MES Production Confirmation POC - Detailed Agile System Audit

Date: 2026-02-12 | **Version:** 1.0 | **Audit Type:** Full System

A. Module Inventory

#	Module	Business Purpose	Screen Count	APIs Used	Key Services	Status	Completion %
1	**Auth**	User login, JWT token management	1	4	AuthService, JwtService	Complete	100%
2	**Dashboard**	KPIs, recent activity, summary metrics	1	2	DashboardService	Complete	100%
3	**Orders**	Customer order lifecycle management	3	10	OrderService	Complete	100%
4	**Production**	Production confirmation, reversal, history	3	10	ProductionService, BomValidationService	Complete	100%
5	**Inventory**	Material stock management, state transitions	4	17	InventoryService, ReceiveMaterialService	Complete	100%
6	**Batches**	Batch lifecycle, genealogy, split/merge	3	22	BatchService, BatchNumberService	Complete	100%
7	**Holds**	Hold/release on any entity	3	6	HoldService	Complete	100%
8	**Equipment**	Equipment CRUD, maintenance, holds	3	13	EquipmentService	Complete	95%
9	**Operations**	Operation tracking, status management	2	6	OperationService	Complete	95%
10	**Customers**	Customer master data CRUD	3	7	CustomerService	Complete	100%
11	**Materials**	Material master data CRUD	3	7	MaterialService	Complete	95%
12	**Products**	Product master data CRUD	3	7	ProductService	Complete	95%
13	**Operators**	Operator master data CRUD	3	6	OperatorService	Complete	100%
14	**Processes**	Process definition management	4	6	ProcessService	Complete	100%
15	**Routing**	Production routing with steps	3	20+	RoutingService	Complete	95%

16	**Operation Templates**	Reusable operation blueprints	3	5	OperationTemplateService	Complete	100%
17	**BOM**	Bill of Materials tree management	3	18	BomService, BomValidationService	Complete	95%
18	**Configuration**	6 config sub-modules (hold/delay reasons, params, batch number/size, quantity type)	12	30+	6 config services	Complete	100%
19	**Reports**	7 report types + executive dashboard	8	8	ReportAnalyticsService, ChartService	Complete	100%
20	**Users**	User management CRUD	3	9	UserService	Complete	100%
21	**Audit**	Audit trail browsing, filtering	1	8	AuditService, FieldChangeAuditService	Complete	100%
22	**Profile**	User profile, password change	2	3	UserService	Complete	100%

B. Screen Inventory Table

Screen Name	Module	Type	API Endpoints Used	Role Access	Validation Level	Te Cov (U/I
LoginComponent	Auth	Execution	POST /auth/login	Public	Email + Password required	9/13
DashboardComponent	Dashboard	Report	GET /dashboard/summary	Authenticated	N/A	6/19
OrderListComponent	Orders	Execution	GET /orders/paged	Authenticated	Search/filter validation	15/1
OrderDetailComponent	Orders	Execution	GET /orders/{id}	Authenticated	N/A	-/47
OrderFormComponent	Orders	Execution	POST /orders, PUT /orders/{id}	Authenticated	Customer, line items required	-/34
ProductionLandingComponent	Production	Execution	GET /orders/available	Authenticated	N/A	-/17
ProductionConfirmComponent	Production	Execution	POST /production/confirm, GET /bom/, *GET /batches/*	Authenticated	BOM validation, parameter ranges, quantity checks	25/6
ProductionHistoryComponent	Production	Report	GET /production/confirmations	Authenticated	Date range filter	-/18

Component	Module	Type	API Endpoints	Access	Validation	
InventoryListComponent	Inventory	Execution	GET /inventory/paged	Authenticated	State/type filter	34/3
InventoryDetailComponent	Inventory	Execution	GET /inventory/{id}	Authenticated	N/A	-/24
InventoryFormComponent	Inventory	Execution	POST /inventory, PUT /inventory/{id}	Authenticated	Material, quantity required	-/12
ReceiveMaterialComponent	Inventory	Execution	POST /inventory/receive-material	Authenticated	Material, quantity, supplier required	-/25
BatchListComponent	Batches	Execution	GET /batches/paged	Authenticated	Status filter	42/1
BatchDetailComponent	Batches	Execution	GET /batches/{id}, GET /batches/{id}/genealogy	Authenticated	N/A	-/45
BatchFormComponent	Batches	Execution	POST /batches/{id}/split, POST /batches/merge	Authenticated	Quantity validation, invariant checks	-/11
HoldListComponent	Holds	Execution	GET /holds/paged	Authenticated	Entity type filter	32/2
HoldDetailComponent	Holds	Execution	GET /holds/{id}	Authenticated	N/A	-/21
HoldFormComponent	Holds	Execution	POST /holds, PUT /holds/{id}/release	Authenticated	Entity type, reason required	-/9-
EquipmentListComponent	Equipment	Master	GET /equipment/paged	Authenticated	Status filter	23/2
EquipmentDetailComponent	Equipment	Master	GET /equipment/{id}	Authenticated	N/A	-/19
EquipmentFormComponent	Equipment	Master	POST /equipment, PUT /equipment/{id}	Authenticated	Code, name, type required	-/12
OperationListComponent	Operations	Execution	GET /operations/paged	Authenticated	Status/type filter	29/2
OperationDetailComponent	Operations	Execution	GET /operations/{id}	Authenticated	N/A	-/22
CustomerListComponent	Customers	Master	GET /customers/paged	Authenticated	Search filter	15/1
CustomerDetailComponent	Customers	Master	GET /customers/{id}	Authenticated	N/A	-/14
CustomerFormComponent	Customers	Master	POST /customers, PUT /customers/{id}	Authenticated	Code, name required	-/13
MaterialListComponent	Materials	Master	GET /materials/paged	Authenticated	Type filter	19/1
MaterialDetailComponent	Materials	Master	GET /materials/{id}	Authenticated	N/A	-/14
MaterialFormComponent	Materials	Master	POST /materials, PUT /materials/{id}	Authenticated	Code, name, type, UOM required	-/21

ProductListComponent	Products	Master	GET /products/paged	Authenticated	Category filter	15/1
ProductDetailComponent	Products	Master	GET /products/{id}	Authenticated	N/A	-/10
ProductFormComponent	Products	Master	POST /products, PUT /products/{id}	Authenticated	SKU, name required	-/25
BomListComponent	BOM	Planning	GET /bom/products	Authenticated	Search filter	29/3
BomTreeComponent	BOM	Planning	GET /bom/{sku}/tree	Authenticated	N/A	-/46
BomNodeFormComponent	BOM	Planning	POST /bom/node, PUT /bom/node/{id}	Authenticated	Material, quantity, yield required	-/39
OperatorListComponent	Operators	Master	GET /operators/paged	Authenticated	Status filter	11/1
OperatorDetailComponent	Operators	Master	GET /operators/{id}	Authenticated	N/A	-/14
OperatorFormComponent	Operators	Master	POST /operators, PUT /operators/{id}	Authenticated	Code, name required	-/18
ProcessListComponent	Processes	Planning	GET /processes/paged	Authenticated	Status filter	27/2
ProcessDetailComponent	Processes	Planning	GET /processes/{id}	Authenticated	N/A	-/22
ProcessFormComponent	Processes	Planning	POST /processes, PUT /processes/{id}	Authenticated	Name required	-/24
QualityPendingComponent	Processes	Execution	GET /batches/pending-approval	Authenticated	N/A	-/3/
RoutingListComponent	Routing	Planning	GET /routing/paged	Authenticated	Status filter	35/4
RoutingDetailComponent	Routing	Planning	GET /routing/{id}	Authenticated	N/A	-/25
RoutingFormComponent	Routing	Planning	POST /routing, PUT /routing/{id}	Authenticated	Name, process required	-/53
OpTemplateListComponent	Templates	Planning	GET /operation-templates	Authenticated	Search filter	12/4
OpTemplateDetailComponent	Templates	Planning	GET /operation-templates/{id}	Authenticated	N/A	-/19
HoldReasonsListComponent	Config	Config	GET /config/hold-reasons/paged	Authenticated	Search filter	-/16
HoldReasonsFormComponent	Config	Config	POST/PUT /config/hold-reasons	Authenticated	Code, description required	-/24
DelayReasonsListComponent	Config	Config	GET /config/delay-reasons/paged	Authenticated	Search filter	-/16
DelayReasonsFormComponent	Config	Config	POST/PUT /config/delay-reasons	Authenticated	Code, description required	-/16

ProcessParamsListComponent	Config	Config	GET /config/process-parameters/paged	Authenticated	Process filter	-/15	
ProcessParamsFormComponent	Config	Config	POST/PUT /config/process-parameters	Authenticated	Name, type, min/max required	-/14	
QuantityTypeListComponent	Config	Config	GET /config/quantity-type/paged	Authenticated	Search filter	-/16	
QuantityTypeFormComponent	Config	Config	POST/PUT /config/quantity-type	Authenticated	Code, description required	-/20	
BatchNumberListComponent	Config	Config	GET /batch-number-config/paged	Authenticated	Type filter	-/18	
BatchNumberFormComponent	Config	Config	POST/PUT /batch-number-config	Authenticated	Prefix, format required	-/25	
BatchSizeListComponent	Config	Config	GET /batch-size-config/paged	Authenticated	Type filter	-/18	
BatchSizeFormComponent	Config	Config	POST/PUT /batch-size-config	Authenticated	Min, max, standard required	-/21	
UserListComponent	Users	Admin	GET /users/paged	Authenticated	Role filter	19/1	
UserDetailComponent	Users	Admin	GET /users/{id}	Authenticated	N/A	-/13	
UserFormComponent	Users	Admin	POST /users, PUT /users/{id}	Authenticated	Username, email, role required	-/13	
AuditListComponent	Audit	Admin	GET /audit/paged	Authenticated	Entity type, action, date filters	17/2	
ReportsLandingComponent	Reports	Report	N/A	Authenticated	N/A	-/4/	
ExecutiveDashboardComponent	Reports	Report	GET /analytics/executive-dashboard	Authenticated	Date range	-/13	
ProductionSummaryComponent	Reports	Report	GET /reports/production-summary	Authenticated	Date range	-/8/	
ScrapAnalysisComponent	Reports	Report	GET /analytics/scrap-analysis	Authenticated	Date range	-/7/	
OrderFulfillmentComponent	Reports	Report	GET /reports/order-fulfillment	Authenticated	Date range	-/6/	
InventoryBalanceComponent	Reports	Report	GET /reports/inventory-balance	Authenticated	Type filter	-/11	
OperationsReportComponent	Reports	Report	GET /analytics/operations	Authenticated	Date range	-/7/2	
ProfileComponent	Profile	Admin	GET /auth/me	Authenticated	N/A	-/9/	

ChangePasswordComponent	Profile	Admin	POST /users/change-password	Authenticated	Current + new + confirm required	-/21
MaterialSelectionModal	Shared	Execution	GET /batches/available	Authenticated	Quantity <= available	-/21
ApplyHoldModal	Shared	Execution	POST /holds	Authenticated	Reason required	-/23

C. Services Documentation

Backend Services (42 Total)

#	Service	Responsibility	API Routes	DB Tables
1	**AuthService**	JWT login, token refresh, user lookup	/auth/*	users
2	**OrderService**	Order CRUD, line item management, status transitions	/orders/*	orders, order_line_items
3	**ProductionService**	Confirm production, manage consumption, reversal	/production/*	production_confirmation, consumed_materials, produced_outputs
4	**BatchService**	Batch lifecycle, split/merge, genealogy, approval	/batches/*	batches, batch_relations
5	**InventoryService**	Stock CRUD, state transitions (block/scrap/reserve)	/inventory/*	inventory
6	**HoldService**	Apply/release holds on any entity	/holds/*	holds, hold_reasons
7	**EquipmentService**	Equipment CRUD, maintenance/hold status	/equipment/*	equipment
8	**BomService**	BOM tree CRUD, versioning, hierarchy	/bom/*	bill_of_materials
9	**BomValidationService**	BOM requirements, suggested consumption, validation	/bom/validate, /bom/operation/*/suggested-consumption	bill_of_materials, batches, inventory

10	**CustomerService**	Customer master CRUD	/customers/*	customers
11	**MaterialService**	Material master CRUD	/materials/*	materials
12	**ProductService**	Product master CRUD	/products/*	products
13	**OperationService**	Operation status management	/operations/*	operations
14	**OperationTemplateService**	Reusable operation blueprint CRUD	/operation-templates/*	operation_templates
15	**OperatorService**	Operator master CRUD	/operators/*	operators
16	**RoutingService**	Routing CRUD, step management, activation	/routing/*	routings, routing_steps
17	**ProcessService**	Process definition CRUD	/processes/*	processes
18	**AuditService**	Audit trail queries, entity history, date ranges	/audit/*	audit_trail
19	**FieldChangeAuditService**	Field-level diff and audit logging	(internal)	audit_trail
20	**DashboardService**	Aggregate metrics for dashboard	/dashboard/*	Multiple (aggregated)
21	**BatchNumberService**	Configurable batch number generation	(internal)	batch_number_config, batch_number_sequence
22	**BatchNumberConfigService**	Batch number config CRUD	/batch-number-config/*	batch_number_config
23	**BatchSizeService**	Batch size config management	/batch-size-config/*	batch_size_config
24	**ProcessParameterService**	Validate process parameters against config	(internal)	process_parameters_config
25	**ProcessParametersConfigService**	Parameter config CRUD	/config/process-parameters/*	process_parameters_config
26	**QuantityTypeConfigService**	Quantity type config CRUD	/config/quantity-type/*	quantity_type_config
27	**HoldReasonService**	Hold reason config CRUD	/config/hold-reasons/*	hold_reasons

28	**DelayReasonService**	Delay reason config CRUD	/config/delay-reasons/*	delay_reasons
29	**InventoryFormService**	Inventory form options	(internal)	inventory_form_config
30	**InventoryMovementService**	Movement logging for inventory changes	/inventory-movements/*	inventory_movements
31	**EquipmentCategoryService**	Equipment classification	(internal)	equipment
32	**EquipmentUsageService**	Track equipment usage per operation	/equipment-usage/*	operation_equipment_usage
33	**ReceiveMaterialService**	Goods receipt (batch + inventory creation)	POST /inventory/receive-material	batches, inventory
34	**BatchAllocationService**	Batch-to-order allocation	/batch-allocation/*	batch_order_allocation
35	**UnitConversionService**	Unit of measure conversion	(internal)	unit_of_measure, unit_conversion
36	**UserService**	User CRUD, password management	/users/*	users
37	**OperationInstantiationService**	Create operations from routing templates	(internal)	operations, routing_steps
38	**ReportAnalyticsService**	Analytics queries for reports	/analytics/*	Multiple (aggregated)
39	**ChartService**	Chart data formatting	(internal)	N/A
40	**ExcelExportService**	Excel file generation	/reports/export/*	Multiple
41	**PdfReportService**	PDF report generation	/reports/export/*	Multiple
42	**ImageProcessingService**	Image processing utilities	(internal)	N/A

D. Data Layer Overview

Core Entities (11)

Entity	Table	Purpose	Key Relationships
Order	orders	Customer order	Has many OrderLineItems; FK to Customer
OrderLineItem	order_line_items	Products in order	FK to Order; Has many Operations
Operation	operations	Production step	FK to Process, OrderLineItem, RoutingStep
ProductionConfirmation	production_confirmation	Confirmation record	FK to Operation; Has ConsumedMaterials, ProducedOutputs
Batch	batches	Trackable material unit	Has many Inventory, BatchRelations
Inventory	inventory	Material stock record	FK to Batch; State machine (AVAILABLE/BLOCKED/etc.)
Equipment	equipment	Machine/tool	Has EquipmentUsage records
HoldRecord	holds	Hold/release record	Polymorphic FK (any entity type)
ConsumedMaterial	consumed_materials	Input consumption	FK to Confirmation, Inventory, Batch
ProducedOutput	produced_outputs	Output production	FK to Confirmation, Batch
BatchRelation	batch_relations	Parent-child genealogy	FK to Batch (parent + child)

Master Data Tables (8)

Entity	Table	Purpose
Customer	customers	Customer master
Material	materials	Material master (RM/IM/FG/WIP)
Product	products	Product master (SKU)
Operator	operators	Personnel master
Process	processes	Process definitions
OperationTemplate	operation_templates	Reusable operation blueprints
Routing	routings	Production routing
RoutingStep	routing_steps	Steps within routing

Configuration Tables (10)

Entity	Table	Purpose
BatchNumberConfig	batch_number_config	Batch number generation rules
BatchSizeConfig	batch_size_config	Min/max/standard batch sizes
ProcessParametersConfig	process_parameters_config	Parameter min/max/default per process
QuantityTypeConfig	quantity_type_config	Quantity type rules
HoldReason	hold_reasons	Configurable hold reasons

DelayReason	delay_reasons	Configurable delay reasons
BillOfMaterial	bill_of_materials	Hierarchical BOM tree
UnitOfMeasure	units_of_measure	UOM reference
UnitConversion	unit_conversion	Conversion factors
InventoryFormConfig	inventory_form_config	Inventory form options

Audit & System Tables (5)

Entity	Table	Purpose
AuditTrail	audit_trail	All entity change history (JSON)
DatabasePatch	database_patches	Applied SQL patch tracker
User	users	Authentication & authorization
InventoryMovement	inventory_movements	Inventory state change log
BatchQuantityAdjustment	batch_quantity_adjustments	Batch quantity change log

Multi-Tenant Handling

- **Not applicable** - Single-tenant POC design
- Tenant isolation would require schema-per-tenant or row-level security for production

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E. Business Workflow Documentation

Lifecycle Sequence

1. System Initialization

Attribute	Value
Entry Trigger	Application startup (Spring Boot)
Screens	None (automatic)
Services	PatchService, PatchRunner, TestPatchRunner
Entities	DatabasePatch
Validation	Patch idempotency (IF NOT EXISTS)
Test Coverage	PatchServiceTest (8), PatchRunnerTest (5)
Gaps	None

2. Master Data Setup

Attribute	Value
Entry Trigger	Admin navigates to /manage/*
Screens	CustomerList/Form, MaterialList/Form, ProductList/Form, OperatorList/Form, EquipmentList/Form
Services	CustomerService, MaterialService, ProductService, OperatorService, EquipmentService

Entities	Customer, Material, Product, Operator, Equipment
Validation	Unique codes, required fields, soft delete
Test Coverage	Full CRUD tests per entity
Gaps	GAP-021 (Equipment category), GAP-022 (Extended fields)

3. Configuration Setup

Attribute	Value
Entry Trigger	Admin navigates to /manage/config/*
Screens	12 config screens (6 list + 6 form)
Services	HoldReasonService, DelayReasonService, ProcessParametersConfigService, BatchNumberConfigService, QuantityTypeConfigService, BatchSizeService
Entities	HoldReason, DelayReason, ProcessParametersConfig, BatchNumberConfig, QuantityTypeConfig, BatchSizeConfig
Validation	Unique codes, range validation, required fields
Test Coverage	41 backend + 158 frontend + 34 E2E tests
Gaps	None

4. Design & Planning

Attribute	Value
Entry Trigger	Admin defines production processes and BOM
Screens	ProcessList/Form, RoutingList/Form, OpTemplateList, BomList/Tree/NodeForm
Services	ProcessService, RoutingService, OperationTemplateService, BomService
Entities	Process, Routing, RoutingStep, OperationTemplate, BillOfMaterial
Validation	Routing activation rules, BOM hierarchy integrity, step sequencing
Test Coverage	35 routing + 29 BOM + 27 process backend tests
Gaps	GAP-017 (Routing pagination), GAP-018 (BOM pagination)

5. Execution

Attribute	Value
Entry Trigger	Order creation or material receipt
Screens	OrderList/Form, ReceiveMaterial, ProductionConfirm, InventoryList, BatchList, HoldList
Services	OrderService, ReceiveMaterialService, ProductionService, InventoryService, BatchService, HoldService, OperationInstantiationService
Entities	Order, OrderLineItem, Operation, ProductionConfirmation, ConsumedMaterial, ProducedOutput, Batch, Inventory, HoldRecord
Validation	BOM consumption, process parameters, batch invariants, hold checks, quantity validation

Test Coverage	25+42+34+32 backend + 102+67+71+58 frontend + 102+43+21+5 E2E tests
Gaps	GAP-016 (Operations pagination)

6. Monitoring

Attribute	Value
Entry Trigger	Dashboard access, audit trail queries
Screens	Dashboard, AuditList
Services	DashboardService, AuditService, FieldChangeAuditService
Entities	AuditTrail (aggregated queries)
Validation	Date range, entity type filters
Test Coverage	6+17 backend + 19+25 frontend + 24+29 E2E tests
Gaps	None

7. Reporting

Attribute	Value
Entry Trigger	User navigates to /reports
Screens	ReportsLanding, ExecutiveDashboard, ProductionSummary, ScrapAnalysis, OrderFulfillment, InventoryBalance, OperationsReport
Services	ReportAnalyticsService, ChartService, ExcelExportService, PdfReportService
Entities	Aggregated queries across all tables
Validation	Date range validation
Test Coverage	24 backend + 64 frontend + 24 E2E tests
Gaps	None

8. Administration

Attribute	Value
Entry Trigger	Admin navigates to /manage/users
Screens	UserList/Form, Profile, ChangePassword
Services	UserService, AuthService
Entities	User
Validation	Email uniqueness, password strength, role assignment
Test Coverage	19 backend + 39+30 frontend + 14+18 E2E tests
Gaps	No RBAC beyond admin role

High-Level System Flow

```
flowchart TD
    A[System Start] --> B[Patch Runner<br/>51 SQL patches]
    B --> C{Profile?}
    C -->|Production| D[PostgreSQL]
    C -->|Demo| E[H2 In-Memory]
    C -->|Test| F[PostgreSQL mes_test<br/>Schema Reset]

    D --> G[Application Ready]
    E --> G
    F --> G

    G --> H[Login<br/>JWT Auth]
    H --> I[Dashboard<br/>KPIs & Metrics]

    I --> J[Master Data Setup]
    J --> J1[Customers]
    J --> J2[Materials]
    J --> J3[Products]
    J --> J4[Equipment]
    J --> J5[Operators]

    I --> K[Design & Planning]
    K --> K1[Processes]
    K --> K2[Routing + Steps]
    K --> K3[Operation Templates]
    K --> K4[BOM Tree]
    K --> K5[Configuration]

    I --> L[Execution Workflow]
    L --> L1[Create Order]
    L1 --> L2[Operations Instantiated<br/>from Routing]
    L2 --> L3[Receive Material<br/>Goods Receipt]
    L3 --> L4[Production Confirmation<br/>BOM + Parameters]
    L4 --> L5{Partial?}
    L5 -->|Yes| L6[Save Partial<br/>Continue Later]
    L5 -->|No| L7[Confirm Complete]
    L6 --> L4
    L7 --> L8[Output Batch Created<br/>Inventory Updated]
    L8 --> L9[Batch Split/Merge<br/>if needed]
    L9 --> L10[Next Operation<br/>or Order Complete]

    L4 --> L11[Hold Applied?]
    L11 -->|Yes| L12[Hold Management<br/>Apply/Release]
    L12 --> L4

    I --> M[Monitoring]
    M --> M1[Audit Trail<br/>Field-Level Changes]
    M --> M2[Batch Genealogy<br/>Traceability]

    I --> N[Reporting]
    N --> N1[Executive Dashboard]
    N --> N2[Production Summary]
    N --> N3[Scrap Analysis]
```

```
    N --> N4[Order Fulfillment]
    N --> N5[Inventory Balance]
    N --> N6[PDF/Excel Export]

    I --> O[Administration]
    O --> O1[User Management]
    O --> O2[Password Change]
```

F. E2E Coverage Mapping

#	Business Flow	Covered?	Test File	Criticality	Data Dependency	Regression?
1	User Login/Logout	Yes	01-auth.test.js	Critical	User credentials	Yes
2	Dashboard Metrics	Yes	02-dashboard.test.js, 38-dashboard-features.test.js	High	Seeded data	Yes
3	Order List & Filters	Yes	03-orders.test.js	High	Seeded orders	Yes
4	Order CRUD	Yes	32-order-crud.test.js, 11-crud.test.js	Critical	Customers, Products	Yes
5	Production Confirmation	Yes	04-production.test.js, 33-production-complete.test.js	Critical	Orders, Materials, BOM	Yes
6	Partial Confirmation	Yes	24-partial-confirmation.test.js	High	Active operations	Yes
7	Material Receipt	Yes	34-receive-material.test.js	Critical	Materials	Yes
8	Inventory Management	Yes	05-inventory.test.js	High	Batches, Materials	Yes
9	Batch List & Genealogy	Yes	06-batches.test.js, 35-batch-operations.test.js	Critical	Production data	Yes
10	Batch Split/Merge	Yes	35-batch-operations.test.js	High	Available batches	Yes
11	Hold Apply/Release	Yes	07-holds.test.js	High	Any entity	Yes
12	Equipment Management	Yes	08-equipment.test.js	Medium	Equipment master	Yes
13	Quality Inspection	Yes	09-quality.test.js	High	Pending batches	Yes
14	Pagination (all lists)	Yes	10-pagination.test.js	Medium	Seeded data	Yes
15	Master Data CRUD	Yes	11-crud.test.js, 12-entity-crud.test.js	High	None	Yes
16	BOM CRUD	Yes	13-bom-crud.test.js	High	Products, Materials	Yes

17	Config CRUD	Yes	14-config-crud.test.js	Medium	None	Yes
18	Audit Trail	Yes	15-audit-history.test.js	High	Any entity changes	Yes
19	Routing Design	Yes	22-routing.test.js, 36-routing-crud.test.js	High	Processes, Templates	Yes
20	Operation Templates	Yes	37-operation-templates.test.js	Medium	None	Yes
21	Full Workflow (E2E)	Yes	30-full-workflow-setup.test.js, 40-e2e-workflow-verification.test.js, 41-production-flow-e2e.test.js	Critical	Full setup	Yes
22	Form Validations	Yes	39-form-validations.test.js	Medium	None	Yes
23	Reports	Yes	48-reports.test.js	Medium	Production data	Yes
24	Mobile Responsive	Yes	49-mobile-responsive.test.js, 50-responsive-breakpoints.test.js	Medium	Any page	Yes
25	Auth Security	Yes	51-auth-security.test.js	Critical	None	Yes
26	API Error Handling	Yes	52-api-error-handling.test.js	High	None	Yes
27	Page Validation	Yes	53-page-level-validation.test.js	Medium	None	Yes
28	User Management	Yes	20-users.test.js	Medium	None	Yes
29	Password Change	Yes	43-change-password.test.js	Medium	User account	Yes

G. Test Pyramid Overview

Layer	Test Count	% of Total	Framework	Automation
Backend Unit Tests	1,337	37%	JUnit 5 + Mockito	`./gradlew test`
Frontend Component Tests	1,524	43%	Karma + Jasmine	`npx ng test`
E2E Tests	719	20%	Playwright	`node run-all-tests.js`
Manual Tests	0 (documented)	-	N/A	N/A
TOTAL	**3,580**	**100%**	3 frameworks	Local runners

Automation Maturity Score: 7/10

Criterion	Score	Notes
Test automation coverage	9/10	All 3 layers automated
CI/CD integration	2/10	No pipeline configured
Code coverage reporting	3/10	No JaCoCo/Istanbul

Test data management	7/10	Demo mode + patch system
Regression suite	8/10	run-tests.bat orchestrates all
Performance testing	1/10	Not implemented
Security testing	5/10	Basic auth E2E only

H. CI/CD Integration

Attribute	Status
CI/CD Platform	**Not configured**
Trigger Conditions	N/A - Manual execution only
Test Execution Stage	Manual: `run-tests.bat`
Deployment Gating	None - No automated quality gates
Reporting Visibility	Console output only
Artifact Storage	Local (`e2e/output/screenshots/`)

Current Test Execution Model

```
Manual Trigger
    ├── run-tests.bat --backend    → ./gradlew test (PostgreSQL mes_test)
    ├── run-tests.bat --frontend   → npx ng test --browsers=ChromeHeadless
    └── run-tests.bat --e2e        → node e2e/run-all-tests.js (Playwright)
```

Recommended CI/CD Pipeline (Not Yet Implemented)

```
Push to main
    ├── Stage 1: Build
    │   ├── ./gradlew build
    │   └── npm run build
    ├── Stage 2: Test
    │   ├── ./gradlew test (backend)
    │   ├── npx ng test (frontend)
    │   └── node run-all-tests.js (E2E)
    ├── Stage 3: Quality Gate
    │   ├── JaCoCo coverage > 70%
    │   ├── Istanbul coverage > 70%
    │   └── All E2E pass
    └── Stage 4: Deploy (manual approval)
```

I. Open Gaps & Action Plan

#	Gap Description	Severity	Area	Suggested Action	Owner
1	Operations list uses client-side pagination (GAP-016)	HIGH	Backend + Frontend	Add server-side /operations/paged endpoint + update component	TBD

2	Routing list uses client-side pagination (GAP-017)	HIGH	Backend + Frontend	Add server-side /routing/paged endpoint + update component	TBD
3	BOM products list uses client-side pagination (GAP-018)	MEDIUM	Backend + Frontend	Add server-side /bom/products/paged endpoint + update component	TBD
4	Equipment category field missing (GAP-021)	MEDIUM	Data Model	Add category field to Equipment entity + SQL patch	TBD
5	Material/Product extended fields missing (GAP-022)	LOW	Data Model	Add cost, threshold, weight fields + SQL patch	TBD
6	No CI/CD pipeline configured	HIGH	DevOps	Set up GitHub Actions or Jenkins pipeline	TBD
7	No code coverage metrics (JaCoCo/Istanbul)	MEDIUM	Testing	Integrate coverage tools into build	TBD
8	No RBAC beyond admin role	MEDIUM	Security	Implement role-based access (VIEWER, OPERATOR, SUPERVISOR, ADMIN)	TBD
9	No Swagger/OpenAPI documentation	LOW	API	Add springdoc-openapi dependency	TBD
10	No Docker containerization	MEDIUM	DevOps	Create Dockerfile + docker-compose.yml	TBD
11	No performance/load testing	LOW	Testing	Add JMeter or k6 scripts for key workflows	TBD
12	No application monitoring (APM)	MEDIUM	Operations	Add Spring Boot Actuator + Prometheus/Grafana	TBD
13	No centralized logging	LOW	Operations	Add ELK stack or CloudWatch integration	TBD
14	Custom SQL patch system vs Flyway/Liquibase	LOW	Data	Evaluate migration to standard tool	TBD
15	No database backup strategy	MEDIUM	Operations	Configure pg_dump schedule	TBD