliminates driver idle time, achieves near-complete material recovery (99%+), and reduces fuel consumption and emissions by approximately 30–40% per load compared to conventional pneumatic operations.

The system addresses three converging market pressures: acute CDL driver shortages with turnover rates exceeding 90% annually in some segments, increasingly stringent OSHA silica dust exposure limits (0.025 mg/m^3 as an 8-hour time-weighted average), and customer demands for faster site turnarounds that minimize congestion and demurrage costs. By enabling drivers to complete deliveries in under five minutes and transferring discharge operations to automated, site-based infrastructure, the Hourglass system transforms both fleet economics and site throughput while improving worker safety and environmental performance.

The architecture is optimized for high-frequency, regional delivery operations where rapid turnaround compounds economic advantage—ready-mix concrete plants, oilfield well-pad logistics, construction material distribution, and specialty powder applications where maneuverability, contamination control, and product recovery are critical. Facilities with limited or variable silo capacity particularly benefit from the system's smart shutdown capability, which enables partial load delivery without the risk of spills or returned product.

System Architecture and Physical Design

The Hourglass system divides transport and discharge functions between two geometrically complementary units that create the system's distinctive stacked configuration. The Transport Cell is a mobile container with a 14-foot length and approximately 461 cubic feet of internal volume, designed with a wider top (100 inches)

tapering to a narrower bottom (58 inches) to facilitate gravity discharge and secure transport on specialized chassis trailers. This compact length—roughly one-third that of a standard 45–53 foot pneumatic trailer—dramatically improves maneuverability on narrow ranch roads, congested construction sites, and urban delivery zones where long-wheelbase equipment creates safety hazards and site access constraints.

The Stationary Cell is a permanent on-site receiving unit with approximately 526 cubic feet of volume, featuring geometry inverted relative to the Transport Cell: narrow at the top (to mate with the Transport Cell's discharge opening) and wide at the bottom (to accommodate fluidization aerators and maximize storage). When the Transport Cell is positioned atop the Stationary Cell, the two units form the signature hourglass profile that gives the system its name and creates a sealed, automated transfer pathway. The stationary unit remains permanently installed at the customer site alongside the Automated Cargo Transfer System (ACTS) blower infrastructure, consolidating capital investment at the point of use rather than distributing specialized equipment across a mobile fleet.

Customer sites include approved storage racks that hold multiple Transport Cells (both full and empty), enabling buffer inventory management and continuous operations. Full cells can be staged during high-delivery periods and processed as silo capacity becomes available, while empty cells await pickup during the next inbound delivery.

Operating Workflow: Three-Phase Material Handling

Phase 1: Loading, Rapid Drop-and-Swap Delivery

At the supplier facility, the Transport Cell is loaded through a top manhole using silo discharge, conveyor systems, bulk sack consolidation, or tray/front-end loader methods, with weight monitoring to ensure capacity limits are observed. Once loading is complete, the operator closes and secures the top manhole lid and verifies chassis securement before transport.

Upon arrival at the customer site, the driver positions the truck at the designated exchange area and unlocks the chassis securement system. A site operator using a heavy-duty forklift (minimum 20,000-pound capacity) removes the full Transport Cell from the chassis and immediately replaces it with an empty unit. The driver secures the empty cell and departs—typically within five minutes of arrival—while the site team initiates material transfer. This rapid exchange eliminates the 40–60 minutes of tractor idle time, fuel burn, and driver engagement that define pneumatic operations, enabling a single driver and truck to complete 4–6 deliveries per day compared to 3–4 loads with conventional equipment.

Phase 2: Inter-Cell Transfer (The Hourglass Effect)

Material transfer begins when the forklift operator lifts the loaded Transport Cell and stacks it directly atop the empty Stationary Cell, creating a sealed vertical pathway. The operator connects the airline, verifies there are no obstructions in the gear actuator mechanism, and activates the system via push-button switch. Activation engages a gear actuator to mechanically open the valve on the Transport Cell without manual cranking or hammering. Material flows from the upper Transport Cell into the lower Stationary Cell via gravity, with air assist ensuring complete evacuation of the upper unit. Sensors signal when the transfer is complete via audible alarm or flashing light indicator. The actuator closes the valve when flow ceases. After inter-cell transfer completes, the operator disconnects the air line, verifies the valve is closed, lifts the empty Transport Cell to the storage rack, and closes the lid, readying it for return shipment on the next inbound delivery. This automated inter-cell transfer eliminates the manual intervention, vibration equipment, and external pneumatic assist ("sand kings") that modular container systems require to overcome bridging and rat-holing, achieving 99%+ recovery compared to 80–90% for gravity-only architectures.

Phase 3: Automated Injection to Silo

Once ready for final discharge from the Stationary Cell to the silo, the operator pushes a switch to start the Automated Cargo Transfer System (ACTS) unloading process, activating the electric motor and positive displacement blower. ACTS manages final delivery to the customer's silo. The Stationary Cell is equipped with internal aerators that fluidize the material using the same pneumatic principles employed in traditional tanker trailers—compressed air reduces inter-particle friction, transforming the static powder bed into a flowable state. An electric motor drives a site-based positive displacement blower, generating the airflow necessary to convey material through the delivery pipe into the silo. The ACTS continuously monitors air pressure and flow sensors, actively managing four material valves to optimize movement and prevent line clogging.

The system's smart shutdown capability represents a significant departure from pneumatic operations, where silo overfill results in costly spills, cleanup, and inventory loss. If the receiving silo reaches capacity mid-transfer, the ACTS automatically closes material valves, clears delivery lines, and depressurizes the Stationary Cell—pausing operations without risk of line plugging. The system notifies the operator via flashing light or audible signal. The system remains ready to resume immediately once silo space becomes available, enabling precise inventory management and eliminating the need to return undelivered product. This walk-away automation allows site operators to attend to other duties during discharge, unlike pneumatic systems that demand continuous driver

attention to monitor pressure gauges and prevent blowbacks. Upon detecting a complete discharge, the operator repeats the cycle with the next staged Transport Cell, enabling continuous material flow and precise inventory control without overfilling or interruption.

Technical Innovations and Contamination Control

The Hourglass system's design mitigates several failure modes endemic to dry bulk transport. The gear-actuated valve mechanism eliminates the physical strain and error potential associated with manual valve operation, reducing maintenance incidents and ensuring consistent seal integrity across thousands of cycles. The sealed stacking architecture during inter-cell transfer prevents dust escape, addressing OSHA crystalline silica exposure limits that pneumatic blow-off operations frequently exceed. High-velocity pneumatic discharge in traditional systems generates noise levels exceeding 100 dB, requiring mandatory hearing protection and limiting operational hours near residential areas; the Hourglass architecture operates at 70–80 dB through electric-motor-driven, site-based blowers that eliminate diesel engine idle noise.

The separation of different materials is inherently supported: each Transport Cell is a discrete, sealed unit that can carry distinct products without cross-contamination risk, while the Stationary Cell's near-complete evacuation between loads (99%+ recovery) prevents residue buildup that compromises batch purity in food-grade and pharmaceutical applications. For moisture-sensitive materials—cement, fly ash, specialty chemicals—the sealed transport and discharge pathway eliminates exposure to humidity, precipitation, and airborne contaminants that flexible intermediate bulk containers (woven polypropylene fabric) cannot fully prevent.

The 14-foot Transport Cell length and neutral center of gravity deliver measurable safety advantages on steep grades and confined maneuvering zones. Pneumatic trailers spanning 45–53 feet create high turning radii and rollover risk on uneven terrain; 40-foot modular containers exhibit relatively high centers of gravity that exacerbate stability challenges during tilting operations. The Hourglass Transport Cell's compact footprint and tapered geometry distribute load more favorably, enabling access to well pads, hillside construction sites, and narrow industrial yards where long-wheelbase equipment is prohibited or impractical.

Operational Throughput and Driver Productivity

The sub-five-minute site turnaround transforms fleet utilization. By decoupling transport from discharge, a single tractor can service 33–50% more loads per day on dedicated routes compared to pneumatic operations, generating proportional revenue gains without adding headcount. For fleet operators, this productivity increase offsets the upfront cost of

Transport Cell inventory and site infrastructure installation, particularly on high-frequency lanes (≥10 loads per week) where rapid cycles amortize capital investment.

Driver retention improves measurably: eliminating 40–60 minutes of monotonous, hazardous idling per load—exposure to >100 dB noise, silica dust, heat stress from blower operation, and manual hose handling—directly addresses the factors driving >90% annual turnover in segments reliant on pneumatic delivery. Clean, quiet, five-minute cycles with zero manual unloading labor position the Hourglass system as a competitive advantage in markets with acute CDL driver shortages.

Capital Cost Comparison

Capital expenditure structure differs fundamentally from pneumatic systems. Traditional fleets distribute capital across mobile assets: each tractor requires a $10,000+ power take-off (PTO) blower assembly, and each trailer is a pressure-rated vessel costing approximately $257,500 per rig (truck, trailer, blower). Expanding capacity necessitates linear capital scaling—every additional truck incurs full discharge hardware costs. The Hourglass system centralizes investment at customer sites: standard tractors (no PTO blowers) pull Transport Cells, while the Stationary Cell and ACTS blower infrastructure are permanent site assets. For a concrete plant requiring 25 loads per week (1,300 loads annually), two pneumatic rigs cost approximately $515,000 in specialized CAPEX, while one complete Hourglass system (Stationary Cell, four Transport Cells, ACTS blower, truck, chassis) costs approximately $516,900—effectively equivalent upfront investment.

The divergence emerges in operating cost. Pneumatic operations at this volume generate approximately $58,250 in annual OPEX (fuel for 40–60 minutes of idle per load, driver labor during discharge, dual-blower maintenance, truck/trailer upkeep). The Hourglass architecture reduces annual OPEX to approximately $17,490—a 70% reduction—through elimination of truck idle fuel burn, minimized driver discharge labor, centralized single-blower maintenance, and reduced wear on Transport Cells versus pneumatic trailers. Over a five-year lifecycle, total cost of ownership for pneumatic systems reaches approximately $806,250 compared to $604,350 for the Hourglass system—a savings of roughly $201,900, or 25%. Higher savings are achievable in high-volume, short-haul lanes where rapid turnaround frequency magnifies productivity gains.

Environmental and Regulatory Performance

The Hourglass system reduces per-load CO_2 emissions by approximately 30–40% through rapid site turnaround (reduced idle time), elimination of diesel-powered onboard blower operation, use of electric motors for site-based blowers, higher payload per trip (fewer total trips required), and optimized vehicle weight distribution. The electric-drive ACTS blower

creates a zero-emission discharge phase, eliminating diesel idle emissions entirely at the point of use. This positions the architecture favorably for sustainability-mandated operations, ESG procurement criteria, and jurisdictions with aggressive emissions policy—California, urban airshed non-attainment zones, and facilities pursuing carbon neutrality commitments.

The sealed-stack, low-velocity architecture dramatically reduces silica dust generation, improving worker health and reducing employer liability under OSHA's crystalline silica standard. Pneumatic discharge operations frequently exceed the 0.025 mg/m^3 permissible exposure limit during high-pressure blow-off phases, necessitating continuous respiratory protection, regular health monitoring, and engineering controls. The Hourglass system's enclosed inter-cell transfer and controlled ACTS fluidization minimize fugitive dust, simplifying compliance and enabling operations in noise- and dust-sensitive zones near residential areas.

Applications and Ideal Customer Profiles

The Hourglass system excels in high-efficiency, rapid-turnaround operations requiring complete material recovery, particularly where site accessibility and maneuverability are constrained. Target materials include frac sand, fine cement, fly ash, plastic pellets, fiberglass, carbon black, light ash, talc, roofing granules, and other powders prone to bridging or caking that demand active fluidization for complete discharge. Material handling performance is rated "excellent" for frac sand, fine cement, fly ash, and moisture-sensitive materials—applications where pneumatic systems have historically dominated but now face cost and regulatory pressure.

Ideal customer profiles span small-to-medium producers with limited silo space, regional bulk haulers serving dedicated high-frequency lanes, rebuilding and recovery operations (post-wildfire construction requiring rapid material staging in remote locations), and manufacturers in stricter-regulation regions prioritizing environmental compliance and worker safety. The system's smart shutdown capability makes it particularly valuable for facilities with variable silo capacity—ready-mix plants cycling between high and low demand, construction sites with phased material requirements, or specialty manufacturers managing multiple product streams through shared infrastructure.

Conversely, the system is less competitive for sporadic, ad-hoc routing across broad geographic networks where pneumatic trailers' self-contained mobility avoids site-specific infrastructure investment. Long-haul, high-volume commodity corridors where existing pneumatic fleets are fully depreciated and customer sites are optimized around traditional discharge infrastructure retain pneumatic advantage. The Hourglass system is best

positioned as a replacement or complement to existing pneumatic assets at constrained sites where maneuverability, dust control, full recovery, and driver retention materially improve unit economics.

Strategic Differentiation

Compared to pneumatic tank trailers, the Hourglass system delivers equivalent material handling capability (excellent performance on cohesive, bridging-prone materials) while eliminating on-site driver engagement, reducing emissions by 30–40%, cutting noise by 20+ dB, and cutting annual operating costs by roughly 70% which translates into lowering five-year total cost of ownership by approximately 25% in target applications. Compared to containerized systems, the Hourglass architecture achieves 99%+ recovery versus 80–90% for gravity-only modular containers, eliminates the need for customer-operated external pneumatic equipment ("sand kings") or vibration devices, and automates discharge through ACTS rather than relying on passive gravity flow that leaves 10–20% residual heel in the container.

The system supports zero-emission material handling concepts through compatibility with electric yard equipment (battery-powered forklifts) and electric-motor-driven site blowers powered by grid electricity or on-site renewables. This positions the architecture for accelerated adoption scenarios where stricter OSHA enforcement on crystalline silica, local emissions constraints, and ESG-driven procurement policies shift selection criteria from pure freight rate to lifecycle safety and environmental performance. As regulatory and market pressures mount, architectures that centralize blowers on-site, minimize idle time, and deliver near-complete recovery gain structural advantage over both legacy pneumatic systems and passive modular containers.

Summary

The VBTS Hourglass Bulk Delivery System represents a fundamental shift in dry bulk logistics, replacing extended on-site idle time with rapid, automated material transfer. By decoupling transportation from discharge through a split-cell architecture and site-based automation, the system enables drivers to complete deliveries in under five minutes—versus 40–60 minutes with conventional pneumatic trailers—while achieving 99%+ material recovery compared to 80–90% for gravity-only modular containers. Annual operating costs drop by approximately 70% through elimination of truck idle fuel burn, reduction of driver engagement time, centralized single-point blower maintenance, and smart inventory management that prevents costly spills and overfilling. Over a five-year lifecycle, total cost of ownership falls by roughly 25% despite equivalent upfront capital requirements. The system simultaneously delivers measurable safety and environmental

gains: sealed transfer pathways minimize crystalline silica dust exposure (addressing OSHA limits), electric-motor-driven site blowers reduce on-site noise by 20+ dB and per-load emissions by 30–40%, and automated valve actuators eliminate manual cranking strain on workers.

The architecture is purpose-built for high-frequency, regional delivery operations where rapid turnaround compounds economic advantage—concrete plants, oilfield logistics, construction material distribution, and specialty powder applications where maneuverability on narrow sites, complete product recovery, and contamination control are critical. The system's flexibility in loading methods (silo, conveyor, bulk sack, front-end loader), buffer storage rack capacity, and push-button operator interface ensure seamless integration with existing supplier infrastructure and customer workflows, while the smart shutdown capability enables precise inventory control for facilities with variable silo capacity or phased material requirements.

For detailed technical specifications, site feasibility assessments, or to discuss integration with your existing fleet and infrastructure, please contact us at miketaylor@vbts.net.

