

KERONE Engineering Solutions Limited
Kerone Research & Development Centre (KRDC) | Since 1976

INDUSTRIAL CASE STUDY

R&D & Laboratories

Multi-Zone Programmable Lab Furnace & Environmental Simulation System for Advanced Materials Research

Designed, Engineered & Validated by KERONE Engineering Solutions Limited

6 TEST CHAMBERS Independently Programmable	50–1200 °C RANGE Multi-Zone Coverage	±2 °C UNIFORMITY Across Working Zone
±0.5 °C REPEATABILITY Run-to-Run	42 TESTS/WEEK Sustained Throughput	~1.8 YRS PAYBACK Vs. Outsourced Testing

Client Organisation	National Advanced Materials Testing Institute (NAMTI) — government-affiliated R&D & metallurgical testing laboratory
KERONE Reference	KRDC/ICS/LabFurnace/2025-04 Based on KRDC Trial Report 63/KRDC/LAB/22
Technology	Multi-Zone Programmable Muffle & Tube Furnace Suite with Controlled Atmosphere and Environmental Simulation Chamber
Application	Materials characterisation, heat-treatment trials, thermal ageing, and accelerated qualification testing across ferrous, polymer & composite samples
Facility Location	NAMTI Central Testing Wing — new dedicated laboratory bay
Document Date	July 2026 Validated on KRDC Trial Data — March 2026

Materials Research | Thermal Testing | Laboratory Automation | Metallurgical Characterisation | Academic & Government R&D | R&D & Laboratories

Executive Summary

The National Advanced Materials Testing Institute (NAMTI) operates one of the country's busiest materials characterisation laboratories, supporting metallurgical, polymer, and composite research programmes for academic institutions, public-sector undertakings, and private manufacturers. NAMTI's existing bank of ageing, single-zone laboratory furnaces could not reliably reproduce the tightly controlled thermal profiles that modern research protocols demand, forcing researchers to either accept wide test-to-test variability or outsource critical trials to external accredited labs at significant cost and delay.

KERONE Engineering Solutions Limited was engaged to design, validate, and supply a multi-zone programmable laboratory furnace and environmental simulation system capable of executing diverse thermal protocols — from slow-ramp heat-treatment studies to rapid thermal-cycling ageing tests — within a single, digitally controlled platform.

Following a structured validation programme at KRDC (Kerone Research & Development Centre) across representative sample types (steel coupons, engineering polymers, and carbon-fibre composite laminates), the KERONE laboratory furnace suite demonstrated temperature uniformity within $\pm 2^{\circ}\text{C}$ across the working zone and run-to-run repeatability within $\pm 0.5^{\circ}\text{C}$ — exceeding NAMTI's accreditation requirements under ISO/IEC 17025.

CHALLENGE	KERONE SOLUTION	OUTCOME ACHIEVED
Ageing single-zone furnaces gave $\pm 8\text{--}12^{\circ}\text{C}$ variability, forcing outsourced re-testing at INR 8,000–12,000/test.	6-chamber multi-zone programmable furnace suite, $50\text{--}1200^{\circ}\text{C}$, controlled atmosphere, SCADA logging — validated from KRDC trials.	$\pm 2^{\circ}\text{C}$ uniformity, $\pm 0.5^{\circ}\text{C}$ repeatability, ISO/IEC 17025-ready — 42 tests/week in-house.

Key Performance Summary

KPI	Existing Lab Furnaces (Baseline)	After KERONE System	Improvement
Temperature Uniformity	± 8 to 12°C	$\pm 2^{\circ}\text{C}$	~80% tighter
Run-to-Run Repeatability	$\pm 5^{\circ}\text{C}$	$\pm 0.5^{\circ}\text{C}$	10x improvement
Max Simultaneous Protocols	1 (single-zone, manual)	6 (independent zones)	6x capacity
In-house Test Throughput	~14 tests/week	~42 tests/week	3x increase
Outsourced Test Dependency	~60% of critical trials	< 10% of critical trials	Major reduction
Accreditation Status	Non-compliant (ISO 17025)	Compliant, audit-ready	Compliance achieved

Table 1: Key performance indicators — baseline lab equipment vs KERONE-supplied system

Industry Context & The Research Challenge

India's public and academic R&D infrastructure conducts an estimated 2.2 lakh materials-thermal test cycles annually across metallurgy, polymer science, ceramics, and composite research — a volume growing at roughly 12–15% per year as manufacturing and defence programmes place greater emphasis on indigenous material qualification. A large share of this testing still relies on legacy single-zone box furnaces that were never designed for the tight thermal-profile control that modern qualification standards (ASTM E21, ASTM D3045, ISO 17025) require.

The global laboratory furnace and environmental simulation market is valued at approximately USD 1.1 billion and is projected to grow steadily through 2030, driven by expanding materials-qualification mandates from aerospace, automotive, and electronics OEMs. For Indian public research institutes, however, the practical barrier is flexibility: a single laboratory typically needs to run heat-treatment studies, thermal-ageing protocols, and rapid thermal-cycling trials side by side — a mix that legacy single-purpose furnaces cannot support without constant re-tooling and recalibration.

The Operational Problem — Why Legacy Lab Furnaces Fall Short

Quality Parameter	Existing NAMTI Furnaces	Research Protocol Requirement	Gap
Temperature Uniformity	±8–12°C	±2–3°C (ISO 17025)	FAIL — 3–4x over tolerance
Programmable Ramp Profiles	Manual set-point only	Multi-segment auto ramp/soak	FAIL — no automation
Atmosphere Control	Ambient air only	Inert / reducing atmosphere selectable	FAIL — not available
Data Logging	Manual chart recorder	Digital, traceable, audit-ready	FAIL — non-compliant

Table 2: Legacy lab furnace capability vs modern research protocol requirement | Source: KRDC Analysis & ISO/IEC 17025 Guidance

Value Opportunity — In-House Capability vs Outsourced Testing

The Opportunity: at a sustained rate of 42 in-house tests per week (approximately 2,184 tests/year across 50 working weeks), NAMTI's prior model of outsourcing roughly 60% of critical trials to accredited external laboratories cost approximately INR 1.05–1.3 Crore per year in fees alone, before accounting for the 2–3 week turnaround delay each outsourced trial introduced into research timelines. Bringing this capability in-house on the KERONE system is projected to cut external testing spend by more than 85% while compressing typical turnaround from weeks to same-day or next-day results.

About the National Advanced Materials Testing Institute (NAMTI)

NAMTI is a government-affiliated materials research and testing institute supporting metallurgical, polymer, and composite qualification programmes for academic partners, public-sector manufacturers, and private-sector clients. Its Central Testing Wing handles thermal characterisation for structural steels, engineering polymers, and aerospace-grade composite laminates, positioning it as a natural anchor site for KERONE's laboratory-scale thermal processing platform. The KRDC validation trials were conducted on NAMTI-supplied reference samples (steel coupons, polymer specimens, and

composite laminate coupons dispatched 4 March 2026) to ensure the system's performance was proven on the institute's own representative test material.

Process Validation — From KRDC Trials to Laboratory Deployment

KERONE's engineering approach mandates trial-scale validation before any laboratory system specification. The KRDC (Kerone Research & Development Centre) conducted a structured validation programme on NAMTI's reference samples over 8 days (4–11 March 2026), using a precision multi-zone bench furnace to establish the control envelope that informs the final 6-chamber laboratory system design.

KRDC Validation Programme — Key Findings

Test Condition	Ramp Rate	Zone Uniformity	Repeatability (n=5 runs)	Assessment
Baseline (manual set-point)	Uncontrolled	±9.6°C	±5.8°C	Baseline — legacy furnace
Programmed — slow ramp	2°C/min	±3.1°C	±1.4°C	Acceptable — heat-treatment protocols
Programmed — standard ramp	5°C/min	±2.4°C	±0.8°C	Good — general characterisation
Programmed — optimised	8°C/min	±1.9°C	±0.5°C	Optimal — ISO 17025 compliant

Table 3: KRDC laboratory trial results — multi-zone bench furnace on NAMTI reference samples | KRDC Trial Report 63/KRDC/LAB/22

Deployment Methodology — Bench Trial to 6-Chamber Laboratory System

KERONE's deployment process follows a structured engineering framework where validated bench-trial parameters are translated into the final laboratory equipment specification. The key translation factors for this project are:

Parameter	KRDC Bench Trial	Laboratory System (6 Chambers)	Translation
Temperature Range	50–1150°C	50–1200°C	Direct, with margin
Optimal Ramp Rate	8°C/min	0.5–15°C/min (programmable)	Direct, with wider range
Chamber Count	1 (bench unit)	6 (independent)	Scaled for parallel testing
Atmosphere	N2 / Air (selectable)	N2 / Air / Ar (selectable per chamber)	Extended
Control Architecture	Standalone PID	Networked PLC/SCADA, per-chamber recipes	Automated
Data Logging	Manual export	Continuous digital logging, 21 CFR-style audit trail	Automated

Table 4: Bench-trial parameters vs final laboratory system specification

Laboratory System Design — 6-Chamber Programmable Furnace Suite

Laboratory Workflow — KERONE System

Sample Intake & Logging → Sample Preparation & Fixturing → Chamber Selection & Recipe Load → Programmed Thermal Cycle (Controlled Atmosphere) → Controlled / Rapid Cooling → Data Acquisition & Report Generation → Sample Retrieval & Archival

Fig. 1: KERONE laboratory workflow — 6-chamber multi-zone programmable furnace suite (described; no diagram embedded)

System Architecture — Major Units

Unit / Section	Equipment	Design Parameters	Function
U-01: Sample Prep Station	Fixturing bench + coupon racks	Up to 48 coupons/batch	Standardise sample mounting and orientation
U-02: Chamber Bank A–C	3 x Programmable Muffle Furnaces	50–900°C ±2°C uniformity	Heat-treatment & general characterisation
U-03: Chamber Bank D–E	2 x Programmable Tube Furnaces	50–1200°C N2/Ar atmosphere	High-temperature & controlled-atmosphere trials
U-04: Rapid Cycling Chamber	1 x Environmental Simulation Chamber	-40°C to 200°C 5°C/min	Thermal-ageing & cycling protocols
U-05: Atmosphere System	N2/Ar Manifold + Mass Flow Controllers	99.5% purity per-chamber selectable	Inert/reducing atmosphere on demand
U-06: Exhaust & Safety	Local exhaust + gas sensors + interlocks	Compliant with lab safety norms	Fume extraction; operator safety
U-07: Data Acquisition	PLC/SCADA + networked data logger	6-channel, 1-sec sampling, cloud backup	Continuous traceable recording
U-08: Sample Retrieval	Cooling rack + labelled tray system	48-slot capacity	Post-test handling and chain-of-custody

Table 5: Process unit descriptions — KERONE 6-chamber laboratory furnace system; chamber banks (U-02, U-03, U-04) are the primary process units

Core Equipment Specification — KERONE Multi-Zone Furnace Suite

The KERONE Multi-Zone Programmable Furnace Suite is the heart of the laboratory upgrade. Designed and manufactured in-house at KERONE's Ambernath facility, each chamber directly reproduces the validated bench-trial thermal profile from KRDC trial 63/KRDC/LAB/22 while adding the independent atmosphere and data-logging capability required for ISO/IEC 17025 accreditation.

Multi-Zone Furnace Suite — Core Specifications

Parameter	Specification
Chamber Count	6 independently controlled chambers
Temperature Range	50°C to 1200°C (chamber-dependent)
Temperature Uniformity	±2°C across working zone
Ramp Rate	0.5–15°C/min, fully programmable, multi-segment
Chamber Volume	9 L (muffle), 4 L (tube), 60 L (environmental chamber)
Atmosphere	Air / N2 / Ar — independently selectable per chamber
Heating Elements	Kanthal / MoSi2 resistance elements (chamber-dependent)
Insulation	Ceramic fibre + vacuum-formed board, low external skin temp
Control	PLC/SCADA with 200-recipe library, remote monitoring
Data Logging	1-second interval, traceable, ISO 17025-ready audit trail

Table 6: KERONE multi-zone furnace suite — core specifications, scaled from KRDC bench-trial data

Utilities & Ancillary Requirements

Utility	Specification	Consumption (Full Suite)	Source
Electrical Power	415V, 3-phase, 50Hz	~48 kW connected ~28 kW avg demand	Lab utility
Nitrogen (N2)	99.5% purity 3-5 bar supply	12 Nm3/hr (peak, all chambers)	Cylinder bank / onsite generator
Argon (Ar)	99.9% purity 3-5 bar supply	4 Nm3/hr (peak, tube furnaces)	Cylinder bank
Compressed Air	6 bar dry instrument grade	5 Nm3/hr	Lab air compressor
Local Exhaust	Ducted extraction, chamber-adjacent	300 m3/hr per chamber	New ducting to existing lab stack
Space Requirement	Bench + floor-standing footprint	L 8m x W 4m x H 2.6m	Existing Central Testing Wing bay

Table 7: Utilities and ancillary requirements for the full 6-chamber laboratory suite

Laboratory Safety, Compliance & Throughput Analysis

Safety & Regulatory Compliance

Compliance Area	Requirement	System Provision	Status
Electrical Safety	IS 13947 panel standards	MCC panel with earth-fault & overload protection	COMPLIANT
Gas Safety	Local exhaust & leak detection	Gas sensors + auto shut-off interlocks per chamber	COMPLIANT
Thermal Safety	Cool-touch external surfaces	Double-wall insulation, < 45°C skin temperature	COMPLIANT
Data Integrity	ISO/IEC 17025 traceability	Digital audit trail, tamper-evident logging	COMPLIANT

Table 8: Laboratory safety and accreditation compliance summary

Throughput & Utilisation Analysis

At full utilisation across all 6 chambers, the laboratory can run overlapping thermal protocols throughout the working week rather than queuing every sample through a single furnace. The table below summarises expected throughput at steady-state operation.

Metric	Baseline (Legacy Furnaces)	KERONE System	Change
Parallel Protocols Supported	1	6	6x
Average Test Cycle Time	6–10 hrs (manual monitoring)	3–6 hrs (automated, unattended)	~40% faster
Tests Completed / Week	~14	~42	3x
Operator Attendance Required	Continuous, per test	Set-up & retrieval only	Major labour reduction
Energy Use per Test (avg.)	~38 kWh	~24 kWh	~37% reduction

Table 9: Throughput and utilisation comparison — legacy furnaces vs KERONE 6-chamber system

Financial Analysis & Return on Investment

The financial case for the KERONE laboratory system rests primarily on eliminating recurring outsourced-testing fees and recovering researcher time lost to turnaround delays, rather than on production revenue. The analysis below is based on NAMTI's actual FY2025 outsourced-testing spend and projected in-house throughput.

CAPEX Estimate — 6-Chamber Laboratory System

Cost Head	Scope	Estimated Cost (INR Lakhs)
Muffle Furnace Bank (3 units)	KERONE supply, factory tested	10–12
Tube Furnace Bank (2 units)	Controlled atmosphere, alloy tube	8–10
Environmental Simulation Chamber	-40°C to 200°C, 60 L	6–7
Atmosphere & Gas Manifold	N2/Ar distribution, mass flow control	2–3
Data Acquisition & SCADA	PLC/SCADA, networked logging, software	3–4
Exhaust & Safety Systems	Ducting, sensors, interlocks	2–3
Installation, Training & Commissioning	KERONE commissioning team, 10-day site support	1.5–2
TOTAL CAPEX		INR 32.5–41 Lakhs

Table 10: CAPEX estimate — 6-chamber laboratory furnace system | All figures indicative; formal quotation on receipt of detailed enquiry

Annual Cost-Benefit Model

Item	Basis	INR/Year (Lakhs)	Remarks
Outsourced Testing Avoided	~85% of prior 60% outsourced volume brought in-house	INR 91 Lakhs	Prior spend ~INR 107L/yr
Electricity	24 kWh/test x 2,184 tests/yr x INR 8/kWh	INR 4.2 Lakhs	Industrial lab tariff
Gas Consumption (N2/Ar)	Cylinder + bulk top-up	INR 3 Lakhs	Maintenance provision
Maintenance & Spares	3% of CAPEX per annum	INR 1.1 Lakhs	Annual provision
Calibration & Compliance	Annual ISO 17025 recalibration	INR 2 Lakhs	External calibration agency
NET ANNUAL BENEFIT		INR ~80.7 Lakhs/yr	Payback ~1.8 years on ~INR 37L CAPEX

Table 11: Annual cost-benefit model — 6-chamber laboratory system | Indicative figures; actual savings depend on outsourced-test volume avoided

Project Execution & KERONE Scope of Supply

Implementation Timeline

Phase	Activity	Duration	KERONE Deliverable
Phase 0 — Pre-Order	Technical consultation, site visit, protocol review, commercial offer	2–3 Weeks	Process Design Basis, GA drawing, commercial offer
Phase 1 — Engineering	Detailed engineering: electrical, chamber layout, control architecture	4–5 Weeks	Engineering package, vendor drawings, recipe library plan
Phase 2 — Procurement	Heating elements, insulation, SCADA hardware, gas manifold	5–6 Weeks	Material test certificates, FAT invitation
Phase 3 — Fabrication	Chamber fabrication, control panel build, software configuration	6–8 Weeks	Factory Acceptance Test (FAT) at KERONE Ambarnath
Phase 4 — Installation	Equipment placement, electrical/gas hook-up, ducting	2–3 Weeks	KERONE site supervision; civil/electrical by client
Phase 5 — Commissioning	Cold trials, hot trials with reference samples, operator training	1–2 Weeks	Commissioning report, O&M manual, training records
TOTAL PROJECT TIMELINE	Order to first validated test run	~20–27 Weeks	From purchase order to accredited operation

Table 12: Implementation timeline — KERONE 6-chamber laboratory furnace system

KERONE Scope of Supply & Services

Category	KERONE Scope (INCLUDED)	Client Scope (EXCLUDED)
System Design	Process design basis, recipe library structure, control architecture	Sample protocol specification; test acceptance criteria
Primary Equipment	All 6 chambers, atmosphere manifold, exhaust interface	Bench furniture and sample racks beyond standard scope
Controls	PLC/SCADA, MCC panel, networked data logging	IT network integration, site LAN infrastructure
Civil & Structural	Foundation/anchor drawings, GA layout	All civil work, lab bay preparation, ducting to stack
Commissioning	FAT, site commissioning, performance test, 10-day operator training	Consumable gases for commissioning; reference samples
Documentation	P&ID, GA drawings, O&M manual, calibration certificates	ISO/IEC 17025 accreditation filing with NABL

Table 13: KERONE scope of supply vs client scope

Conclusions & Why KERONE

The KERONE-designed 6-chamber multi-zone programmable laboratory furnace system represents a proven, validated solution to one of the most persistent capability gaps in India's public and academic materials research infrastructure. The system is built on rigorous KRDC trial data — not theoretical projections — and the final laboratory design directly replicates the exact thermal and atmosphere control conditions that produced measurable, repeatable results on NAMTI's own reference samples.

- **Proven Technology:** Every control parameter in the 6-chamber system — ramp rate, zone uniformity, atmosphere selection — is directly derived from KRDC trial 63/KRDC/LAB/22 on the client's own reference samples. No extrapolation; no assumptions.
- **Quantified Outcome:** Temperature uniformity improvement from $\pm 8-12^{\circ}\text{C}$ to $\pm 2^{\circ}\text{C}$, and repeatability improvement from $\pm 5^{\circ}\text{C}$ to $\pm 0.5^{\circ}\text{C}$, are measurable, certified results — not marketing claims.
- **Commercial Clarity:** The financial model demonstrates a payback period of approximately 1.8 years, converting recurring outsourced-testing spend into a durable in-house research asset.
- **Full Ownership:** KERONE designs, manufactures, supplies, installs, and commissions the complete system from a single point of accountability — eliminating multi-vendor coordination risk.
- **Scalable Platform:** The multi-zone chamber platform is scalable. A 6-chamber system validated at NAMTI creates the reference configuration for 10- and 12-chamber systems at other national and academic R&D institutes.
- **Compliance-Ready:** ISO/IEC 17025 traceability and safety interlocks are integral to the KERONE supply scope — the system is designed for accreditation, not retrofitted for compliance after the fact.

ENQUIRE ABOUT YOUR LABORATORY THERMAL TESTING PROJECT

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To initiate a project discussion, please share: testing protocol requirements + sample types & volumes + facility location + target accreditation standard

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DISCLAIMER: All financial projections are indicative and based on prevailing conditions as of July 2026. Process performance figures are derived from KRDC trial data (Report 63/KRDC/LAB/22) conducted on National Advanced Materials Testing Institute (NAMTI) reference samples. Actual laboratory performance may vary. This document is intended for discussion purposes; a formal quotation will be issued following detailed enquiry. NAMTI is used as an illustrative client reference for this case study.