

ISA-95 Asset Model Reference

Enterprise B (ProveItBeverage)
└─ Site1 (Plant1)
└─ FillerProduction (Area)
└─ FillingLine01 "Line A" [Asset ID: 7]
└─ Filler [Asset ID: 23] – Rotary Filler, 300 bpm
└─ Washer [Asset ID: 24] – Bottle Washer
└─ CapLoader "Capper" [Asset ID: 22]
└─ LiquidProcessing (Area)
└─ MixRoom01 [Asset ID: 10]
└─ Vat01 "Jeff" [Asset ID: 31] – 15,000L capacity
└─ Vat02 [Asset ID: 32]
└─ Vat03 "Billy" [Asset ID: 33]
└─ Vat04 [Asset ID: 34]
└─ Packaging (Area)
└─ PackagingLine01 [Asset ID: 45]
└─ Labeler [Asset ID: 46]
└─ DateCoder [Asset ID: 47]
└─ ShrinkWrapper [Asset ID: 48]
└─ CasePacker [Asset ID: 49]
└─ Warehouse (Area)
└─ Palletizing01 [Asset ID: 55]
└─ LayerFormer [Asset ID: 56]
└─ PalletizingRobot [Asset ID: 57] – FANUC M-410iC
└─ StretchWrapper [Asset ID: 58]

Demo Overview

Scenario	Duration	Equipment	Key Highlight
1. Filler Vibration Anomaly	4 min	Filler (23)	Real-time detection → Agent workflow
2. Mixing Vat Temperature Drift	4 min	Vat01 "Jeff" (31)	Process parameter anomaly → Quality impact
3. Capper Torque Degradation	4 min	CapLoader (22)	Predictive maintenance → RUL
4. Line Cascade Prevention	5 min	FillingLine01 (7)	Multi-agent collaboration
5. Quality Root Cause Analysis	3 min	Cross-line	AI investigation → Hidden correlation
6. Natural Language Interface	3 min	All assets	Conversational queries

Scenario 1: Rotary Filler Vibration Anomaly

Equipment Context

- **Asset:** Filler (Asset ID: 23)
- **Location:** Enterprise B/Site1/FillerProduction/FillingLine01/Filler
- **Type:** High-Speed Rotary Filler
- **Standard Rate:** 300 bottles/min
- **Current WO:** WO-L03-0428 (Orange Soda 0.5L)

MQTT Topics Monitored

Enterprise B/Site1/fillerproduction/fillingline01/filler/processdata/state/name
Enterprise B/Site1/fillerproduction/fillingline01/filler/metric/oe

Demo Flow

Step 1: Normal Operations (30 sec)

FILLER – Asset ID: 23	Status: ✔ RUNNING
Location: FillingLine01 "Line A"	
OEE: 87.8% Availability: 89.8% Performance: 97.7%	
Rate: 307 bpm (Standard: 300 bpm)	
Vibration: 2.1 mm/s (Normal < 5.0 mm/s)	
Temperature: 42°C	
Work Order: W0-L03-0428 Lot: L03-0428	
Product: Orange Soda 0.5L Progress: 19,586 / 52,000 (37.7%)	

Step 2: Anomaly Detected (30 sec)

FILLER – Asset ID: 23	Status: ● ALERT
Location: FillingLine01 "Line A"	
⚠ ANOMALY DETECTED – Vibration Spike	
Vibration: 8.4 mm/s ⚠ 4x NORMAL (Threshold: 5.0 mm/s)	
Temperature: 48°C	↑ Rising
Rate: 295 bpm	↓ Declining
Pattern Match: Bearing degradation signature (94% confidence)	

Step 3: Agent Workflow (2 min)

MULTI-AGENT WORKFLOW – LIVE	
🤖 Anomaly Detection Agent:	"Vibration spike on Filler (Asset 23) at FillingLine01. Pattern matches bearing wear signature from SOP document SOP_HIGH_SPEED_ROTARY_FILLER.md – Error Code E008. Failure probability: 89% within 4 days if uncorrected."
🤖 Impact Analysis Agent:	"Filler failure stops FillingLine01 (Line A). Downstream impact: Washer (24) and Capper (22) idle. Current W0-L03-0428 has 32,414 bottles remaining. Production loss: \$12,000/hour (52,000 bottles/shift)"
🤖 Inventory Check Agent:	"Replacement bearing SKF-6205-2RS available. Warehouse location: Bin A-23. Quantity: 4 units. Delivery to FillerProduction area: 45 minutes."
🤖 Scheduling Optimizer Agent:	"Current shift ends at 6:00 PM. Recommended maintenance window: Tonight 10PM-2AM."

Technician: Maria Garcia (Filler certified).
Estimated repair time: 2.5 hours per SOP procedure."

Step 4: Orchestrator Decision (1 min)

🔧 ORCHESTRATOR RECOMMENDATION

- ✅ Schedule emergency maintenance tonight 10PM-2AM
- ✅ Reserve bearing SKF-6205-2RS from warehouse (Bin A-23)
- ✅ Assign technician Maria Garcia
- ✅ Create work order WO-MAINT-2847 in CMMS
- ✅ Notify shift supervisor (auto-email sent)
- ✅ Pre-stage tools per SOP Section 4.2 (E008 resolution)

💰 Estimated Savings: \$42,000
(Avoided 3.5 hours unplanned downtime at \$12K/hour)

📄 SOP Reference: SOP_HIGH_SPEED_ROTARY_FILLER.md
Section 4.2 - Error E008: Drive Fault (Motor/Bearing)

[APPROVE] [RESCHEDULE] [VIEW SOP] [IGNORE]

Scenario 2: Mixing Vat Temperature Drift

Equipment Context

- **Asset:** Vat01 "Jeff" (Asset ID: 31)
- **Location:** Enterprise B/Site1/LiquidProcessing/MixRoom01/Vat01
- **Type:** Industrial Mixing Vat
- **Capacity:** 15,000 liters
- **Current WO:** WO-L02-0126 (Cola Mix)

MQTT Topics Monitored

Enterprise B/Site1/liquidprocessing/mixroom01/vat01/processdata/process/temperature
Enterprise B/Site1/liquidprocessing/mixroom01/vat01/processdata/process/weight
Enterprise B/Site1/liquidprocessing/mixroom01/vat01/processdata/state/name
Enterprise B/Site1/liquidprocessing/mixroom01/vat01/metric/oeo
Enterprise B/Site1/liquidprocessing/mixroom01/vat01/workorder/quantityactual

Demo Flow

Step 1: Normal Mixing Operation

VAT01 "Jeff" - Asset ID: 31 Status: ✅ MIXING
Location: MixRoom01 / LiquidProcessing

State: Mixing Duration: 1,245 sec Agitator: 45 RPM

Temperature: 32.5°C (Target: 32°C ± 2°C) ✅
Weight: 11,250 kg (Capacity: 13,000 kg)
Flow Rate: 0 L/min (Mixing - no transfer)

Recipe: Cola Mix | Batch: L02-0126

Ingredients: Water 65%, Suga Syrup 25%, Concentrate 10%

Step 2: Temperature Drift Detected

VAT01 "Jeff" – Asset ID: 31 Status: ⚠️ WARNING
Location: MixRoom01 / LiquidProcessing

⚠️ PROCESS ANOMALY – Temperature Drift

Temperature: 38.2°C ⚠️ +6.2°C above target
Trend: Rising 0.8°C per minute

Quality Risk: HIGH
– Cola Mix spec requires 30–34°C for proper dissolution
– Above 40°C: Caramelization risk, batch rejection

Root Cause Analysis in progress...

Step 3: Agent Investigation

🧠 Root Cause Analysis Agent

Analyzing Vat01 "Jeff" temperature anomaly...

INVESTIGATION:
└─ Agitator motor current..... ✓ Normal (12.3A)
└─ Cooling jacket flow..... ⚠️ LOW (15 L/min)
└─ Cooling water inlet temp..... ✓ Normal (18°C)
└─ Steam valve position..... ✓ Closed
└─ Ambient temperature..... ✓ Normal (22°C)

ROOT CAUSE IDENTIFIED:
Cooling jacket flow reduced 70% (normal: 50 L/min)
Probable cause: Cooling water valve V-201 partially closed

CORRELATION: Maintenance performed on V-201 yesterday
(WO-MAINT-2831 – valve stem lubrication)

RECOMMENDATION:
1. Immediately open V-201 to 100%
2. Monitor temperature decline
3. If temp exceeds 40°C, initiate emergency cooling

📄 SOP Reference: SOP_INDUSTRIAL_MIXING_VAT_SYSTEM.md
Section 4.3 – Error A001: High Temperature (CRITICAL)
Section 4.1 – Temperature Not Reaching Setpoint

Step 4: Automated Response

🎯 ORCHESTRATOR ACTIONS

✅ Alert sent to MixRoom01 operator panel

✔ Cooling valve V-201 command: OPEN 100% (pending confirm)

✔ Quality hold placed on batch L02-0126

✔ Lab sample request generated

✔ Incident logged: INC-2026-0128-001

BATCH STATUS:

Current: 12,930 kg produced (99.5% complete)

Quality: HOLD pending temperature verification

If temperature returns to spec within 10 minutes:

→ Batch can be released after QC verification

→ Estimated impact: 15 minute delay

If temperature exceeds 40°C:

→ Batch rejection required per SOP

→ Loss: \$8,500 (materials + processing)

Scenario 3: Capper Torque Degradation (Predictive Maintenance)

Equipment Context

- **Asset:** CapLoader "Capper" (Asset ID: 22)
- **Location:** Enterprise B/Site1/FillerProduction/FillingLine01/CapLoader
- **Type:** Rotary Capping Machine
- **Function:** Applies and torques bottle caps
- **Parent:** FillingLine01 (Asset ID: 7)

MQTT Topics Monitored

Enterprise B/Site1/fillerproduction/fillingline01/caploader/processdata/state/name
Enterprise B/Site1/fillerproduction/fillingline01/caploader/metric/oe
Enterprise B/Site1/fillerproduction/fillingline01/caploader/processdata/torque/actual (simulated)
Enterprise B/Site1/fillerproduction/fillingline01/caploader/processdata/torque/variance (simulated)

Demo Flow

Step 1: Predictive Maintenance Dashboard

PREDICTIVE MAINTENANCE – FillingLine01 Equipment

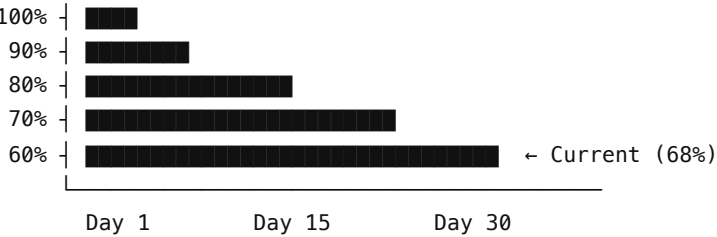
Equipment	Health	RUL (Days)	Trend	Action
Filler (23)	91%	28	Stable	Monitor
Washer (24)	94%	45	Stable	Schedule
Capper (22)	68%	9 ⚠️	Declining	URGENT

⚠️ Capper requires attention – click for details

Step 2: Capper Deep Dive

CAPPER (Asset ID: 22) – DETAILED ANALYSIS

Health Score Trend (30 days):



DEGRADATION INDICATORS:

- Torque variance: +15% (was $\pm 2\%$, now $\pm 17\%$)
- Capping head vibration: +8% above baseline
- Reject rate: 0.3% \rightarrow 0.8% (cap seal failures)

ML MODEL PREDICTION:

- Failure mode: Capping head clutch wear
- Confidence: 87%
- Remaining Useful Life: 9 ± 2 days

SIMILAR PAST FAILURES: 2 occurrences

- March 2025: Clutch replacement after 14 months
- September 2024: Clutch replacement after 13 months
- Current clutch age: 12.5 months

Step 3: Agent Recommendation

 Predictive Maintenance Agent

DIAGNOSIS: Capping head clutch wear

CONFIDENCE: 87%

PREDICTED FAILURE: 9 ± 2 days

RECOMMENDED ACTION:

Optimal Maintenance Window: Saturday 6:00 AM – 11:00 AM

Reasoning:

- Production schedule: Planned line changeover
- Parts: Clutch kit #CAP-CLT-200 (in stock, Bin B-15)
- Technician: Carlos Rodriguez (Capper certified)
- Estimated repair time: 4 hours per SOP

Cost Comparison:

- Planned maintenance: \$1,800 (parts + labor)
- Unplanned failure: \$38,000
 - Emergency parts: \$2,400 (expedited shipping)
 - Downtime: 8 hours \times \$4,000/hr = \$32,000
 - Quality rejects: ~\$3,600 (loose caps)

 SOP: SOP_HIGH_SPEED_ROTARY_FILLER.md

Section 4.1 – Poor Fill Accuracy (Torque Variance)

Section 6.1 – Quarterly: Replace filling valve seals

[APPROVE MAINTENANCE] [RESCHEDULE] [VIEW SOP] [GET MORE INFO]

Scenario 4: FillingLine01 Cascade Prevention

Equipment Context

- **Asset:** FillingLine01 "Line A" (Asset ID: 7)
- **Location:** Enterprise B/Site1/FillerProduction/FillingLine01
- **Child Equipment:** Washer (24) → Filler (23) → Capper (22)
- **Downstream:** Packaging Line (45) → Palletizing (55)

Process Flow

MixRoom01 (Vat01) → FillingLine01 → PackagingLine01 → Palletizing01			
↓	↓	↓	↓
Cola Mix (Asset 31)	Bottle Fill (Assets 22–24)	Label/Pack (Assets 46–49)	Palletize (Assets 56–58)

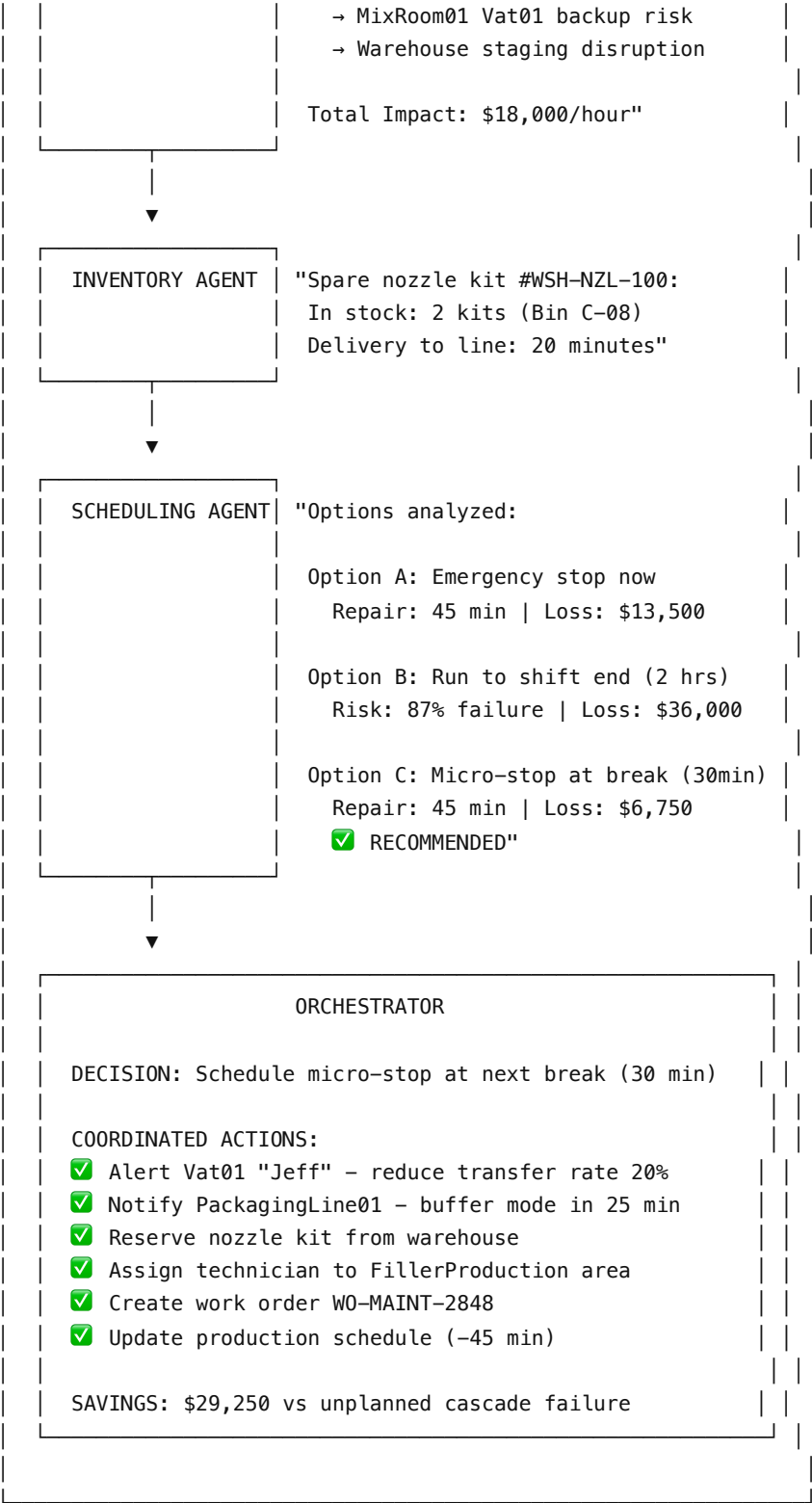
Demo Flow

Step 1: Trigger Event - Washer Efficiency Drop

<div><div>⚠️ ALERT: FillingLine01 – Washer Efficiency Degradation</div><div></div></div>
<div><div>Asset: Washer (ID: 24)</div><div>Location: FillingLine01 "Line A"</div><div></div><div>Current Efficiency: 82% (was 98%)</div><div>Trend: Declining 3% per hour</div><div>Risk: High probability of stoppage within 4 hours</div><div></div><div>Symptom: Rinse cycle time increasing</div><div>Possible cause: Spray nozzle blockage</div></div>

Step 2: Multi-Agent Cascade Analysis

MULTI-AGENT WORKFLOW – CASCADE PREVENTION	
<div><div>ANOMALY AGENT</div><div>▼</div><div>IMPACT AGENT</div></div>	<div>"Washer (24) efficiency at 82%. Spray nozzle blockage detected. Stoppage risk: 87% within 4 hours"</div> <div>"CASCADE IMPACT ANALYSIS: Level 1: Washer (24) stops → Filler (23) starved in 8 min → Capper (22) idle in 10 min Level 2: FillingLine01 stops → PackagingLine01 starved in 15 min → Palletizing01 idle in 25 min Level 3: Full plant impact"</div>



Scenario 5: Quality Root Cause Analysis

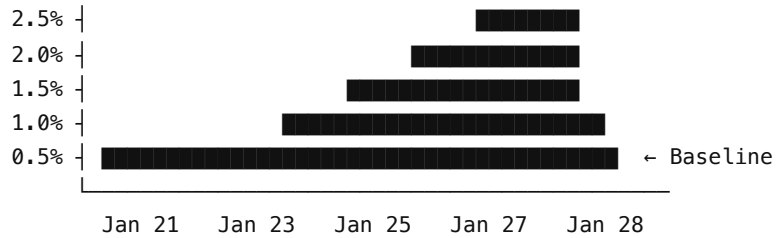
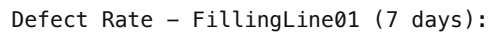
Context

- Quality defect rate increased across multiple products
- Affects bottles from FillingLine01
- Need to identify hidden correlation

Demo Flow

Step 1: Quality Alert Dashboard

QUALITY DASHBOARD – DEFECT RATE ALERT



⚠ Defect rate 4.2x above baseline

Affected: Orange Soda 0.5L, Cola 0.5L, Lemon-Lime 0.5L

Defect type: Fill level variance (underfill/overfill)

Step 2: User Query

 User: "Why did the fill level defect rate increase on Line A?"

Step 3: Agent Investigation

 Root Cause Analysis Agent

Analyzing FillingLine01 quality data...

INVESTIGATION PROGRESS:

	Filler (23) calibration logs.....	✓	No change
	Product temperature from Vat01.....	✓	Within spec
	Bottle supplier batches.....	✓	No correlation
	Operator shift patterns.....	✓	No correlation
	Filler valve timing.....	✓	Within spec
	Product viscosity readings.....	⚠	CORRELATION
	└ C02 carbonation level.....		94% correlation
	Upstream process review.....	⚠	RELATED EVENT

FINDINGS:

ROOT CAUSE IDENTIFIED

Primary Factor: CO2 Carbonation Level Variance
Correlation: 94%

Timeline Analysis:

- Jan 23: CO2 supply tank changed (Tank B → Tank C)
- Jan 23: Carbonation level began varying ($\pm 8\%$ vs $\pm 2\%$)
- Jan 24: Fill level defects began increasing

Technical Explanation:

C02 Tank C has higher pressure variance than Tank B. Variable carbonation causes foam during filling, leading to inconsistent fill levels.

Affected Equipment:

- Carbonator (upstream of Vat01)
- Filler (23) – fill valve timing affected by foam

RECOMMENDATION:

Note: Batch nearly complete. Next batch: Lemon-Lime Mix"

Date	Error	Description	Resolution
Jan 15	E001	Bottle Jam	12 min
Jan 08	E008	Drive Fault	Scheduled
Dec 28	E014	Valve Stuck	45 min
Dec 20	E011	High Product Temp	8 min

Summary:

- Total incidents: 4
- Total downtime: 65 minutes
- Most common: Mechanical (E008, E014)

Full error codes in SOP_HIGH_SPEED_ROTARY_FILLER.md"

SOP Error Code Quick Reference

Filler Error Codes (SOP_HIGH_SPEED_ROTARY_FILLER.md)

Code	Priority	Description	Immediate Action
E001	HIGH	Bottle jam	Stop, clear jam
E002	MEDIUM	Missing bottle	Check infeed
E003	HIGH	Overfill	Stop, check valve
E004	CRITICAL	Low air pressure	Stop, check supply
E005	HIGH	Guard open	Close guard
E006	CRITICAL	E-stop	Investigate
E007	MEDIUM	Comm fault	Check network
E008	HIGH	Drive fault	Check motor/bearing
E009	LOW	Maintenance due	Schedule PM
E010	MEDIUM	CIP required	Run CIP
E011	HIGH	High product temp	Cool product
E012	CRITICAL	Overflow	Stop, clean
E013	MEDIUM	Low product level	Refill tank
E014	HIGH	Valve stuck	Replace valve
E015	LOW	Filter dirty	Replace filter

Mixing Vat Error Codes (SOP_INDUSTRIAL_MIXING_VAT_SYSTEM.md)

Code	Priority	Description	Immediate Action
A001	CRITICAL	High temperature	Stop heating, investigate
A002	CRITICAL	High pressure	Open vent, stop process
A003	HIGH	Agitator overload	Stop agitator, check load
A004	HIGH	Low level	Stop agitator, check level
A005	HIGH	Weight deviation	Verify additions
A006	MEDIUM	Temperature deviation	Check control loop
A007	MEDIUM	Agitator speed deviation	Check VFD
A008	LOW	CIP due	Schedule CIP

A009	LOW	Calibration due	Schedule calibration
A010	HIGH	Manway open	Close and seal
A011	CRITICAL	E-stop activated	Investigate cause

Labeler Error Codes (SOP_PACKAGING_LABELER_LINE.md)

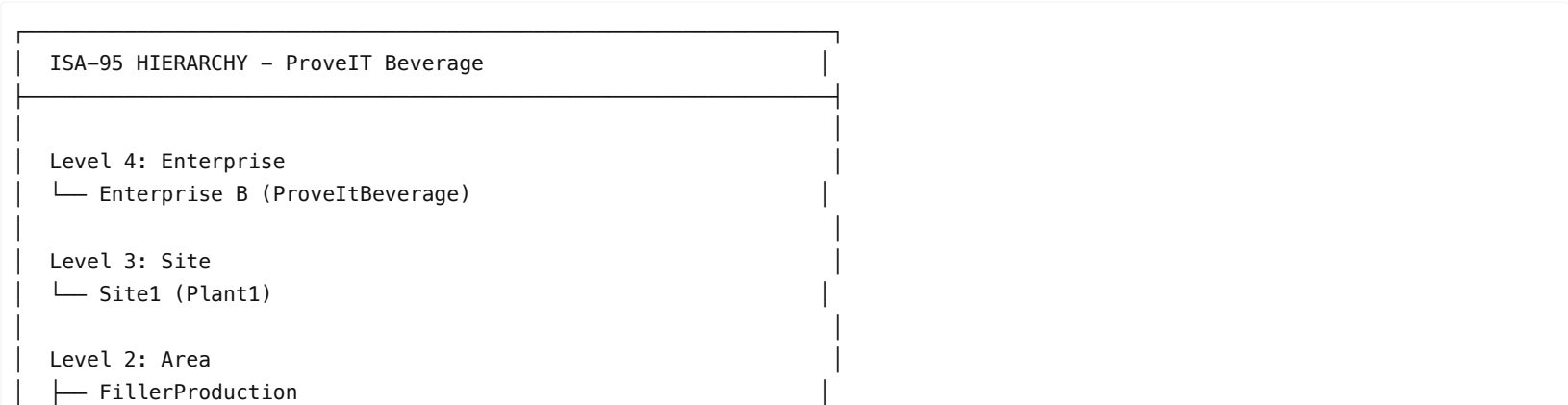
Code	Priority	Description	Immediate Action
L001	HIGH	Label roll empty	Replace roll
L002	MEDIUM	Label low warning	Prepare new roll
L003	HIGH	Misalignment detected	Check applicator
L004	CRITICAL	E-stop activated	Investigate
P001	HIGH	Case jam	Clear jam
P002	MEDIUM	Case blanks low	Refill
P003	HIGH	Bottle backup	Check downstream
S001	HIGH	Sealer fault	Check tape/glue

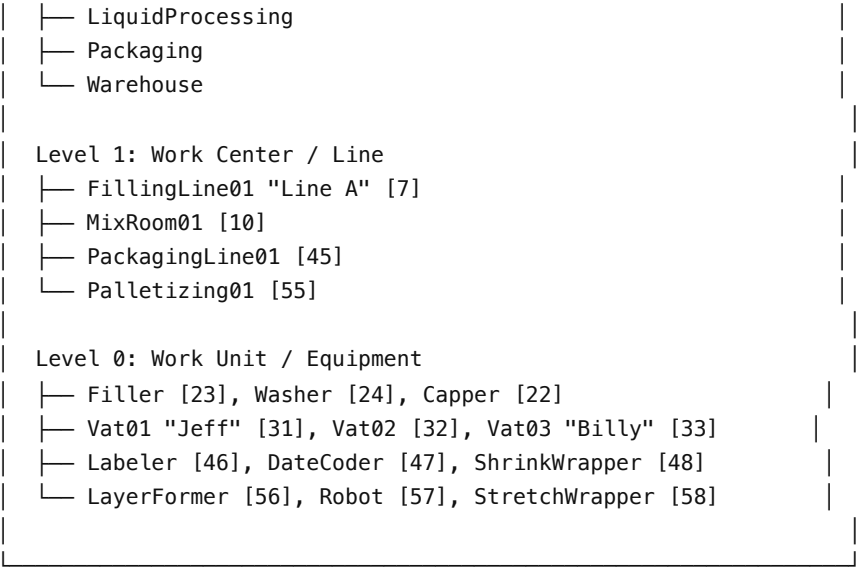
Palletizer Error Codes (SOP_PALLETIZING_SYSTEM.md)

Code	Priority	Description	Immediate Action
PAL-001	CRITICAL	Robot E-stop	Investigate cause
PAL-002	HIGH	Robot fault	Check teach pendant
PAL-003	HIGH	Gripper fault	Check vacuum/sensors
PAL-004	MEDIUM	Case jam	Clear infeed
PAL-005	MEDIUM	Pallet full	Exchange pallet
PAL-006	LOW	Pallet low	Replenish pallets
WRP-001	HIGH	Film break	Rethread film
WRP-002	MEDIUM	Film low	Prepare new roll
WRP-003	HIGH	Wrapper fault	Check wrapper

Technical Architecture

ISA-95 Data Model





MQTT Topic Structure

Enterprise B/Site1/{area}/{workcenter}/{equipment}/{category}/{metric}

Examples:

- └─ Enterprise B/Site1/fillerproduction/fillingline01/filler/metric/oeo
- └─ Enterprise B/Site1/fillerproduction/fillingline01/filler/processdata/state/name
- └─ Enterprise B/Site1/liquidprocessing/mixroom01/vat01/processdata/process/temperature
- └─ Enterprise B/Site1/liquidprocessing/mixroom01/vat01/workorder/quantityactual
- └─ Enterprise B/Site1/packaging/packagingline01/labeler/metric/availability