

LOGISTICS CANON

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Abstract

Example

hadleylab.org Governed Research. Every claim cited.

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Every shipment **MUST** be uniquely identified, serialized, and traceable from origin to destination using GS1 standards.

Example: GS1 standards define global identification: GTIN (Global Trade Item Number) 14-digit product identifier encoded in UPC/EAN barcodes, used across 2M+ companies in 150+ countries. SSCC (Serial Shipping Container Code) 18-digit logistics unit identifier on GS1-128 barcode for pallet/container tracking. GLN (Global Location Number) 13-digit identifier for physical/digital/functional locations (warehouses, docks, racks). GS1 DataMatrix 2D symbology encoding GTIN + serial number + batch/lot + expiry for unit-level serialization. RFID: EPC Gen2 (ISO 18000-63) 96-bit Electronic Product Code, UHF 860-960 MHz, read range 1-12m, anti-collision for 1000+ tags/second. Serialization mandates: DSCSA (Drug Supply Chain Security Act) unit-level serialization required for pharmaceuticals by 2023. EU FMD (Falsified Medicines Directive) unique identifier + tamper-evident features. GS1 EPCIS (Electronic Product Code Information Services) standard for sharing what, where, when, why event data across supply chain partners.

0.1 2. Chain of Custody

Goods in transit **MUST** maintain documented, tamper-evident chain of custody with verified handoff at each transfer point.

Example: ISO 28000 (Specification for Security Management Systems for the Supply Chain) risk assessment, security management policy, threat identification, and incident response for supply chain operations. C-TPAT (Customs-Trade Partnership Against Terrorism) U.S. CBP program with 11,400+ certified members receiving reduced inspections, priority processing (Tier 1: basic, Tier 2: validated, Tier 3: green lane). AEO (Authorized Economic Operator) WCO SAFE Framework equivalent in 90+ countries, mutual recognition agreements (US C-TPAT EU AEO Japan AEO). Tamper evidence: ISO 17712

(mechanical seals for freight containers) High Security H seal (bolt seal), Security S seal (cable seal), Indicative I seal (strap seal). Electronic seals (e-seals) per ISO 18185 real-time container security monitoring via satellite/cellular. Bill of Lading: Hague-Visby Rules, Rotterdam Rules document of title, receipt for goods, evidence of contract. Blockchain-based BoL: TradeLens (Maersk/IBM), GSBN digital original documents with immutable chain of custody.

0.2 3. Delivery Governance

International shipment documentation MUST comply with customs, trade, and carrier-specific regulatory requirements.

Example: IATA e-freight paperless air cargo initiative covering 20 key documents: electronic Air Waybill (e-AWB) per Resolution 672, adoption rate > 75% globally. Customs declaration: WCO Data Model (harmonized dataset for cross-border trade), Single Window systems (ASYCUDA, ACE in US). Incoterms 2020 (ICC) 11 rules defining buyer/seller obligations: EXW (Ex Works), FCA (Free Carrier), CPT (Carriage Paid To), CIP (Carriage and Insurance Paid), DAP (Delivered at Place), DPU (Delivered at Place Unloaded), DDP (Delivered Duty Paid), FAS, FOB, CFR, CIF (last 4: sea/inland waterway only). HS Code (Harmonized System) WCO 6-digit tariff classification used by 211 countries, determines duty rates and trade restrictions. AMS (Automated Manifest System) 24-hour advance cargo filing for US-bound ocean shipments. ICS2 (Import Control System 2) EU advance cargo information for all transport modes by 2024. ATA Carnet international customs document for temporary imports (exhibitions, samples, equipment).

0.3 4. Fleet Management

Commercial fleet operations MUST comply with safety regulations, driver qualification, and vehicle maintenance requirements.

Example: ISO 39001 (Road Traffic Safety Management Systems) organizational framework for reducing fatal and serious injuries, applicable to fleet operators, transport companies, and logistics providers. ELD mandate (FMCSA, 49 CFR Part 395) Electronic Logging Devices required for all CMV (Commercial Motor Vehicle) operators since December 2017, replacing paper logs. HOS (Hours of Service) regulations: 11-hour driving limit after 10 consecutive hours off-duty, 14-hour on-duty window, 60/70-hour 7/8-day limit, mandatory 30-minute break after 8 cumulative hours. Telematics: GPS tracking (sub-meter accuracy), OBD-II/J1939 (vehicle diagnostics), accelerometer (harsh braking/cornering), fuel consumption monitoring. CSA (Compliance, Safety, Accountability) FMCSA scoring system with 7 BASICs (Behavioral Analysis and Safety Improvement Categories): Unsafe Driving, HOS, Driver Fitness, Controlled Substances, Vehicle Maintenance, Hazardous Materials, Crash Indicator. DVIR (Driver Vehicle Inspection Report) pre-trip and post-trip inspection requirements per 49 CFR 396.11. IFTA (International Fuel Tax Agreement) fuel tax reporting for interstate/interprovincial commercial vehicles.

0.4 5. Warehouse Automation

Automated warehouse systems MUST comply with industrial safety standards and maintain governed material flow operations.

Example: ISO 3691-4 (Industrial Trucks Driverless Industrial Trucks and Their Systems Safety Requirements) defines safety requirements for AGVs (Automated Guided Vehicles) and AMRs (Autonomous Mobile Robots) including personnel detection, emergency stop, speed limits (max 1.2 m/s with personnel present), and defined path operation. WMS (Warehouse Man-

agement System) manages receiving, put-away, storage, picking, packing, and shipping with location-level inventory accuracy (target > 99.5%). Pick-to-light: directed picking with light displays at pick locations, achieving 300-500 picks/hour. Goods-to-person: automated storage/retrieval systems (AS/RS), shuttle systems (AutoStore, Ocado), robotic mobile shelving (Amazon Robotics/Kiva) throughput 200-600 units/hour per station. ANSI/RIA R15.08 (Industrial Mobile Robot Safety) safety requirements for autonomous mobile robots in industrial environments. Conveyor safety: ASME B20.1 (Safety Standard for Conveyors and Related Equipment) guards, E-stops, pull-cord switches. Slotting optimization: ABC analysis, velocity-based assignment, ergonomic zone placement. Voice picking: 99.99% accuracy, hands-free operation, multi-language support.

0.5 6. Last Mile

Last-mile delivery operations MUST meet regulatory requirements for autonomous delivery, drone delivery, and route optimization.

Example: Autonomous delivery: Nuro R2/R3 first autonomous vehicle to receive NHTSA exemption (February 2020), 25 mph max, designated for goods-only delivery with no occupant protection requirements. Starship Technologies sidewalk delivery robots, 4 mph, operational in 100+ cities, PCC (Personal Delivery Device) legislation in 25+ US states. Drone delivery: FAA Part 135 certification required for beyond-visual-line-of-sight (BVLOS) commercial operations, obtained by Wing (Alphabet), Amazon Prime Air, UPS Flight Forward, Zipline. FAA Part 107 small UAS (<55 lbs) operations for visual line of sight. Remote ID rule (14 CFR Part 89) broadcast identification and location for all UAS effective March 2024. Route optimization: Vehicle Routing Problem (VRP) with time windows, capacity constraints, and driver preferences NP-hard, solved via metaheuristics (genetic algorithms, simulated annealing,

ant colony) and commercial solvers (OR-Tools, Routific, OptimoRoute). Delivery density metrics: stops per hour, packages per stop, cost per delivery. USPS Informed Delivery daily digital preview of incoming mail/packages.

1. Constraints

MUST: Cite GS1 standard, ISO 28000, or domain-spec.

MUST: Distinguish between shipment tracking (visib

MUST NOT: Present GPS location data as equivalent to g

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