

# Royal Danish Navy Commissions LM500 Test Cell

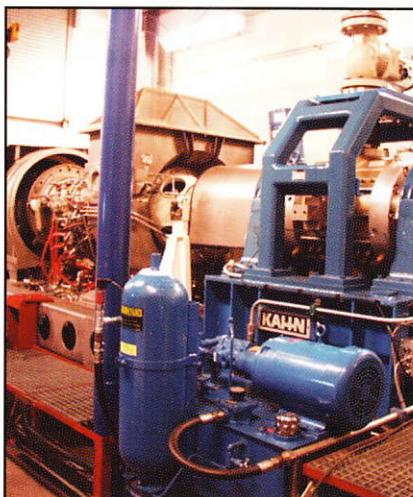
To maintain the combat readiness of its most versatile combatant ship, the Royal Danish Navy recently commissioned a test cell for performance testing of General Electric LM500 marine gas turbines at its Korsør Naval Base.

With 14 ships in service, the Standard Flex 300, or *Flyvefisken Class*, represents the numerically largest class of ships in the Danish Navy. Because of their multi-role design concept, these ships can be configured for a variety of missions, including surveillance, combat, mine laying, mine countermeasures and anti-submarine warfare.

To meet the Navy's requirements for speed and economy, the Standard Flex 300 is equipped with a CODAG power plant, consisting of two MTU diesels and one GE LM 500 rated 4500 kW. The LM500 drives a fixed pitch center propeller through a speed reducing gearbox, while the MTU diesels each drive a variable pitch wing propeller. Derived from the high efficiency TF34 turbofan engine, the LM500 is GE's smallest aeroderivative marine gas turbine.

The new LM500 test cell at Korsør will enable the Danish Navy to perform diagnostic test procedures and verify the performance of the gas turbines after overhaul. This is the first and only test cell in the world built specifically for testing LM500 marine gas turbines. A typical post-overhaul performance test of the LM500 includes operation at partial loads and full power and requires approximately four hours. During the test, more than 35 engine operating parameters are measured and recorded at each operating point.

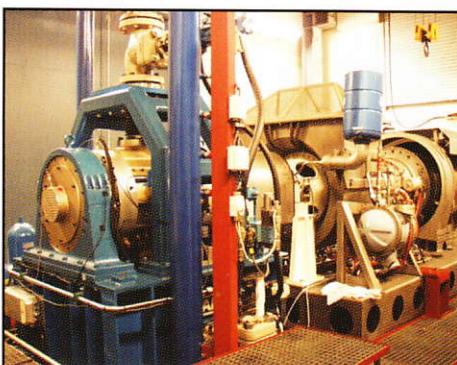
The key element of the new test cell is a Kahn model 108-130 hydraulic dynamometer. Capable of absorbing 12 000 kW at rotational speeds up to 10 000 r/min, the dynamometer is directly coupled to the LM500. Using water as the operating medium, it absorbs and measures the power output of the gas turbine.



A Kahn model 108-130 hydraulic dynamometer, capable of absorbing 12 000 kW at speeds up to 10 000 r/min, is the key element of the Royal Danish Navy's new LM500 engine test cell.

In this particular application, a water flow rate of 136 m<sup>3</sup>/h allows conversion of mechanical energy from the turbine into heat. While operating at the maximum power level of the turbine, the water temperature rise across the dynamometer is 28°C.

Developed for performance testing of industrial and marine gas turbines, the Kahn Series 100 line of hydraulic dynamometers includes eight standard models with power outputs ranging from 4800 to 60 000 kW. With over 25 units in service, the Series 100 are the most widely used high-speed, high-power dynamometers in the world, according to the Wethersfield, Connecticut, U.S.A., company. A compact design and proven reliability have made the Series 100 the choice of many of the world's leading gas turbine manufacturers, research organizations, and turbine overhaul facilities,



The Royal Danish Navy recently commissioned an LM500 engine test cell at its Korsør Naval Base. The LM500 aeroderivative gas turbine is part of the CODAG power plant that powers the Navy's Standard Flex 300 multirole ships.

including ABB Alstom, Argentine Navy, Dresser-Rand, General Electric, ITP, Kawasaki Heavy Industries, Mitsubishi Heavy Industries, NASA, GE Nuovo Pignone, Pratt & Whitney, Rolls-Royce, Royal Danish Navy, SNECMA, U.S. Navy, and Volvo.

The ability to provide highly stable operation and accurate and reliable turbine performance data was a primary consideration in the selection of the dynamometer equipment. To meet this requirement, Kahn supplied its Series 535 closed-loop control system along with the dynamometer. Developed specifically for steady state and dynamic testing of gas turbines, the Series 535 includes a fast response microprocessor-based PID controller and high-performance electro-hydraulic control valves. The system features an overall controller loop time of 12 ms and a valve frequency response in excess of 45 Hz. During initial performance tests when the dynamometer was operating in the speed control mode, the Series 535 provided precise steady state speed control within ±1 r/min.

Another important requirement of the Danish Navy was the capability of the dynamometer to provide quick, safe emergency shutdowns. Equipped with mechanical carbon face seals, the model 108-130 provides positive sealing between the water and bearing compartments under all operating conditions, including zero speed. This feature is particularly useful during emergency shutdowns, where it is critical to reduce speed quickly by applying full load until the turbine reaches zero speed.

To reduce setup time for future turbine test applications, the Royal Danish Navy also required that the dynamometer could be driven in either direction of rotation from either end of the shaft without the need for repositioning of the equipment. Bidirectional operation is a standard feature of Kahn's Series 100 dynamometers. It eliminates complicated setup and alignment procedures associated with unidirectional dynamometers.

The new facility will serve as an important quality assurance tool which will enable the Navy to diagnose the conditions of its engines and to verify their performance after overhaul under actual operating conditions. ♦

# HYDRAULIC DYNAMOMETERS FOR LOAD TESTING PRIME MOVERS

Specializing exclusively in dynamometers and associated equipment, Kahn introduced the flange trunnion mounted hydraulic dynamometer over forty years ago. Since then, significant advances have been continuously incorporated, particularly in the areas of higher operating speeds and increasingly sophisticated automatic controls. The result has been a widely acknowledged leadership in product performance and reliability. Capable of delivering up to 80,000 hp (60,000 kW) and operating at speeds up to 60,000 rpm, Kahn dynamometers provide full power absorption in both directions of rotation. Depending on individual test needs, they are equipped with either manual or closed loop automatic feedback controls and are available for a wide range of applications.

## ■ AEROSPACE

Inherent low inertia and quick transient response make Kahn Series 101, 102 and 404/405/406 dynamometers ideal for load-testing turboshaft engines, light turboprop engines, APUs, PTOs and aircraft accessory gearboxes. In many applications, time-consuming coupling alignment is eliminated by mounting the dynamometer directly to the engine power output pad. Adapters and lightweight engine skids for popular APUs, and for turboshaft and turboprop engines are available. Twenty models from 70 hp (52 kW) to 5500 hp (4100 kW).

## ■ TURBINES

Introduction of the Kahn Series 400 cavitation-free design was a giant step forward in high-speed, high-power hydraulic dynamometers. Intended primarily for long-term endurance and production testing of gas and steam turbines, these Kahn dynamometers offer many significant advantages, of which the most important is virtually unlimited service life due to cavitation-free smooth-disc power elements. Seven models from 7000 hp (5200 kW) to 80,000 hp (60,000 kW).



Kahn Model 109-200  
Hydraulic Dynamometer  
with control cabinet

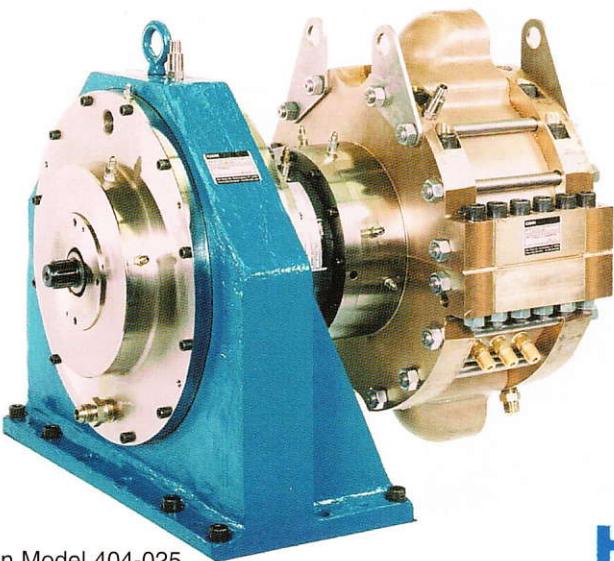
Also in the field of gas and steam turbines, Kahn Series 100 dynamometers offer a cost effective alternative for development and production testing. Features include hardened stainless steel power elements and a self-centering polygon connection between shaft and rotor discs that permits quick overhaul by eliminating shrink fits. Seven models from 6400 hp (4770 kW) to 80,000 hp (60,000 kW).

## ■ DIESEL

Kahn Series 302 dynamometers cover a wide range of low-speed, high-torque test applications including marine diesel engines, large electric motors and heavy turboprop engines. Conservative design and rugged construction ensure long service life with minimum maintenance. Three models from 2200 hp (1610 kW) to 6600 hp (4840 kW).

## ■ AUTOMOTIVE

Kahn Series 301 hydraulic dynamometers for load-testing automotive diesel and gasoline engines are now available with a programmer for fully automatic control of multi-step engine test cycles. Lightweight, flange trunnion mounted design permits quick no-alignment-needed installation directly on the engine flywheel housing. Tough nickel-aluminum-bronze power elements insure superior service life. Modular construction permits replacement of the carbon face seal in less than an hour. Adapters are available for popular engines. Four models with power ratings from 400 hp (298 kW) to 1350 hp (1000 kW).



Kahn Model 404-025  
Dynamometer with Flywheel

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**HYDRAULIC DYNAMOMETERS** **KAHN**  
KAHN INDUSTRIES INC.