

CNG High Pressure Regulator Test Bench



About us:

Neometrix Defence Celebrating 20 Years of Excellence! For the past two decades, Neometrix Defence has maintained its position as a premier provider of advanced test benches and rigs.

Our accreditation by the Directorate General of Aeronautical Quality Assurance, India (DGAQA) and Defence Research & Development Organization, India (DRDO) underscores our commitment to upholding the highest international defence industry standards.

Counting the Indian Air Force/Army/Navy, Ministry of Defence, Hindustan Aeronautical Limited, and DRDO among our esteemed clientele, we are recognized for delivering state-of-the-art solutions and unwavering performance reliability.

Strengths & Capabilities:

Neometrix Defence is a powerhouse of engineering brilliance, proudly serving every Indian Air Force station and partnering with the Indian Army, Navy, Railways, BARC, NPCIL, and ISRO. With a team of over 100 elite engineers and visionary founders from IIT Kanpur and IIT Delhi, we harness cutting-edge technology to set the gold standard in mechanical engineering.

We Don't Just Meet Industry Demands – We Define Them!



- We have established our presence in all Air Force stations across India. With the Indian Air Force as our leading customer, we are dedicated to upholding the highest standards of excellence in the aerospace industry.
- Our extensive clientele extends beyond the defence industry, including projects with the Indian Army, Navy, Railways, BARC, NPCIL, ISRO, and more. In essence, we excel in all aspects of mechanical engineering!
- Our team comprises over 100 graduate engineers, supported by a cutting-edge manufacturing site equipped with state-of-the-art machinery, enabling us to meet the highest Engineering standards.
- The founders of our company are distinguished graduates from IIT Kanpur and IIT Delhi, bringing extensive expertise and a wealth of engineering knowledge to Neometrix Defence.

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Introduction:

Natural gas vehicles rely on precision-engineered pressure regulators to maintain a stable downstream pressure for safe and efficient engine operation. Regulators must withstand thousands of load cycles, fluctuating supply pressures, and extreme temperatures without failure or unacceptable leakage. Any compromise in performance can lead to drivability issues, increased emissions, and—even more critically—safety hazards on board the vehicle.

The CNG High-Pressure Regulator Test Bench is purpose-built to meet these real-world challenges head-on. At its core is a 6 L stainless-steel reservoir charged to 300 bar, providing a stable source of high-pressure gas for testing. A Haskel-brand balanced-piston booster elevates inlet pressure automatically from 10 to 260 bar—extendable to 310 bar under manual control—so that regulators experience the full spectrum of service conditions. Integrated PLC logic then executes up to 50,000 pressurization/depressurization cycles per ISO 15500-9:2001(E), simulating years of on-road use in just a few hours.

Beyond endurance, the bench's precision leak-detection system isolates the unit under test and monitors pressure decay at a sensitivity of $\leq 15 \text{ cm}^3/\text{hr}$. This capability ensures that even minute seal imperfections are identified and weeded out before a regulator ever leaves production. Real-time data capture—complete with bi-color LED pass/fail indicators on the HMI—allows operators to immediately validate each cycle, safeguarding both product quality and line throughput.

Modular by design, the test bench can accommodate a broad range of OEM-specific regulator fixtures, making it ideal for both R&D validation of new designs and high-volume end-of-line quality assurance. Mounted on lockable wheels and requiring only a single electrical connection and clean, filtered drive air, it brings laboratory-grade testing directly to the production floor—or even to field service depots—wherever rigorous CNG regulator qualification is needed.



Purpose & Applications:

The versatility of the CNG High-Pressure Regulator Test Bench makes it an indispensable asset across multiple stages of the regulator lifecycle:

OEM Production & End-of-Line QA

- **High-Throughput Certification:** Integrated bi-color LED pass/fail indicators and automated test sequencing enable operators to validate each regulator in under 90 seconds, achieving up to 1,000 units per shift without sacrificing accuracy.
- **Process Integration:** The bench's trigger-based PLC interface can be linked directly to automated assembly lines, initiating a test cycle the moment a regulator is clamped into the fixture—eliminating manual setup delays.
- **Statistical Process Control:** Real-time data aggregation feeds into SPC dashboards, allowing quality engineers to detect process drift (e.g., seal wear trends) before regulators fall out of tolerance.

R&D & Design Validation

- **Accelerated Life-Cycle Simulation:** By running cycles at up to 60 per minute, designers can compress years of field operation into hours, uncovering fatigue points in diaphragms, springs, and seals.
- **Variable-Profile Testing:** Customizable pressure ramps, dwell periods, and temperature conditioning (with optional thermal-chamber integration) let engineers simulate extreme cold starts or hot-soak conditions, refining component materials and geometries.
- **Failure Mode Analysis:** Detailed pressure-vs-time graphs and leak decay curves help root-cause failures—whether ductile fracture in valve seats or micro-cracking in polymer seals—fast-tracking design improvements.



Key Features:

Automated Endurance Cycling

- Executes up to 50,000 full-pressure cycles per ISO 15500-9:2001(E) without operator intervention. Customizable cycle profiles (pressure ramps, dwell times, and cycle counts) can be stored and recalled, ensuring consistent replication of complex endurance tests across batches. High-speed actuation (up to 60 cycles per minute) compresses years of field usage into hours, accelerating R&D feedback loops and production throughput.

High-Resolution Leak Detection

- Utilizes precision pressure transducers and a decay-analysis algorithm to detect leakage rates as low as 15 cm³/hr. The system automatically isolates the Unit Under Test (UUT) and logs continuous pressure-versus-time curves at 100 Hz sampling, flagging any deviation beyond the threshold and halting the test for immediate inspection. Integrated bi-color LEDs and HMI alarms provide instant go/no-go feedback at each cycle.

Wide Pressure Envelope

- Automatically regulates inlet pressure between 10 bar and 260 bar, covering the entire operational range of automotive and industrial CNG regulators. For extreme over-pressure or specialized tests, a manual override extends the envelope up to 310 bar. All pressure set-points, ramps, and limits are managed via the HMI, with dual-channel safety interlocks preventing excursions outside the programmed range.

Intelligent Gas Booster

- Features a balanced-piston booster with auto-start/stop logic: it engages when inlet pressure drops below 20 bar and disengages above 300 bar to protect both booster and UUT. Real-time monitoring of booster oil temperature and inlet flow ensures optimal performance and longevity. A built-in bypass valve allows manual override during maintenance or specialty test procedures.

Stainless-Steel Reservoir

- Houses a 6 L, 300 bar charge of dry, filtered air or nitrogen, guaranteeing consistent supply throughout high-speed cycling. The reservoir's seamless, electropolished 316 SS construction resists corrosion and meets PED requirements for pressure equipment. A quick-disconnect pressure gauge and fill port expedite swap-outs and refill operations, minimizing downtime.

Technical Specifications:

Parameter	Specification
Drive Air Supply	≥ 5 bar, 50 CFM; 5 μm filter; dew point -40 °C
Booster Model	Haskel AG-15/75; inlet ≥ 100 psi; outlet to 15,000 psi
Inlet Pressure Range	10–260 bar (auto) / up to 310 bar (manual)
Leak Detection Threshold	≤ 15 cm ³ /hr
Cycling Speed	Up to 60 cycles/min (PLC-controlled)
Temperature Range	-20 °C to $+50$ °C (optional thermal chamber)
Reservoir Capacity	6 L SS @ 300 bar
Data Acquisition	16-bit ADC; 100 Hz sampling; network export
Software Compatibility	LIMS, OPC UA, CSV, PDF



System Components & Architecture:

The Pneumatic Drive Module ensures clean, consistent actuation by drawing filtered air through a two-stage 40 µm filter and precision regulator. Dual stainless-steel isolation and exhaust valves—operated via quick-release fittings—allow rapid unit-under-test (UUT) swaps and controlled venting during leak checks.

At the heart of pressure generation, the High-Pressure Booster Module employs a balanced-piston design to smoothly ramp inlet pressure from 10 bar to 260 bar under PLC control. An onboard micrometre-style regulator provides 0.1 bar resolution for dwell settings, while built-in auto-start/stop logic protects the booster and UUT by engaging below 20 bar and disengaging above 300 bar.

The Control Cabinet is built around a Siemens S7-1200 PLC and dual-channel safety relays. Ladder logic handles cycle sequencing, interlock monitoring, and emergency shutdowns. A 7" colour HMI displays live pressure-vs-time curves, cycle counts, and bi-colour pass/fail indicators, and guides operators through setup and diagnostics.

For data capture, precision pressure transducers ($\pm 0.25\%$ FS) sample at 100 Hz and feed into a 16-bit ADC card. Test logs can be streamed over Ethernet via OPC UA or exported as CSV/PDF directly from the HMI, ensuring seamless integration with LIMS or QC systems.

All subsystems are mounted on a mobility frame of powder-coated steel tubing with industrial swivel casters. Vibration-damped wheels lock securely in place, and an ergonomic handle plus protected cable routing make the entire bench easy for a single technician to manoeuvre between lab, shop floor, or field locations.

Installation & Maintenance

Site Requirements:

- Drive Air: 6–16 bar dry, 40 µm @ 60 SCFM
- Environment: 10 °C–40 °C, indoor, dust-free

Routine Checks:

- Daily: Inspect hoses, gauges, quick-disconnects
- Monthly: Lubricate booster seals; verify filter ΔP
- Quarterly: Replace drive filter; test relief valves & burst disc
- Annual: Full leak test; transducer recalibration; grease refresh

Operational Workflow

Safety Check: Verify guard panels, emergency stops and interlocks; confirm drive air (-40 °C dew point, $40\text{ }\mu\text{m}$) and ambient conditions ($10\text{--}40\text{ °C}$).

Mount & Connect: Secure regulator in the quick-change fixture; attach drive-air and high-pressure hoses.

Prime: Fill reservoir to 300 bar, purge lines via the inlet valve, and match drive-air to reservoir within ± 0.5 bar.

Boost & Test: Hit “Boost” on the HMI—booster ramps to set-point (e.g., 260 bar)—then run the stored cycle profile; pass/fail LEDs indicate leaks $> 15\text{ cm}^3/\text{hr}$.

Data & Change-Out: Auto-generate PDF/CSV report; PLC stages depressurization, then unlock fixture and prep the next regulator.

Safety, Compliance & Quality:

- Dual Relief System: Safety relief @ 405 bar; burst disc @ 430 bar
- Dual-Channel Interlocks: Prevent over-pressure events
- Emergency Stops: Accessible on all sides
- Standards: ISO 15500-9, ISO 4413, ISO 13849-1 Cat.3, IEC 60204-1
- Traceability: Serialized frame, digital QA/QC logs, weld radiography