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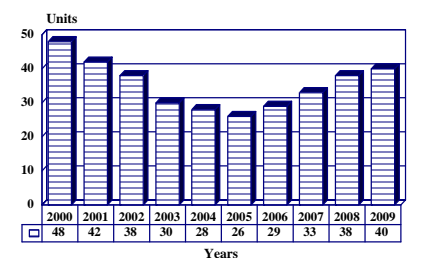
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Alstom Hurricane - Archived 10/2001

Outlook

- Alstom's entry in the 1-3 MW gas turbine sector is launched with high expectation of sales in power projects worldwide
- Mechanical drive applications also hoped to emerge, but at a slower pace than for power generation

10 Year Unit Production Forecast
2000 - 2009



Orientation

Description. Simple-cycle, single-shaft industrial gas turbine machine in the 1.5-1.75 MW class, of compact design. A two-shaft version has been projected to be made available at a later date.

Sponsor. The Hurricane gas turbine machine was privately developed by the prime manufacturer.

Contractors/Manufacturers. The prime manufacturer is Alstom Power (formerly known as European Gas Turbines Ltd); Lincoln, UK.

Power Class. 1.5-1.75 MW (2,011-2,345 hp).

Status. In production.

Total Produced. As of 2000, an estimated 40 machines had been assembled.

Application. For single-shaft machines: electric power generation. For two-shaft machines: mechanical drive, including gas compression and pumping.

Price Range. Estimated in 2000 US dollars at \$1.25-\$1.35 million for a gas turbine-equipped electric power generation package.

Competition. The Hurricane fits into the power band between the Dresser-Rand Turbo Products Division KG2-3C and the Dresser-Rand Turbo Products Division KG2-3E and Nuovo Pignone PGT2.

Technical Data

Design Features. Design features of the Alstom Hurricane gas turbine machine are as follows:

Compressor. A single-stage centrifugal compressor design, featuring backward-swept vanes, producing a pressure ratio of 9.2:1; efficiency is approximately 82 percent. Impeller has 13 full vanes and 13 splitter vanes. Compressor is machined from solid titanium alloy forging.

Combustor. Horizontally mounted single lean burn reverse-flow combustion chamber, designed for liquid or dual fuel systems, with automatic changeover from

primary to secondary fuel across entire load range. Provision for water injection for NO_x abatement. Development continues for a dry low NO_x burner.

Turbine. Two-stage overhung transonic turbine – with first row stator air-cooled, and second-stage rotor and both rotating rows of blades being uncooled; first rotating stage made of MA6000 alloy with NiCrCoAlY coating. First stage of turbine supplies only the compressor drive power; second stage supplies only the output power. Stage 1-2 nozzle vanes are cast from IN939 and have Sermetel J coating. Turbine speed

approximately 27,245 rpm. TIT approximately 2,073°F (1,134°C).

Bearings. Rotor supported by three-lobe bearings, with rotor axial position maintained by use of tilting pad thrust bearing.

Control System. A programmable Rustronic Division-designed microprocessor control system, with plant interface, is standard.

Dimensions. The approximate dimensions of the Alstom Hurricane gas turbine machine are as follows (basic machine)^(a):

	<u>Metric Units</u>	<u>English Units</u>
<i>Length</i> ^(b) :	5.75 m	18.8 ft
<i>Width, Packaged:</i>	2.0 m	6.5 ft
<i>Height:</i>	2.38 m	7.8 ft
<i>Weight</i> ^(c)		
<i>Engine/Gearbox:</i>	3,000 kg	6,600 lb
<i>Package:</i>	13,500 kg	29,750 lb

^(a)Overall dimensions include generator unit and baseplate.

^(b)Not including exhaust.

^(c)Packaged weight can vary depending on generator or alternator selected.

Performance. The approximate performance parameters of the Alstom Hurricane gas turbine machine are as follows (ISO Base Rating, burning distillate fuel, residual fuel ratings):

	Output	Base LHV	Pressure	Exhaust	EGT
	<u>(kW)</u>	<u>(kJ/kWh)</u>	<u>Ratio</u>	<u>Flow</u>	<u>(°C)</u>
				<u>(kg/sec)</u>	
Hurricane	1,630	14,687	9.2:1	7.4	602

The Hurricane has a thermal efficiency of 25.5-26.5 percent.

Variants/Upgrades

In 1997, EGTL was reportedly considering a two-shaft version of the Hurricane machine. Information regarding what designation EGTL would give to that variant or when the variant would emerge was not provided.

Program Review

Background. In May 1987, then-Ruston Gas Turbines (at the time part of General Electric Company plc [GEC] of the UK) announced details of its next-generation models. Two new engines, the Hurricane (formerly the RH) in the 1.5-2.0 MW class and the Typhoon (formerly the RM) in the 3.5-4.5 MW class, were designed to provide compact, lightweight gas turbine machines with higher efficiency and lower cost than machines then available. Additional features are low fuel consumption, ease of maintenance, and rapid-start capability. With the two new models, Ruston expanded its product line at the lower end of its product range. The Hurricane is expected to be the successor to the venerable (but no longer in series production) EGTL

TA1750, of which an estimated 410 machines were built.

The Hurricane is designed for liquid fuel or dual fuel systems, with automatic changeover from primary to secondary fuel across the entire range load. While the machine's combustion chamber was designed to achieve low NOx levels, a water injection system is provided in the event that requirement is needed.

A microprocessor control system with plant interface provides start/stop sequencing, speed control, temperature monitoring, fault monitoring, and annunciation. Operator information and fault indication are displayed on the system's display unit.

Alstom Hurricane Sales/Applications. In early 1988, it was announced that EGTL had sold its first Hurricane machine to I/S Vestkraft of Denmark for an extension of the district heating plant at Ringkobing, in the county of Jutland. The gas turbine package was to drive a GEC Unipak 1,500 rpm electric generator, with the gas turbine exhaust ducted into a supplementary-fired Danstoker heat recovery boiler. The facility's maximum overall efficiency was projected to be in excess of 90 percent. However, due to a change in the

requirements of the Danish plant, whereby more power and less heat was required, the order was later changed to a 6 MW EGTL Tornado machine.

In April 1990, Ruston Gas Turbines Inc indicated that the first production-standard Hurricane machine for a cogeneration project in the UK would be ready for shipment in 1991, with on-line status in 1992. The customer was later identified as the new Westminster and Chelsea Hospital in London.

Funding

Funding specifically pertaining to the Alstom Hurricane has not been identified.

Recent Contracts

No major commercial or military contracts specifically pertaining to the Hurricane industrial gas turbine have been announced in the recent past.

Timetable

Among the major events in the Alstom Hurricane program are the following:

<u>Month</u>	<u>Year</u>	<u>Major Development</u>
May	1987	Ruston announces Hurricane project
Early	1988	First order announced (order later changed for a different machine)
Early	1990	First UK order placed; EGTL formed
	1991	First Hurricane machine shipped to London
Mar	1999	GE, Alstom disband EGT N.V., with GE taking back 20+ MW distribution
Thru	2009	Continued production/availability of Hurricane machine projected

Worldwide Distribution

As of the start of 2000, an estimated 40 machines had been built, including those for bench testing, proof-of-concept, and shipment. The launch order was for an installation in the **UK**.

Forecast Rationale

The Hurricane machine became EGTL's modern entry in the 1-3 MW gas turbine sector. With series production of the older TA2500 and TA1750 having ended, the Typhoon and Hurricane machines were seen as being a definitive sign that EGTL (now Alstom) had chosen to remain an active market participant at the low end of the power spectrum. The marketing arrangement with GE is expected to give the Hurricane more visibility in power projects worldwide.

Given Alstom's reputation of building rugged, virtually maintenance-free machines, the Hurricane should eventually begin attracting orders, especially in the

emerging market for small industrial combined heat and power schemes. Its main customers are likely to be smaller industrial sites such as breweries, and self-contained facilities such as hospitals, universities and other medical facilities, especially in Europe and Africa.

Much of the Hurricane's sales efforts should be directed at the market and customers of the TA2500 and TA1750.

In the decade extending through the year 2009, we project that 360-or-so Hurricane machines will be built, either by Alstom or undesignated associates/licensees.

All are expected to be for power generation (including CHP schemes). For the near term, sales are expected to be concentrated in the CHP marketplace.

Offering a viable alternative to the Dresser-Rand KG2-3C and KG2-3E, and considering the interest in the 1-3 MW power band, the Hurricane should be of great interest to operators looking for a power source of less than 2 MW that is based on existing technology.

Furthermore, the Hurricane is probably available at a reasonable price by now, considering market entry time and the technology available to Alstom. Even though sales of the Hurricane have been sluggish thus far, we expect sales to begin to accumulate soon for IPP projects. Also, the deregulation of the electric market is giving a strong boost to small- to medium-size generators, enhancing the outlook for Hurricane.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR PRODUCTION

Engine	(Application)	thru 99	<u>High Confidence Level</u>				<u>Good Confidence Level</u>				<u>Speculative</u>			Total 00-09
			00	01	02	03	04	05	06	07	08	09		
ALSTOM POWER HURRICANE (a)	GENERATION	40	48	42	38	30	28	26	29	33	38	40	352	
Total Production		40	48	42	38	30	28	26	29	33	38	40	352	

(a) Historical production includes T&E and bench-test units.