

Concepts **NREC**

The Experts in Turbomachinery

VAROC[®] Air Dynamometers

For load testing gas turbine engines



- Engineering
- Software
- Manufacturing
- Training

Concepts NREC

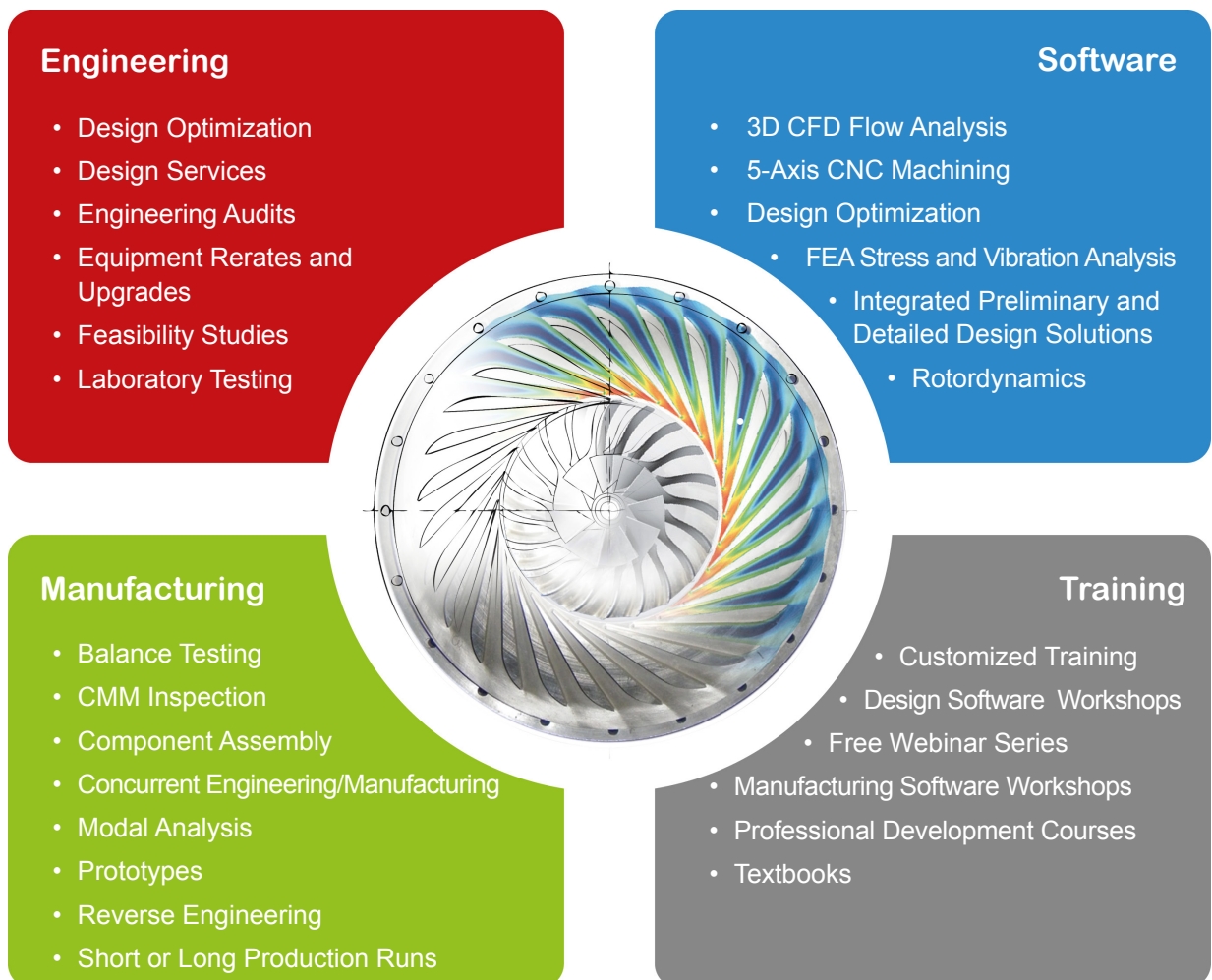
For over 60 years, Concepts NREC has been partnering with the world's leading OEMs to improve the performance and manufacturability of turbomachines. We are the only company in the world whose in-house capabilities span the entire process — from concept through design software, manufacturing, testing, 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.

We are ISO 9001:2008 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.



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.

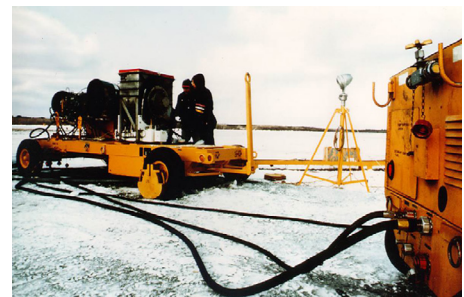
No Complex Water Systems and Support Equipment Needed

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.



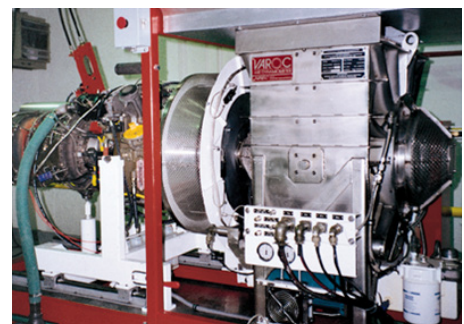
Can Be Used in Fixed Test-Cell Installations or Mobile Field Applications in Any Climate

Using no water and only 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 is compact, lightweight, highly portable, and needs little support equipment, so it can be used anywhere, regardless of climate.



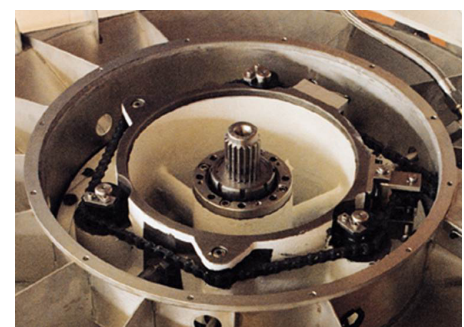
Stable Operation and Precise Control

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 stepping motor and a rugged chain drive. The high inertia of the impeller allows very stable open-loop control even at low loads.



Simple to Operate, Easy to Maintain, and Very Reliable

No special training is required to use a VAROC dynamometer, and the simplicity of the VAROC design substantially reduces maintenance. Moving parts are limited to the impeller, bearings, and the shroud-actuating mechanism. The impeller is supported between rugged oil-damped ball bearings. With minimum regular maintenance, the proven VAROC dynamometer can achieve long overhaul periods with overhauls performed on-condition.



Applicable to a Wide-Range of Engine Types

The VAROC comes in three 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.

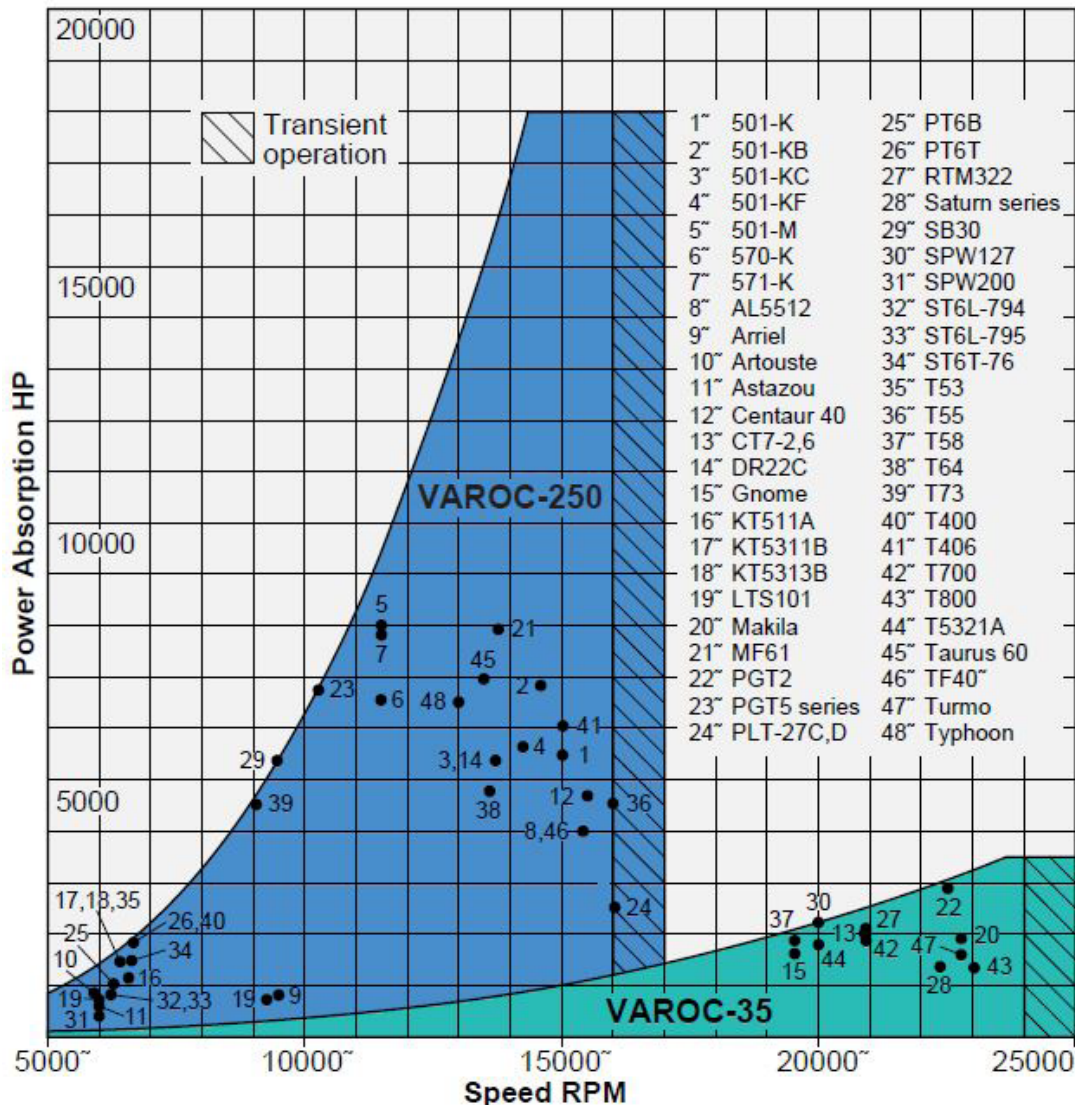
Turnkey Test Packages Available

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.

Dynamometer Operating Envelope



Dynamometer Design Comparison

Dynamometer type	VAROC	Eddy Current	Hydraulic
Working media	● Air	● Electricity/Water	● Water
Environmental risk	● Low	● High	● High
Operating climate	● All	● Limited	● Limited
Speed range	● Low to very high	● Low to high	● Low to high
High-speed gearbox	● None	● Often	● Often
External support	● Minimal	● Complex	● Complex
Installation	● Fixed or portable	● Fixed	● Primarily fixed
Cooling	● Ambient air	● Treated water	● Treated water
System weight	● Light	● Heavy	● Heavy
System size	● Small	● Large	● Large
Operation cost	● Low	● Moderate	● Moderate

The VAROC Air Dynamometer

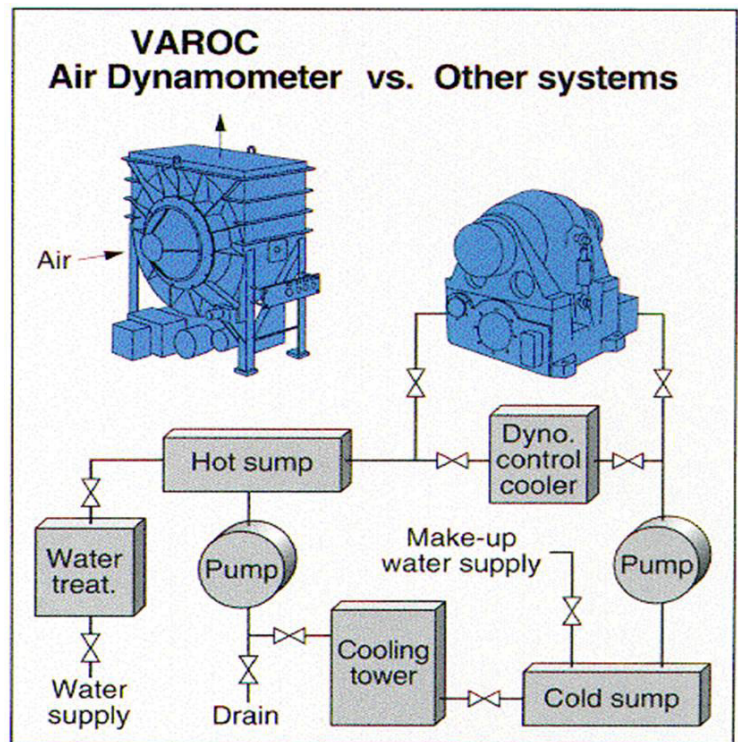
The VAROC uses a unique patented radial-outflow compressor with sliding shrouds that effectively modify the geometry of the flow path to vary engine load. The simple VAROC design provides stable operation over a wide range of speed and power, and permits low weight, small size, minimal maintenance, and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

Eddy Current Dynamometers

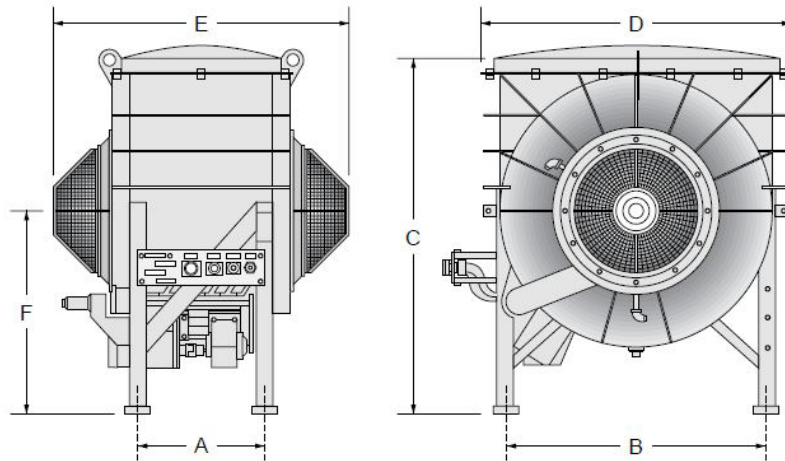
Eddy current dynamometers are large, heavy devices for fixed installations with cooling systems that generally require water treatment. Besides not being portable, eddy current dynamometers are expensive to operate and maintain, and have a relatively narrow operating range which limits the number of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

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.



Specifications



	A	B	C	D	E	F
VAROC -35	13.5	28.7	40.2	35.2	33.3	23.7
Inches (cm)	(34.3)	(72.9)	(102.1)	(89.4)	(84.6)	(60.3)
VAROC -250	24.5	50.5	58.9	60.0	47.6	30.0
Inches (cm)	(62.2)	(128.3)	(149.6)	(152.4)	(120.9)	(76.2)
VAROC -35-85	13.5	28.7	40.2	35.2	33.0	23.7
	(34.3)	(72.9)	(102.1)	(89.4)	(83.8)	(60.3)

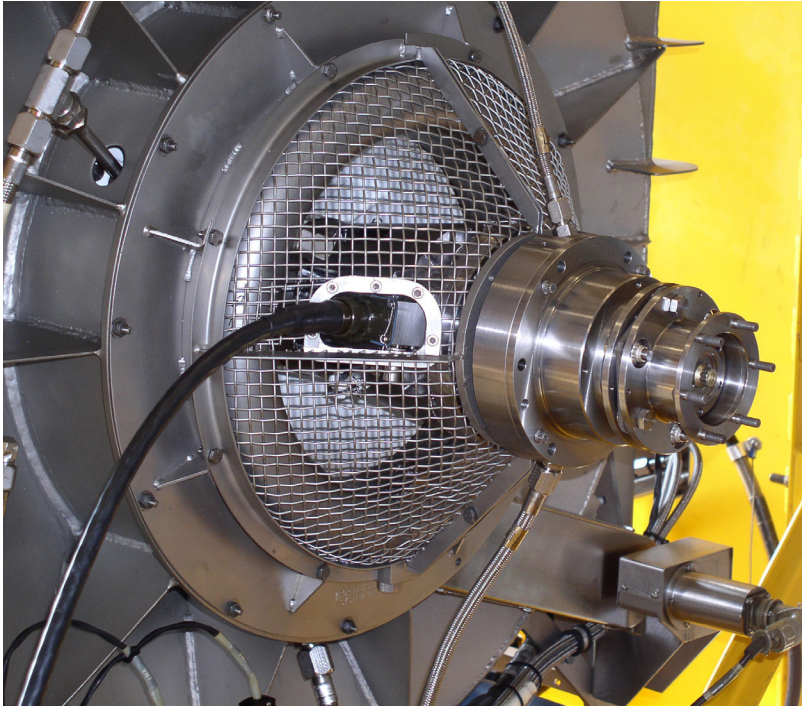
Performance

	VAROC-35	VAROC-250	VAROC-35-85
Speed range RPM	0-24,000	0-16,000	0-24,000
Power range HP (kW)	0-3,500 (0-2,600)	0-18,000 (0-13,500)	0-5,500 (0-4,100)
Weight lbs (Kg)	830 (376)	2,875 (1304)	862 (931)
Operating voltage VAC (Hz)	100-440 (50-60)	100-440 (50-60)	100-440 (50-60)
Integral Lube System	Integral	Optional	Integral
Torque Options	Reaction	Reaction or shaft	Reaction or shaft
Control Options	Manual or automatic		
Mass Flow Lb/sec (Kg/sec)	18.2 (8.3)	77.4 (35.1)	16.56 (17.51)
Rotor Inertia Slug-ft ² (Kg-m ²)	0.5 (0.68)	2.99 (4.05)	0.436 (0.591)

Component Characteristics

	VAROC-35	VAROC-250	VAROC-35-85
Plenum	Stainless steel		
Impeller	Stainless steel	Titanium	Stainless steel
Seals	Wear-compensated segment carbon		
Bearings	Preloaded angular contact ball bearings		

High Precision Torque Measurement System



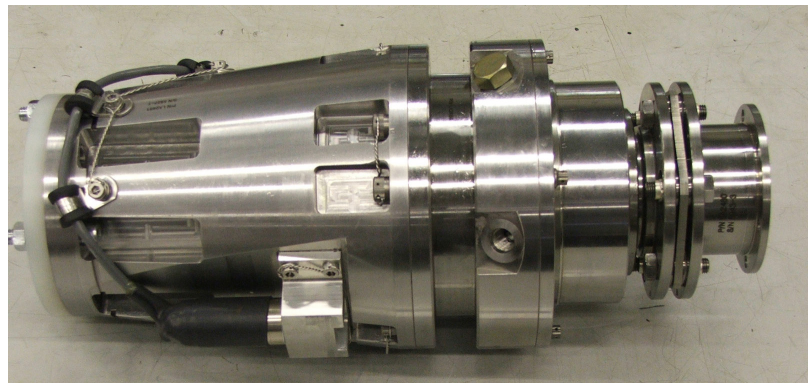
The VAROC High Precision Torque Measurement System (TMS) provides high speed torque measurement for turboshaft engine testing. It delivers accuracy, repeatability and reliability, and the system can be easily calibrated in the field.

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.

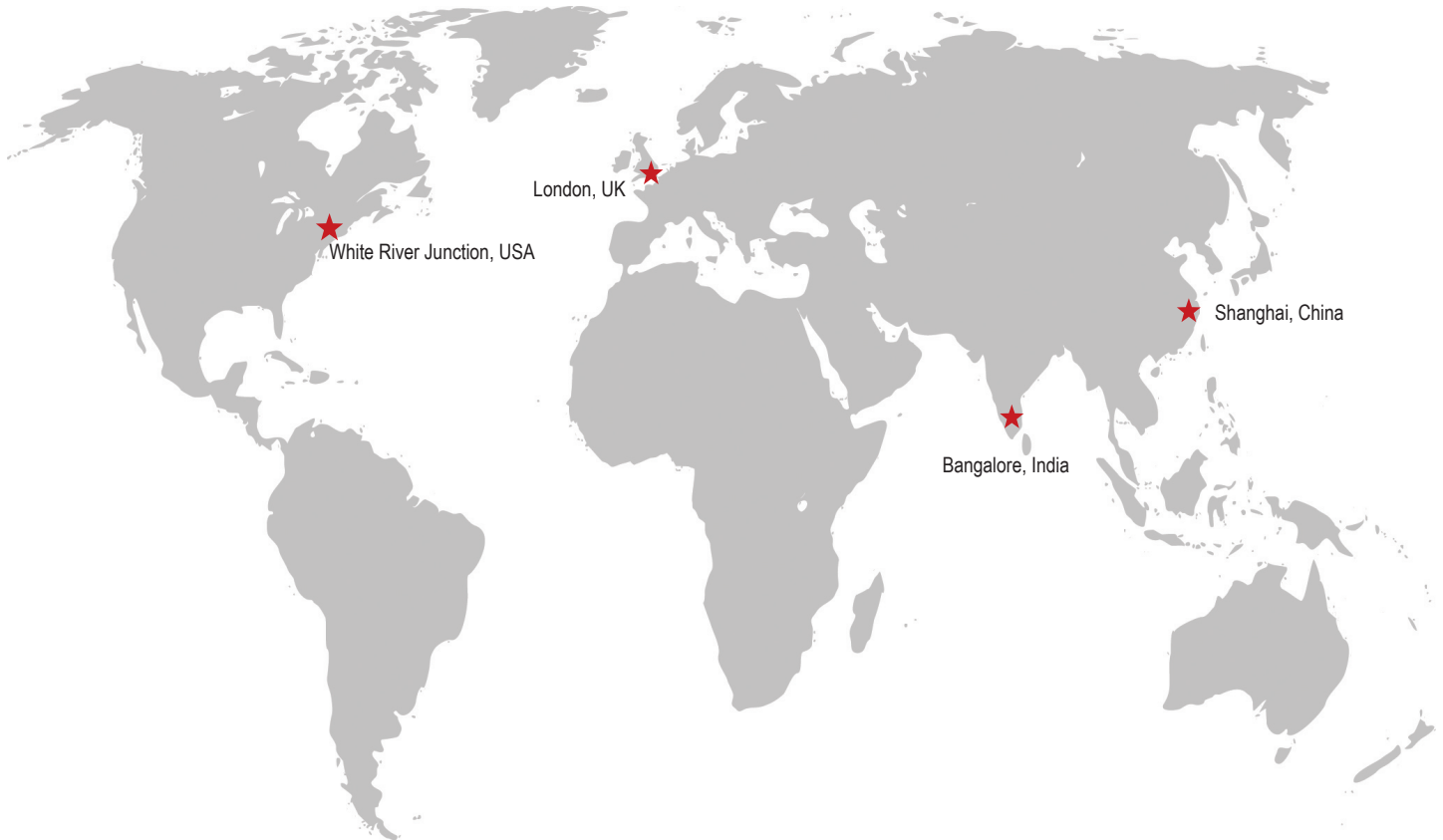
The improved accuracy of the torque system (.5% FS) provides a significant cost savings. Engine acceptance criteria must consider the system accuracy. A narrow tolerance band results in fewer rejections of the items under test. In addition, the ability to calibrate the torque system serves to put to 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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★ 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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