MediAsset AI

Hospital Asset Management & Maintenance System

ENTERPRISE SPECIFICATION DOSSIER & COMMERCIAL PROPOSAL SPEC SHEET

A unified clinical engineering command center featuring 13 integrated modules, 5-role server-enforced RBAC permissions, 8 NABH-ready operational reports, and deterministic total cost of ownership (TCO) decision intelligence. Built for multi-specialty clinical networks with local-first data sovereignty.

LEGAL DISCLAIMER & STATUTORY NOTICE

The name, tagline, logo concept, and palette are proposed brand assets and remain subject to clearance. Designed in accordance with NABH 5th Edition Chapter FMS (Facility Management & Safety) standards. Complies with the mandatory 7-year statutory record retention policy for medical equipment maintenance.

DOCUMENT CONTROL & SPECIFICATION METADATA

Metadata Parameter	Specification Value	Governance Parameter	Specification Value
Document Reference	DOC-MAS-2026-V1.0	Target Deployment	XYZ Hospital (Clinical Engineering)
System Release	Version 0.1.0 — Production Ready	Parent Identity	AI India Innovations Pvt. Ltd.
Effective Date	19-November-2026	Security Classification	RESTRICTED / COMMERCIAL IN CONFIDENCE
Accreditation Scope	NABH 5th Ed. Chapter FMS	Retention Standard	7-Year Mandatory Record Retention
Target Roles	Management, Biomedical, IT	Deployment Topology	On-Premise / Docker Local Container

EXECUTIVE SALES & TECHNICAL MEMORANDUM

This document serves as the formal technical dossier and functional specification sheet for MediAsset AI. It articulates all 13 integrated modules, mathematical formulations behind the deterministic AI reporting engine, server-side authorization boundaries, verified database benchmarks (<35ms latency), and turnkey deployment guidelines.

SECTION 1: EXECUTIVE SUMMARY & STRATEGIC VALUE

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1.2 The Healthcare Challenge & Strategic Value

Tertiary care hospitals operate hundreds of life-critical biomedical devices across Intensive Care Units (ICU), Operating Theaters (OT), and Diagnostic Radiology. Managing these assets using disparate spreadsheets introduces severe clinical, operational, and financial risks: unmonitored equipment downtime directly impacts patient safety, missed calibration cycles lead to regulatory audit failures during NABH/JCI inspections, and untracked contract expirations cause hospitals to incur massive out-of-pocket repair costs on devices covered by active warranties.

> Total Equipment Lifecycle: Governs procurement onboarding, warranty tracking, routine PM, regulatory calibration, breakdown ticketing, and condemnation.

> NABH Chapter FMS Assurance: Engineered to satisfy Chapter FMS (Facility Management & Safety) accreditation criteria with immutable 7-year record retention.

> Sub-35ms Velocity: Ultra-fast response times powered by SQLite WAL mode, in-memory 5s TTL caching, and 64MB RAM caching, rendering complex records in milliseconds.

> Deterministic Financial AI: Zero cloud AI dependency; replacement reviews and TCO comparisons use pure functions with full mathematical audit transparency.

1.3 Verified Production API Latency Benchmarks

Performance measurements recorded live on local host under concurrent multi-session operations:

API Route	Operation Scope	Average Latency	Minimum Latency	HTTP Status
/api/health	System Heartbeat & DB Connection Check	2.3 ms	1.9 ms	200 OK
/api/auth/me	JWT Bearer Validation & User Permissions	5.8 ms	4.3 ms	200 OK
/api/dashboard/summary	7 KPI Cards + 4 Visual Graphs + Urgent Alerts	33.1 ms	25.7 ms	200 OK
/api/assets?limit=50	Asset Inventory + Real-Time Warranty Status	28.0 ms	20.7 ms	200 OK
/api/complaints?limit=50	Breakdown Tickets + Response Time Calculations	20.0 ms	16.7 ms	200 OK
/api/pm/schedules	In-House & Outsourced Preventive Maintenance	22.2 ms	16.2 ms	200 OK
/api/calibration/records	Calibration Plans, Status & Agency Data	12.9 ms	9.2 ms	200 OK
/api/contracts	AMC/CMC Contracts & Renewal Chains	11.5 ms	9.1 ms	200 OK
/api/notifications?limit=20	Real-Time Alert Feed (60s bell polling)	6.7 ms	6.2 ms	200 OK

SECTION 2: SYSTEM ARCHITECTURE & 19-TABLE DATA MODEL

2.1 Architectural Topology

MediAsset AI utilizes an enterprise three-tier architecture optimized for high-throughput on-premise execution:

* Presentation Layer: React 18 + TypeScript SPA, styled with Tailwind CSS tokens and Radix UI accessible primitives. Features TanStack Table v8 for high-density tabular filtering and Recharts for interactive operational telemetry.
* Application Layer: FastAPI (Python 3.11+) asynchronous micro-framework. Enforces strict Pydantic v2 schemas, sliding-window IP rate limiting, JWT bearer authentication, and APScheduler background daemon tasks.
* Persistence Layer: SQLite 3 engine configured in Write-Ahead Logging (WAL) mode, PRAGMA synchronous=NORMAL, 64MB RAM cache, and memory temp store. Fully isolates short-lived scheduler sessions via get_scheduler_db().

2.2 19-Table Relational Schema Architecture

Normalized relational schema supporting complex clinical and contractual asset graphs:

Table Name	Entity Scope	Key Relationships	Audit & Indexing Strategy
departments	Clinical Wings (ICU, OT, Radiology)	Parent to locations, users, assets	Indexed on code (UNIQUE), soft deletion
locations	Rooms, Wards & Floor Wings	Child of departments; parent to assets	Indexed on department_id and is_active
categories	Equipment Modality Masters	Parent to assets (sets useful life)	Indexed on category name and is_active
vendors	Suppliers, OEMs, Insurers, Agencies	Linked to assets, contracts, calibrations	Indexed on vendor_type enum
users	Hospital Staff & Technicians	Scoped to department; 5 RBAC roles	Bcrypt hashed; sliding-window rate limit (15/60s)
assets	Medical Device Master	Child of depts, cats, locations, vendors	Full field change logging; indexed on status, dept
contracts	AMC / CMC Maintenance Contracts	Linked to asset, vendor, renewed_from	Renewal history chain; is_superseded tracking
warranties	OEM Manufacturer Warranties	Linked to asset and vendor	Auto-calculated end dates; expiry warning chips
insurance_policies	Asset Risk & Insurance Policies	Linked to asset and insurer vendor	INR coverage amount; slide-over drawer link
complaints	Breakdown & Repair Tickets	Linked to asset, registered/attended users	Sequential ticketing; response & downtime tracking
complaint_events	Immutable Ticket Timeline	Child of complaints; linked to users	Audit trail of every status transition & edit
calibration_plans	Regulatory Calibration Frequencies	Linked to asset, agency, approver user	Strict approval gating; indexed on next_due_date
calibration_records	Executed Calibration History	Linked to plan, asset, vendor agency	Digital certificate linkage; status computed at read
pm_schedules	Preventive Maintenance Plans	Linked to asset, contract, provider	In-house vs outsourced; next planned date index
pm_records	Executed PM Service History	Child of schedule; linked to asset	Calendar add_months auto-advance; reschedule log
demo_equipment	Trial Equipment On Loan	Linked to vendor, department, location	Dynamic return status; 3-day automated alerts
department_visits	Clinical Engineering Rounds	Linked to department and engineer user	Checklist observations; direct complaint ticket link
attachments	Digital Documents (Certificates/PDF)	Polymorphic to entity_type & entity_id	Magic-byte header verification; 10MB limit
notifications	System Alert & Notification Queue	Polymorphic entity link; target role	Deduplication key; indexed on target_role, date
audit_logs	Immutable System Audit Log	Polymorphic entity link; actor user	Read-only for Admin; before/after JSON diffs
settings	Typed Hospital Configuration	Primary key key; updated_by user	5s in-memory TTL caching; instant invalidation

SECTION 3: 13 INTEGRATED OPERATIONAL MODULES

3.1 Complete Module Catalog

The application architecture unifies 13 specialized modules into a single responsive portal, eliminating data silos between biomedical engineering, clinical department heads, hospital management, and procurement teams:

ID	Module Name	Primary Route	Core Operational Capabilities	Primary Stakeholders
M01	Hospital Dashboard	/	7 KPI cards, 4 Recharts visual telemetry graphs, Needs Attention red alert panel, Recent Complaints feed	Medical Directors, CEOs, HODs
M02	Asset Register	/assets	Full CRUD, duplicate check, 8-tab detail dossier, Bulk Excel Import with dry-run validation preview	Biomedical Engineers, IT, Finance
M03	Complaints & Breakdowns	/complaints	Sequential tickets, 5-stage lifecycle, CE technical section, SLA response & ongoing downtime timers	Nursing Staff, Floor Engineers, HODs
M04	Preventive Maintenance	/pm	In-house & outsourced PM, dynamic read-time status, 7-col month calendar, auto-advancing cycles	Biomedical Staff, Service Vendors
M05	Calibration Management	/calibration	Plan creation, management approval gating, certificate archiving, login reminder pop-up modal	Biomedical Staff, NABH Auditors
M06	Contracts & Warranty	/contracts	AMC/CMC/OTHER CRUD, expiry warning chips, renewal history chain, post-warranty coverage tracking	Procurement, Finance, Vendors
M07	Asset Insurance	/insurance	Policy register, INR coverage display, expiry alerts, slide-over InsuranceDrawer across asset screens	Hospital Finance, Risk Officers
M08	Demo Equipment	/demo-equipment	Trial equipment register, return logging, automated 3-day return alerts, supplier loan tracking	Surgeons, Clinicians, Vendors
M09	Department Visits	/visits	Routine ward rounds, multi-asset checklist observations, one-click breakdown complaint raising	Biomedical Engineers, Ward Sisters
M10	Alert Engine & Bell	/notifications	APScheduler daily at 06:00, 8 alert types, deduplicated feeds, 60s bell polling, live toast alerts	All Registered System Users
M11	Operational Reports	/reports	8 reports (Uptime, Maintenance, Visits), openpyxl Excel exports, A4 PDF print with tripartite sign-off	Audit Committees, CFO, Directors
M12	AI & Cost Analysis	/reports/ai	5 deterministic TCO models: Buy vs Rent, Depreciation (SL/WDV), Equipment Efficiency, Lemon detection	CFO, Hospital Management, HODs
M13	Masters & Security	/masters	CRUD for Departments, Locations, Vendors, Users; Audit Log viewer with before/after JSON diffs	System Administrators

SECTION 4: CORE OPERATIONAL WORKFLOWS DEEP-DIVE

4.1 Asset Onboarding & 8-Tab 360-Degree Dossier

Asset records serve as the central anchor for all clinical engineering workflows. When creating or viewing an asset, users interact with an 8-tab operational dossier:

1. Overview Tab: Clinical metadata, department, floor/wing location, acquisition mode (Purchased/Rented), serial number.
2. Warranty Tab: Manufacturer warranty duration, start/end dates, provider, and inline warranty certificate documents.
3. Contracts Tab: AMC/CMC history, coverage duration, annual value, renewal chain, and previous superseded agreements.
4. Insurance Tab: Active policy number, insurer agency, INR coverage sum, valid dates, and digital policy certificate.
5. Calibration Tab: Calibration plan frequency, approving authority, last certificate number, and next due countdown.
6. PM Tab: Preventive maintenance schedules (in-house vs outsourced), cost per visit, and past execution logs.
7. Breakdowns Tab: Chronological ticket history, total lifetime downtime hours, and average response times.
8. Documents Tab: Secure digital repository for user manuals, installation reports, and compliance certificates.

4.2 Breakdown Ticketing & 5-Stage Lifecycle

Breakdown tickets enforce clinical accountability via a 5-stage state machine:

* Registration: Nursing staff or biomedical engineers log an issue. Asset status immediately synchronizes to 'Under Repair'.
* Assignment: Ticket is dispatched to an internal biomedical technician or external service provider.
* Attendance: Technician logs physical arrival, recording response time against SLA targets (Critical 4h / Non-critical 24h).
* Restoration: Device is repaired and operational testing is certified. Asset status automatically reverts to 'In Service'.
* Closure: Final administrative closure capturing root cause, corrective actions, lessons learned, and spare parts costs.

CLINICAL ENGINEERING LOCK BANNER

To protect medical and financial integrity, the technical section (Root Cause, Action Taken, Spares, CE Name) is strictly locked for Department Users with a prominent visual Lock Banner and server-side HTTP 403 enforcement on edit.

4.3 Preventive Maintenance & Regulatory Calibration

Scheduled maintenance is governed by dynamic status evaluation computed at read-time against effective_today():

* PM Schedules: Support monthly, quarterly, semi-annual, and annual cycles. Completing a PM auto-advances the next planned date using calendar add_months logic. If equipment is unavailable, a formal Reschedule workflow captures reasons.
* Calibration Assurance: Gated by strict internal control separation. Biomedical Engineers cannot approve calibration frequencies (FORBIDDEN_CALIBRATION_APPROVAL 403); only Hospital Management, Admin, or Coordinator roles hold approval authority. Executed calibrations require digital certificate uploads with magic-byte verification.

SECTION 5: ROLE-BASED ACCESS CONTROL (RBAC) & SECURITY

5.1 5-Role Permissions Matrix

MediAsset AI enforces multi-tenant security within the hospital across 5 standardized clinical and operational roles:

Functional Scope	Admin	Biomed	Mgmt	Coord	Dept User
Dashboard & Hospital KPIs	Full	Full	Full	Full	Scoped Dept
Asset Register (View)	All	All	All	All	Scoped Dept
Asset Register (Create / Edit)	Full	Full	Read-Only	Restricted	Read-Only (403)
Asset Financials (Costs & Book Value)	Visible	Visible	Visible	Visible	Hidden / Stripped
Bulk Asset Excel Import	Allowed	Allowed	Forbidden	Forbidden	Forbidden (403)
Raise Breakdown Ticket	Allowed	Allowed	Allowed	Allowed	Own Dept Only
Complaint Workflow (Assign / Attend / Restore)	Full	Full	Read-Only	Full	Read-Only
Technical CE / Spares Section Edit	Allowed	Allowed	Read-Only	Read-Only	Forbidden (403)
Admin Complaint Timestamp Correction	Allowed	Forbidden	Forbidden	Forbidden	Forbidden (403)
Preventive Maintenance Execution	Full	Full	Read-Only	Full	Hidden / Denied
Calibration Plan Approval Authority	Allowed	Forbidden	Allowed	Allowed	Forbidden (403)
Calibration Execution & Certificate Upload	Allowed	Allowed	Read-Only	Allowed	Hidden / Denied
Contracts & Warranty CRUD + Renew	Full	Full	Read-Only	Full	Hidden / Denied
Insurance Policies CRUD + Drawer	Full	Full	Read-Only	Full	Hidden / Denied
Demo Equipment Register & Return Log	Full	Full	Read-Only	Full	Hidden / Denied
Department Rounds & Ticket Linking	Allowed	Allowed	Read-Only	Forbidden	Forbidden (403)
Operational Reports (8 Reports)	All 8	All 8	All 8	7 (No Visits)	Scoped Dept Only
AI Report & TCO Decision Engine	Full	Full	Full	Full	Hidden / Denied
Hospital Master Data CRUD	Full	Read-Only	Read-Only	Read-Only	Read-Only
Audit Logs Viewer & System Settings	Full	Forbidden	Forbidden	Forbidden	Forbidden (403)

5.2 Server-Side Security Safeguards

> Sliding-Window Login Rate Limiter: Protects /api/auth/login with a sliding window of 15 attempts per 60 seconds per IP/Email. Violations trigger HTTP 429 RATE_LIMITED.

> JWT Token Versioning: User schema includes an integer token_version. Administrative password resets or revoking increments the version, instantly invalidating active bearer tokens.

> Cryptographic Magic-Byte Validation: Uploaded attachments undergo deep binary header inspection (checking actual JPEG, PNG, and PDF magic bytes) with a strict 10MB file limit.

> Immutable Audit Logging: Every entity creation, modification, status transition, and soft-deletion is recorded in audit_logs with UTC timestamp, actor ID, and full before/after JSON diffs.

SECTION 6: AI REPORT & FINANCIAL DECISION ENGINE

6.1 Deterministic Total Cost of Ownership (TCO) Intelligence

The AI Report module (/reports/ai) provides executive leadership and biomedical heads with transparent, auditable mathematical models. Unlike speculative generative AI chatbots, MediAsset AI's algorithms are 100% deterministic, verifiable against hospital ledger accounts, and backed by comprehensive 'How this is calculated' formula panels:

Analysis Section	Mathematical Formulation & Methodology	Configurable Parameters	Executive Utility
Buy vs Rent Comparison	1. Buy + In-House = (Purchase Value - Book Value at Horizon) + (Horizon * Annual PM Cost) + (Horizon * Annual Breakdown Cost) 2. Buy + Outsourced = (Purchase Value - Book Value at Horizon) + (Horizon * Annual Contract Cost) + (Horizon * Breakdown Cost excluding spares under CMC) 3. Rent = Monthly Rent * 12 * Horizon * Missing required data automatically flags 'Insufficient data: <input>'.	comparison_horizon_years = 5 latest_equipment_count = 10	Objectively proves lowest TCO scenario when acquiring high-capital clinical devices.
Depreciation & Replacement	Straight Line: Annual Charge = (Cost - Salvage) / Useful Life Written Down Value: Rate = 1 - (Salvage/Cost)^(1/Life); Book Value = max(Salvage, Cost * (1-Rate)^Years) Maintenance Ratio = Cumulative Maintenance Cost / Purchase Value Replacement Review Flagged when Maintenance Ratio >= 0.40 (40%)	default_useful_life = 10 yrs default_salvage = 5.0% replacement_review_ratio = 0.40	Prevents overspending on aging equipment where maintenance exceeds replacement threshold.
Equipment Efficiency	Efficiency Score = (0.50 * Uptime%) + (0.20 * PM Compliance%) + (0.15 * Response Score) + (0.15 * Repeat-Free Score) * Uptime % = (Scheduled Mins - Downtime Mins) / Scheduled Mins * 100 * MTTR = Mean(Restored At - Registered At) * MTBF = (Scheduled Hours - Downtime Hours) / Breakdowns * Response Score = 100 if Avg Response <= Target, sliding to 0 at 4x SLA	Weights: Uptime 50%, PM 20%, Response 15%, Repeat 15% scheduled_hours_per_day = 24 Critical SLA = 4h / Non-critical = 24h	Ranks equipment modalities and clinical wards by true operational efficiency.
Breakdown Frequency	* Average Breakdowns per Equipment = Total Breakdowns / Total Assets in Scope * Breakdowns per 1,000 Operating Hours = Total Breakdowns / (Assets * Days * Hours/Day / 1000) * Repeat Failure Detection: Asset has >= 3 breakdowns within past 90 days	repeat_failure_count = 3 repeat_failure_days = 90	Pinpoints chronic 'lemon' equipment causing recurring departmental disruptions.

SECTION 7: OPERATIONAL REPORTS CATALOG & EXPORTS

7.1 8 Executive Operational Reports

MediAsset AI includes 8 pre-configured operational reports engineered for monthly hospital reviews and NABH accreditation:

Key	Report Title	Core Tracked Metrics	Export Formats	Compliance Utility
REP-01	Monthly Maintenance Summary	Department uptime/downtime hours, downtime days, downtime %, breakdown counts	Excel (.xlsx), CSV, Print PDF	Primary NABH monthly engineering review document
REP-02	Monthly Department Report	Department asset census, under repair units, open critical complaints, visit logs	Excel (.xlsx), CSV, Print PDF	Monthly clinical engineering ward status summary
REP-03	Daily Department Visit Report	Biomedical technician round inspections, multi-device checklist, linked tickets	Excel (.xlsx), CSV, Print PDF	Audit evidence of proactive daily equipment checks
REP-04	Breakdown & Complaints Report	Ticket lifecycle, response times, downtime hours, root causes, spare costs	Excel (.xlsx), CSV, Print PDF	MTTR tracking and clinical engineering accountability
REP-05	PM Compliance Report	Planned vs executed PM schedules, adherence %, in-house vs OEM split	Excel (.xlsx), CSV, Print PDF	Statutory PM adherence verification for NABH FMS
REP-06	Calibration Due Report	Upcoming/due/overdue calibrations, agency details, certificate numbers	Excel (.xlsx), CSV, Print PDF	Accreditation safety check against expired devices
REP-07	AMC / CMC & Warranty Report	Contract duration, expiry warning chips, provider details, renewal status	Excel (.xlsx), CSV, Print PDF	Vendor contract governance and budget planning
REP-08	Demo Equipment Report	Supplier trial devices, clinical department, start/return dates, return logging	Excel (.xlsx), CSV, Print PDF	Legal liability and trial device return oversight

7.2 Multi-Format Export Architecture & A4 Print Engine

To ensure frictionless reporting across clinical and administrative workflows, MediAsset AI provides three export modalities:

1. Styled openpyxl Excel Streaming (/api/reports/{key}/export): Generates rich Excel (.xlsx) workbooks with XYZ Hospital Clinical Navy header fills (#102C52), bold white typography, thin borders, zebra-striped data rows, and auto-fit columns.
2. DataTable Client-Side Export: Every data table across Assets, Complaints, PM, Calibration, and Contracts includes an 'Export Excel (.xlsx)' button utilizing xlsx-js-style to capture the exact filtered row set.
3. High-Fidelity A4 Landscape Print Engine: When clicking 'Print A4 / PDF', custom print stylesheets unwrap fixed viewport scrollbars, render ALL filtered rows across multi-page tables (overcoming the standard 10-row screen pagination limit), stabilize Recharts SVG graphics, and append official hospital letterhead with tripartite NABH Chapter FMS sign-off blocks (Prepared By Biomedical Engineer, Verified By HOD, Approved By Medical Superintendent).

SECTION 8: PROACTIVE ALERT ENGINE & SLA ARCHITECTURE

8.1 Automated Alert Engine & Notification Queue

The notification subsystem guarantees zero missed regulatory or maintenance deadlines. A background daemon powered by APScheduler executes every morning at 06:00 AM Asia/Kolkata (utilizing an isolated get_scheduler_db() session) to evaluate 8 distinct alert types with intelligent deduplication keys to prevent notification fatigue:

Alert Key	Display Name	Trigger Criteria & Lead Window	Severity	Target Roles	Channels
amc_expiry	AMC/CMC Expiry	Active contract ending within lead window (30d) or critical threshold (7d)	Yellow / Red	Coord, Mgmt, Biomed, Admin	Bell, Queue, Toast
calibration_due	Calibration Due	Calibration due within inspection window (15d) or past due date	Yellow / Red	Biomed, Coord, Mgmt, Admin	Bell, Queue, Login Modal
pm_due	PM Schedule Due	PM planned date within service window (15d) or past planned date	Yellow / Red	Biomed, Coord, Mgmt, Admin	Bell, Queue, Toast
insurance_expiry	Insurance Expiry	Insurance policy expiration approaching (30d) or critical (7d)	Yellow / Red	Coord, Mgmt, Admin	Bell, Queue, Toast
warranty_expiry	Warranty Expiry	Equipment warranty expiration approaching (30d) or critical (7d)	Yellow / Red	Coord, Biomed, Mgmt, Admin	Bell, Queue, Toast
demo_overdue	Demo Return Overdue	Trial device exceeds expected return date without return log	Red	Biomed, Coord, Mgmt, Admin	Bell, Queue, Toast
critical_complaint	Critical Breakdown	Priority=Critical breakdown remains unrestored after 24 hours	Red	Biomed, Mgmt, Admin, Dept	Bell, Queue, Urgent Card
sla_breach	SLA Response Breach	Breakdown exceeds SLA targets (Critical 4h / Non-critical 24h)	Red	Biomed, Mgmt, Admin, Dept	Bell, Queue, Toast

8.2 Delivery Channels & Real-Time Synchronization

> TopBar Bell Indicator: Polls /api/notifications in the background every 60 seconds with live unread badge counter.

> Interactive Toast Alerts: Pushes instant, non-blocking toast alerts on newly detected critical breakdown breaches.

> Biomedical Login Pop-up: A dedicated CalibrationReminderModal automatically pops up when biomedical technicians log in, displaying all pending calibration records requiring immediate testing.

> Per-User Read Tracking: Records read_at in notification_reads so multiple technicians do not duplicate triage efforts.

SECTION 9: DEPLOYMENT, BACKUPS & ACCEPTANCE SIGN-OFF

9.1 Deployment Topologies

MediAsset AI supports turnkey deployment on hospital-owned infrastructure with zero cloud egress:

* Option A — Docker Compose (Recommended): Production stack packaged in docker-compose.yml including backend, pre-built React frontend, and Nginx reverse proxy. Local volumes persist SQLite data and uploads under ./backend/data.
* Option B — Bare-Metal Hosting: Deployable directly on Windows Server or Linux with Python 3.11+ and Node.js 18+.
* Disaster Recovery Backup: Automated utility in backend/scripts/backup.py leverages SQLite's safe online backup API (sqlite3.Connection.backup) to snapshot database tables and attachments into compressed ZIP files without downtime.

9.2 Verified Demo Credentials

Role	Login Email	Password	Accessible Functional Scope
System Admin	admin@xyz.demo	Demo@123	Full Hospital Administration, Settings, Audit Logs, User Masters
Biomedical	bio@xyz.demo	Demo@123	Asset CRUD, Breakdown Tickets, PM & Calibration Execution
Management	mgmt@xyz.demo	Demo@123	Executive Dashboard, AI Financial Reports, Calibration Approvals
Coordinator	coord@xyz.demo	Demo@123	Vendor Liaison, AMC/CMC Contracts, Insurance, Cross-Dept Triage
Department User	dept@xyz.demo	Demo@123	Raise Breakdown Tickets, View ICU Asset Uptime (Costs Hidden)

9.3 Formal Hospital Stakeholder Acceptance Matrix

Authorized sign-off confirming software verification and technical specification sign-off:

Stakeholder Authority	Designation / Role	Signature & Hospital Stamp	Verification Date
1. PREPARED BY	Lead Solutions Architect, AI India Innovations	_____	____ / ____ / 2026
2. VERIFIED BY	Head of Clinical Engineering (BME HOD)	_____	____ / ____ / 2026
3. IT ENDORSEMENT	Chief Information Officer / IT Director	_____	____ / ____ / 2026
4. APPROVED BY	Medical Superintendent / Executive Director	_____	____ / ____ / 2026