ODDC Scenarios

Conformance Scenario Library

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ODDC Scenarios Industry Applications This document presents representative scenarios illustrating how ODDC with ENVELO-compliant three-tier enforcement applies across industries. Each scenario shows representative ODD boundaries, the Minimum Risk Condition, and how all three enforcement tiers operate. Boundaries may be operator-specified or auto-discovered through the Interlock's adaptive learning mode. These examples are illustrative and non-normative.

1. Data Centers & Hyperscale Computing

Operational Context Autonomous systems allocate power, optimize cooling, place workloads, and orchestrate AI-on-AI stacks.

Real-time decisions affect facility safety, equipment longevity, and operational continuity.

Representative ODD Boundaries

- Power draw: Per-rack limits, row limits, facility aggregate
- Thermal envelope: Inlet temperature ranges, delta-T limits
- Workload density: Compute density per zone, memory utilization ceilings
- AI recursion: Maximum depth for AI systems managing other AI systems MRC: Automated workload shedding to base power; cooling override to maximum Tier 1 — Self-Correction Power draw approaching facility aggregate limit. System pauses new workload placement and begins thermal rebalancing.

Tier 2 — Minimum Risk Condition Thermal envelope breached on rack row. ENVELO forces MRC: shed non-critical workloads, override cooling to maximum, halt new placements.

Tier 3 — Hard Halt Cascading thermal exceedance across multiple rows. ENVELO halts: emergency power-down of affected racks, transfer critical workloads to unaffected zones.

2. Healthcare & Clinical AI

Operational Context Clinical decision support systems and autonomous diagnostic tools operate in high-stakes environments where bounded operation is essential for patient safety.

Representative ODD Boundaries

- Scope limitations: Specific conditions, patient populations, imaging modalities
- Confidence thresholds: Minimum certainty before automated recommendations
- Escalation triggers: Conditions requiring human review
- Formulary boundaries: Medication recommendations constrained to approved formulary MRC: Defer to human clinician with full context provided Tier 1 — Self-Correction Confidence score approaching minimum threshold. System flags uncertainty, increases sampling, alerts clinician of reduced confidence.

Tier 2 — Minimum Risk Condition Confidence below threshold or out-of-scope presentation. ENVELO forces MRC: recommendation withheld, case escalated to human clinician with full context.

Tier 3 — Hard Halt Data integrity failure or unrecognized input modality. ENVELO halts: no output generated, system offline pending integrity verification.

3. Financial Services

Operational Context Algorithmic trading systems, automated underwriting, and fraud detection require demonstrable operational boundaries for regulatory compliance and systemic risk management.

Representative ODD Boundaries

- Position limits: Maximum exposure per asset, sector, counterparty
- Velocity limits: Maximum transactions per time period
- Drawdown limits: Maximum loss before enforcement
- Market impact bounds: Maximum participation rate in any single security MRC: Unwind positions to risk-neutral; cancel all pending orders Tier 1 — Self-Correction Position approaching limit for sector exposure. System reduces position sizing, increases hedging, slows order rate.

Tier 2 — Minimum Risk Condition Drawdown threshold breached. ENVELO forces MRC: automatic position unwinding to risk-neutral, cancellation of all pending orders.

Tier 3 — Hard Halt Flash crash conditions or system integrity error. ENVELO halts: all trading ceased, positions frozen, full human escalation required.

4. Aerospace & Aviation

Operational Context Autonomous and semi-autonomous systems including UAS/drones, autonomous air traffic management, and satellite constellation management in regulated airspace.

Representative ODD Boundaries

- Geospatial boundaries: Maximum altitude, horizontal geofence, prohibited airspace
- Performance envelope: Maximum airspeed, bank angle, rate of climb/descent
- Communication requirements: Maximum time without ground station contact

• Weather minimums: Wind speed limits, visibility minimums, icing restrictions MRC: Enter holding pattern at safe altitude; initiate return-to-base Tier 1 — Self-Correction Approaching geofence boundary. System adjusts heading to maintain safe distance, alerts ground station.

Tier 2 — Minimum Risk Condition Geofence breached or communication timeout exceeded. ENVELO forces MRC: enter holding pattern, reduce altitude, initiate autonomous return-to-base.

Tier 3 — Hard Halt Critical navigation failure or total communication loss. ENVELO halts: automated emergency landing at nearest safe point.

5. Manufacturing & Industrial Automation

Operational Context Autonomous manufacturing systems control robotic assembly, quality inspection, predictive maintenance, and material handling with human proximity concerns.

Representative ODD Boundaries

- Force/torque limits: Per-actuator maximums
- Workspace boundaries: Permitted operating zones per robot
- Temperature thresholds: Tool and workpiece limits
- Human proximity: Collaborative zone safety distances MRC: Speed reduction to collaborative limits; retract to home position Tier 1 — Self-Correction Approaching workspace boundary or force limit. System reduces speed, increases sensor polling rate.

Tier 2 — Minimum Risk Condition Human presence detected in active zone or force limit exceeded. ENVELO forces MRC: speed reduction, retract to safe position.

Tier 3 — Hard Halt Unplanned contact detected or sensor failure. ENVELO halts: all motion stopped, brakes engaged, lockout until manual reset.

6. Energy & Grid Management

Operational Context Autonomous grid management systems balance generation, transmission, and distribution across interconnected power networks.

Representative ODD Boundaries

- Frequency bounds: Acceptable Hz range
- Load limits: Maximum draw per segment
- Voltage ranges: Per-node acceptable bands
- Reserve margins: Minimum spinning reserve requirements MRC: Shed non-critical load by priority matrix; protect critical categories Tier 1 — Self-Correction Frequency drifting toward limit. System adjusts generation dispatch, activates spinning reserves.

Tier 2 — Minimum Risk Condition Frequency or voltage out of bounds. ENVELO forces MRC: load shedding by priority matrix, protect critical infrastructure.

Tier 3 — Hard Halt Cascade failure or control system error. ENVELO halts: island affected segments, transfer to manual control.

7. Autonomous Vehicles

Operational Context Self-driving vehicles operating on public roads with operational domains covering speed, weather, geography, and sensor conditions.

Representative ODD Boundaries

- Speed limits: Posted and environmental maximums
- Lane boundaries: Roadway types
- Weather conditions: Visibility, precipitation, road surface
- Sensor ranges: LiDAR, radar, camera operational bounds MRC: Pull to nearest safe shoulder at minimum speed; activate hazard lights Tier 1 — Self-Correction Approaching speed limit or lane boundary. Internal systems reduce speed, adjust steering to maintain center-lane.

Tier 2 — Minimum Risk Condition Sensor degradation below threshold (e.g., fog). ENVELO forces MRC: pull to shoulder, reduce to crawl speed, activate hazard indicators.

Tier 3 — Hard Halt Total sensor failure at highway speed. ENVELO halts: controlled emergency stop, parking brake engaged.

8. Pharmaceutical AI

Operational Context AI systems in pharmaceutical applications manage dosage optimization, drug interaction screening, and formulary recommendations.

Representative ODD Boundaries

- Dosage ranges: Per-drug, per-patient maximums
- Drug interactions: Known interaction database scope
- Patient contraindications: Condition and allergy profiles
- Regulatory scope: Approved indications only MRC: Withhold recommendation; alert pharmacist with full context Tier 1 — Self-Correction Dosage approaching upper limit for patient profile. System flags for pharmacist review.

Tier 2 — Minimum Risk Condition Drug interaction detected or dosage exceeds range. ENVELO forces MRC: recommendation withheld, pharmacist alerted with clinical context.

Tier 3 — Hard Halt Unknown compound or system integrity error. ENVELO halts: no output, full escalation to clinical team.

9. Autonomous Maritime

Operational Context Autonomous vessel navigation, port operations, and fleet management in complex maritime environments.

Representative ODD Boundaries

- Sea state limits: Maximum wave height and period
- Traffic density: Maximum vessel proximity
- Channel boundaries: Navigable waterway limits
- Cargo stability: Load and trim parameters MRC: Reduce to steerage way; alert bridge crew Tier 1 — Self-Correction Sea state approaching limit. System reduces speed, adjusts heading for optimal stability.

Tier 2 — Minimum Risk Condition Exceeded sea state or channel boundary approach. ENVELO forces MRC: reduce to steerage way, alert bridge crew.

Tier 3 — Hard Halt Navigation failure or critical weather exceedance. ENVELO halts: all-stop, deploy stabilization, transfer to manual helm.

10. Surgical Robotics

Operational Context Robotic-assisted surgical systems performing precise procedures under direct or supervisory surgeon control.

Representative ODD Boundaries

- Force/torque limits: Per-instrument maximums
- Instrument positions: Permitted workspace within patient
- Tissue boundaries: Safe margins
- Patient movement: Maximum acceptable deviation MRC: Retract instruments to safe position; hold; yield to surgeon Tier 1 — Self-Correction Approaching force limit on actuator. System reduces speed, increases compliance, alerts surgeon.

Tier 2 — Minimum Risk Condition Force limit exceeded or tissue boundary approach. ENVELO forces MRC: retract instruments, hold position, alert surgeon for manual takeover.

Tier 3 — Hard Halt Unrecoverable deviation or sensor failure. ENVELO halts: actuators locked in current position, immediate yield to surgeon manual control.

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