Concepts NREC

The Experts in Turbomachinery

VAROC® Air Dynamometers

For load testing gas turbine engines

• Engineering • Software • Manufacturing • Training

Concepts NREC

For over 60 years, Concepts NREC has been partnering with the world's leading OEMs to improve the performance and manufacturability of turbomachines. We are the only company in the world whose in-house capabilities span the entire process — from concept through design software, manufacturing, testing, and installation. This creates powerful synergies that drive innovation across our entire offering. Our clients benefit from having a trusted partner who can see the big picture and provide valuable insights that save them time and money.

Concepts NREC is ISO 9001:2008 and AS9100C certified and committed to providing our customers with products and services that meet international quality standards.

Advancing the State of the Art in Turbomachinery

Concepts NREC maintains a robust in-house research and development program. We hold over 70 patents worldwide, with numerous patents pending. Concepts NREC is also the leader of the global *Advanced Centrifugal Pump and Compressor Consortium for Diffuser and Volute Design*, an internationally-sponsored research venture dedicated to advancing diffuser and volute design.

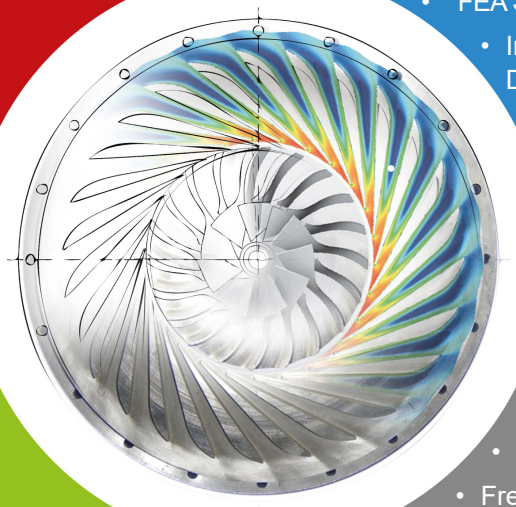
At Concepts NREC, we push past what *has* been done to explore what *can* be done. We have the vision to create great designs and a hard-earned reputation for delivering them.

Engineering

- Design Optimization
- Design Services
- Engineering Audits
- Equipment Rerates and Upgrades
- Feasibility Studies
- Laboratory Testing

Software

- 3D CFD Flow Analysis
- 5-Axis CNC Machining
- Design Optimization
- FEA Stress and Vibration Analysis
- Integrated Preliminary and Detailed Design Solutions
- Rotordynamics



Manufacturing

- Balance Testing
- CMM Inspection
- Component Assembly
- Concurrent Engineering/Manufacturing
- Modal Analysis
- Prototypes
- Reverse Engineering
- Short or Long Production Runs

Training

- Customized Training
- Design Software Workshops
- Free Webinar Series
- Manufacturing Software Workshops
- Professional Development Courses
- Textbooks

VAROC Air Dynamometers

The VAROC Air Dynamometer is used worldwide by both military and commercial organizations to test a broad range of gas-turbine engines. The patented design is a VAriable-geometry, Radial Outflow Compressor (VAROC) that provides significant advantages over all other types of dynamometers. The VAROC can operate in any climate and is designed to be highly reliable, simple to operate, easy to maintain, compact, and lightweight. VAROC dynamometers are now being used by military and commercial organizations throughout the world and are the dynamometers preferred by the defense agencies of many countries.

No Complex Water Systems and Support Equipment Needed

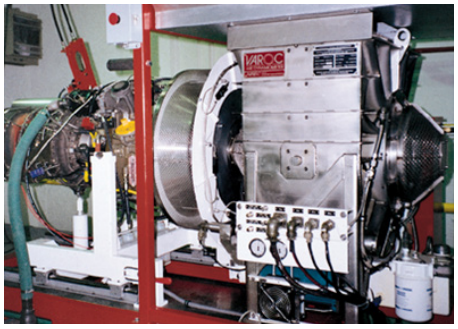
The VAROC uses ambient air for power absorption and does not need the substantial water systems required by conventional dynamometers. VAROC dynamometers completely eliminate the need for fixed plumbing installations, heat exchangers, cooling towers, and electrical load banks. Using air as the working fluid also eliminates environmental pollution caused by oil contamination of the water system.

Can Be Used in Fixed Test-Cell Installations or Mobile Field Applications in Any Climate

Using ambient air to absorb engine output greatly enhances portability and allows the VAROC to operate in any climate. This can be a significant advantage in fixed test-cell operations and is essential for practical remote engine testing. The VAROC can be used anywhere, regardless of climate.

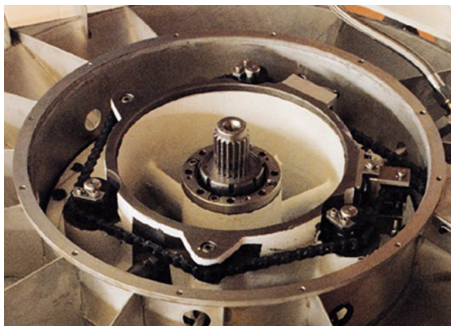
Stable Operation and Precise Control

The unique VAROC design uses a two-sided impeller to create a balanced double air-entry arrangement. Power absorption is precisely controlled by a moving shroud which exposes a portion of the rotating impeller blades to the flow path. This variable-length blade system is accurately regulated by a precision high-speed servo motor. The high inertia of the impeller provides very stable control and eliminates the need for a separate flywheel.



Simple to Operate, Easy to Maintain, and Very Reliable

No special training is required to use a VAROC dynamometer, and the simplicity of the design substantially reduces maintenance. Moving parts are limited to the impeller, bearings, and the shroud-actuating mechanism. The V series dynamometer utilizes oil-damped ball bearings while the S series incorporates fluid film bearings to extend bearing life. VAROC dynamometers require minimal maintenance between overhauls and have decades of proven reliability in the most challenging applications.



Applicable to a Wide-Range of Engine Types

The VAROC comes in four models and can test more than forty engine types. Engine shafts can be coupled to either end of the VAROC for rotation in either engine direction. When used with optional torque-sensor instrumentation, the VAROC dynamometer can test an entire series of engines with a single dynamometer/sensor combination.

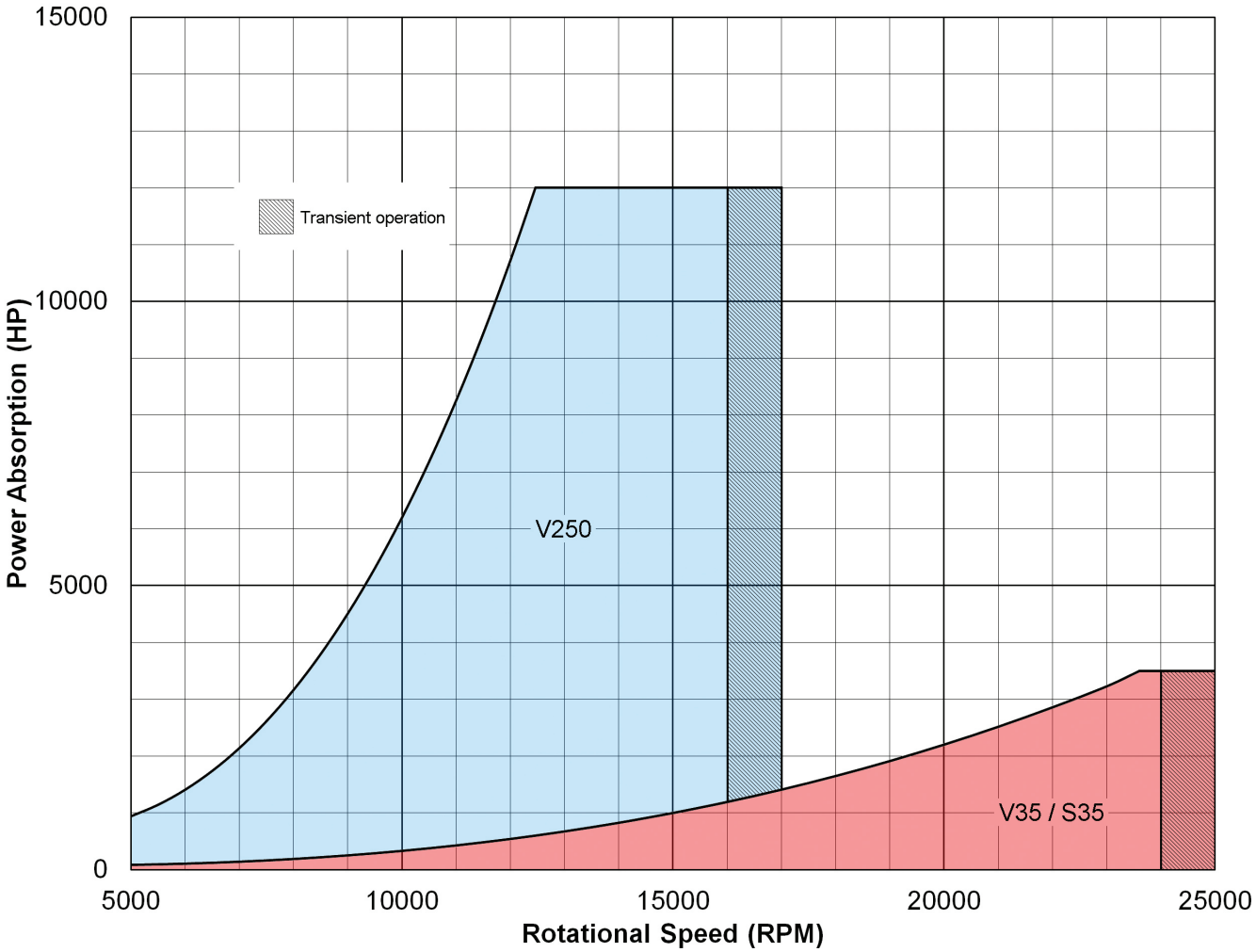
Turnkey Test Packages Available

Concepts NREC can supply only the VAROC dynamometer or work with proven test-system manufacturers to produce a turnkey VAROC test cell. Concepts NREC can also supply all shafting, torque measurement systems, dynamometer control equipment, instrumentation, and special accessories.

Service

Concepts NREC maintains extensive overhaul and maintenance facilities to service the VAROC family of air dynamometers.

Dynamometer Operating Envelope



Dynamometer Design Comparison

Dynamometer type	VAROC V Series	VAROC S Series	Hydraulic Dynomometer
Working Fluid	Air	Air	Water
Infrastructure Requirements	Exhaust Duct (Optional)	Exhaust Duct (Optional)	Supply water tank Water treatment system Water filtration system Booster pumps, motors Water pressure regulator Load control valve Cooling system Water plumbing
Operating Cost	Low	Low	High
Portability	High	Moderate	Limited
Cavitation Risk	None	None	Potential
Load Stability	High	High	Moderate
Flywheel	None	None	Yes
Overhaul Interval	Up to 2,000 hours	Up to 10,000 hours	Up to 10,000 hours
Regular Maintenance	Minimal	Minimal	Significant

Types of Dynamometers

Air Dynamometer

The VAROC air dynamometer uses a unique patented radial-outflow compressor with sliding shrouds that effectively modify the geometry of the flow path to vary engine load. The simple VAROC design provides stable operation over a wide range of speed and power, and permits low weight, small size, minimal maintenance, and high portability, in any climate.

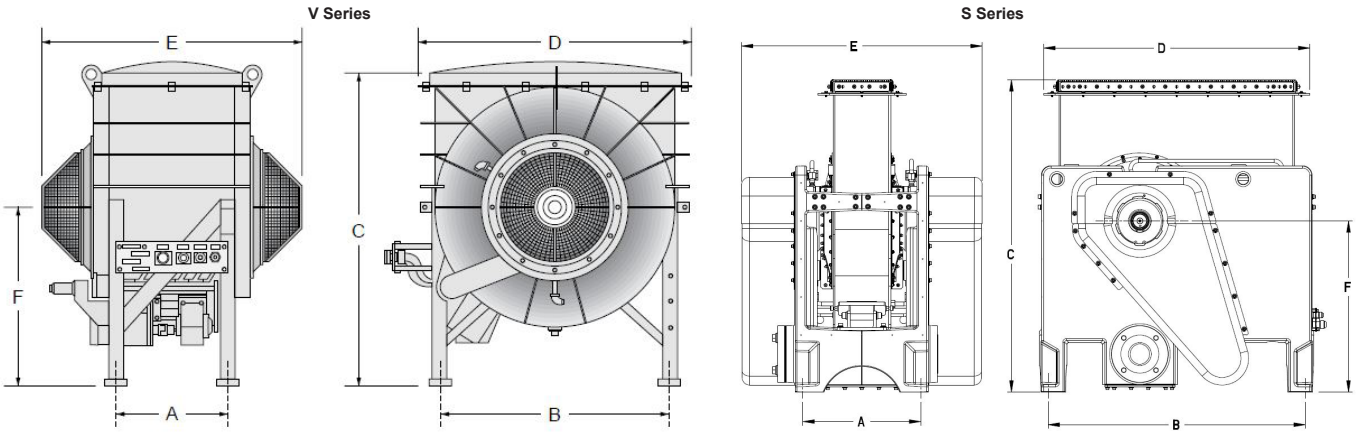
Hydraulic Dynamometers

Hydraulic dynamometer systems are heavy, not easily transportable, and typically limited to low speeds. The water must be cooled for reuse and can become contaminated with chemicals that pose an environmental threat which is expensive to treat. Water impurities and corrosion can also cause poor reliability, premature rotor erosion, and the need for frequent maintenance.

Eddy Current Dynamometers

Eddy current dynamometers are large, heavy devices for fixed installations with cooling systems that generally require water treatment. Besides not being portable, eddy current dynamometers are expensive to operate and maintain, and have a relatively narrow operating range which limits the number of engine models that can be supported by any one unit.

Specifications



Dimensions

	A	B	C	D	E	F
V35 Inches (cm)	13.5 (34.3)	28.7 (72.9)	40.2 (102.1)	35.2 (89.4)	33.3 (84.6)	23.7 (60.3)
V35-85 Inches (cm)	13.5 (34.3)	28.7 (72.9)	40.2 (102.1)	35.2 (89.4)	33.0 (83.8)	23.7 (60.3)
V250 Inches (cm)	24.5 (62.2)	50.5 (128.3)	58.9 (149.6)	60.0 (152.4)	47.6 (120.9)	30.0 (76.2)
S35 Inches (cm)	15.5 (39.4)	33.8 (86.0)	41.0 (104.1)	35.0 (88.9)	31.6 (80.3)	22.5 (57.2)

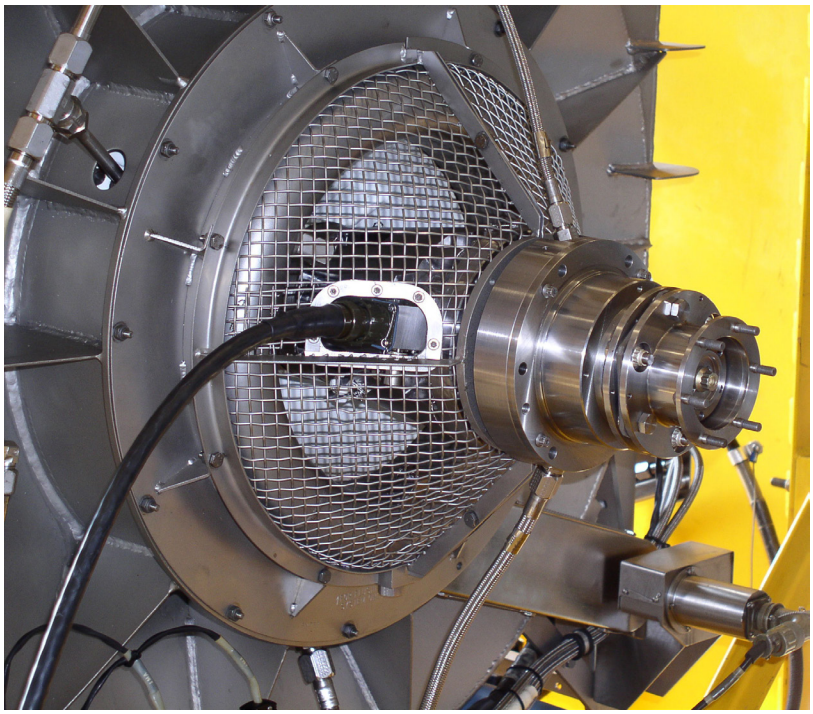
Performance

	V35	V35-85	V250	S35
Speed range (RPM)	24,000	24,000	16,000	24,000
Power Range HP (kW)	3,500 (2600)	5,500 (4,100)	18,000 (13,500)	3,500 (2,600)
Weight lbs (Kg)	830 (376)	862 (391)	2,875 (1,304)	1,750 (794)
Operating Voltage VAC (Hz)	100-440 (50-60)	100-440 (50-60)	100-440 (50-60)	100-440 (50-60)
Lubrication System	Integral	Integral	External	External
Mass Flow Lb/sec (Kg/sec)	18.2 (8.3)	38.6 (17.5)	77.4 (35.1)	18.2 (8.3)
Rotor Inertia Slug-ft2 (Kg-m2)	0.51 (0.69)	0.43 (0.59)	3.02 (4.10)	0.52 (0.70)

Component Characteristics

	V35	V35-85	V250	S35
Plenum	Stainless Steel			
Chassis	Stainless Steel			Cast Iron
Impeller	Stainless Steel		Titanium	Stainless Steel
Seals	Wear-Compensated Segment Carbon			Labyrinth Seals
Bearings	Pre-loaded Angular Contact Bearings			Fluid Film Bearings

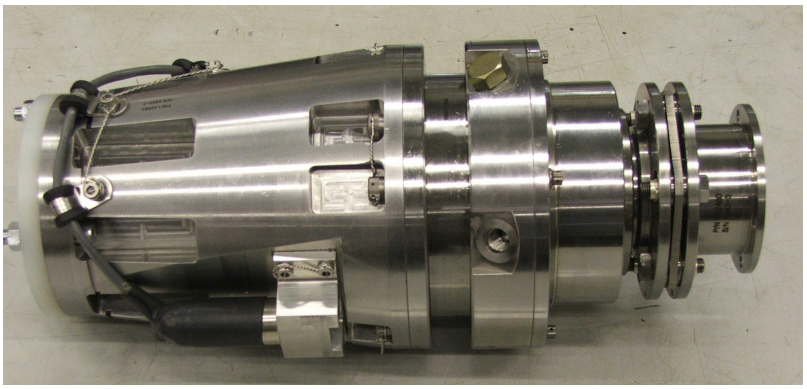
High Precision Torque Measurement System



The VAROC High Precision Torque Measurement System (TMS) provides high speed torque measurement for turboshaft engine testing. It delivers accuracy, repeatability and reliability, and the system can be easily calibrated in the field.

The TMS uses a torquemeter manufactured by Torquemeters LTD. The Torquemeters LTD technology is the state of the art in torque measurement. The heart of the system is a multi-pole sensor, utilizing multiple pick-ups in the form of internally toothed rings. The pick-up/field coils are wound circumferentially giving a toroidal flux path. Radial shaft movement is compensated with the circumferential sensor as an early signal at one tooth is compensated by a late signal from the opposite tooth making the phase output largely independent of shaft radial position. This greatly improves the accuracy in the high-speed drive lines used in turboshaft engine testing.

The integration of the torquemeter to the VAROC dynamometer eliminates external support systems, such as a pedestal or oil supply system. The torquemeter is close coupled to the dynamometer, thereby eliminating the coupling normally used between a torquemeter and dynamometer. Calibration of the system is done with the torquemeter mounted on the dynamometer. Calibration is fast and accurate.



The improved accuracy of the torque system (.5% FS) provides a significant cost savings. Engine acceptance criteria must consider the system accuracy. A narrow tolerance band results in fewer rejections of the items under test. In addition, the ability to calibrate the torque system serves to put to rest any concerns related to test accuracy in the course of engine testing and evaluation of the results. This can save the costs of repeat testing and eliminate the costs spent in defending the test validity. Concerns over test validity can delay repair action and tie up product in long periods of evaluation and resolution. Field calibration and demonstration of an accurate test system saves time and money.

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The Experts in Turbomachinery

★ Worldwide and regional headquarters. We also have sales offices and representatives strategically located throughout the world to support our global clients.

We Offer

- CAE Software
- CAM Software
- Design Audits
- In-house Laboratory Testing
- Manufacturing Services
- Precision Prototypes
- Research and Development
- Scoping Studies
- Specialized Products

Our Focus

- Air Dynamometers
- Compressors
- Fans and Blowers
- Gas Turbines
- ORC Turbine Generators
- Pumps
- Steam Turbines
- Superchargers
- Turbochargers

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