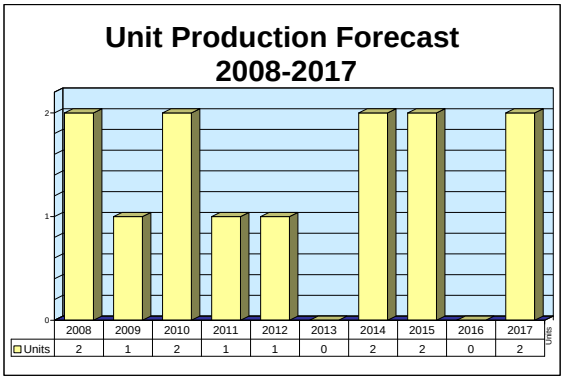
Peter Brotherhood Steam Turbines - Archived 3/2009

Outlook

- Only a small percentage of the company's steam turbine production has been for combined-cycle installations of 20 MW and larger
- PBL's 20-40-MW steam turbines are highly capable machines for use in smaller combined-cycle installations
- Limited production of PBL's machines in the 20-49-MW band is projected



Orientation

Description. Steam turbines with power outputs up to 40 MW, including multi-stage machines in a wide variety of configurations, such as backpressure, condensing, extraction, and mixed pressure.

Note: *This report focuses on steam turbines of 20 MW and larger used in combined-cycle installations. Material about smaller machines is included for reference purposes.*

Sponsor. The steam turbines were privately developed by the prime contractor.

Power Class. Single-stage turbines range in power output up to 2.5 MW; multi-stage turbines range up to 40 MW.

Status. All known steam turbines are still in production or are considered imminently production-viable.

Total Produced. At the start of 2008, Peter Brotherhood Ltd had installed more than 700 steam turbines worldwide, including machines in combined-cycle installations. At least 525 machines have been installed in sugar mills worldwide. The total number of machines used in combined-cycle installations has not been released.

Application. The steam turbines are used in the power generation, sugar, petrochemical, and marine industries, among others. Applications include energy-from-waste, district heating, combined-cycle, and renewables, in addition to FPSO (floating production storage and off-loading) vessels.

Price Range. Each PBL steam turbine is made to meet a customer's specific requirements, and therefore prices vary.

Competition. Steam turbine machines from several manufacturers worldwide compete with the PBL line, above and below the 20-MW power output rating.

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Contractors

Prime

Peter Brotherhood Ltd	http://www.peterbrotherhood.co.uk, Werrington Pkwy, Peterborough, PE4 5HG United Kingdom, Tel: + 44 1733 292200, Fax: + 44 1733 292300, Email: sales@peterbrotherhood.com, Prime
Peter Brotherhood Southern Africa (Pty) Ltd	http://www.peterbrotherhood.co.uk, PO Box 1819, Halfway House, Midrand, 1685 South Africa, Tel: + 27 011 805 2850, Fax: + 27 011 805 2850, Email: linton.lake@xsinet.co.za, Packager

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Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 22 Commerce Road, Newtown, CT 06470, USA; rich.pettibone@forecast1.com

Technical Data

Peter Brotherhood's turbines are tailor-made for each application. Use of modular construction enables standard components to be assembled in various configurations for any application; included in a complete package are the turbine, gearbox, alternator, full instrumentation, control and monitoring systems, and associated auxiliary equipment. Completed units are mounted on a fabricated baseplate so that they can be shipped to site in assembled form.

The steam turbine machines are manufactured in Peterborough, U.K.

Design Features. Among the design features of the PBL line of steam turbines are the following:

Rotor. The rotor is machined from a solid alloy steel forging. The integral thrust collar and journals are precision-ground after chrome plating.

Blades. Over the past few years, the company has introduced new high-reaction blade designs whose overall turbine efficiency has been improved by as much as 4 percent. The company is also doing research into new, twisted and tapered blade designs that could result in additional efficiency improvements.

Glands. The steam, exhaust, and inter-stage gland packings are a spring-loaded, labyrinth type manufactured in stainless steel.

Bearings. Thrust bearings are the tilting pad type, complete with surge pads, with the thrust collar being integral with the rotor shaft. The bearings are usually white metal-lined steel shells of offset design for improved damping and stability.

Condenser. The standard condenser is a multi-pass, water-cooled shell and tube design, either supplied as a separate unit or integrated into the turbine baseplate. The tube bundle is sized to minimize pressure loss and condensate undercooling. The shell is of welded steel, with the exact material selected for each application; it is fitted with tubes expanded or packed into the tubeplates.

Gearing. The speed-reduction unit, located between the turbine and the machine to be driven, is housed in a cast-iron gearbox. The gears are single-reduction, single-helical design, with both the pinion and gear wheel in steel forgings. The teeth are hardened by nitriding and (where required) are precision ground (Maag process).

Lubrication. Forced lubrication is provided by a gear-type oil pump driven from the gearbox. The oil is contained in the turbine baseplate and passed through a shell and tube cooler, then through a duplex cartridge-type filter to the bearings and gear train. A completely separate lubrication oil console can be supplied in accordance with customer specifications or to the requirements of the API 614 standard.

Control/Monitoring Systems. The steam turbines have either electronic or mechanical speed governing devices; the turbine speed can be either remotely or locally regulated. Systems for monitoring vibration and axial displacement of the rotor shaft can also be incorporated.

Instrumentation. The level of instrumentation is designed to suit the needs of each individual order. Instrumentation can range from a simple local control

panel to a sophisticated computer-based monitoring system remote from the turbine.

Combined Stop and Emergency Valves. PBL stop and emergency valves provide a swift and safe shutdown of steam turbines. Its oil-operated stop and emergency valves have been fitted to more than 1,000 turbines supplied to over 80 countries.

During normal turbine operation, PBL stop and emergency valves are held open against spring pressure by hydraulic pressure from the turbine control oil system. Loss of oil pressure trips the valve, which closes to give a steam-tight seal of the turbine steam inlet in approximately 0.5 seconds. Parameters include the following:

- Valves sizes: 4-10 inches (101-254mm) nominal bore
- Operating temperatures: Up to 500°C
- Steam pressures: Up to 60 bar(g)
- Oil pressure: 6 or 14 bar(g) (other pressures can be accommodated)
- Valve body: Cast alloy steel with raised face inlet and outlet flanges

Valves are supplied with a steam strainer, drain leak-off connections and manual exerciser. Provision can be made for spring supports and limit switches if required.

Every valve is subject to an operational test before shipment. A material test certificate for the valve body and cover, and a hydraulic test certificate are supplied with each valve.

Emergency Trip System. An emergency trip system is fitted to each turbine to close the combined stop and emergency valve rapidly. Any fault condition will cause the master trip valve to initiate this action.

20-MW backpressure turbine installed in a sugar mill in Zimbabwe.

Source: Peter Brotherhood Ltd

Variants/Upgrades

Condensing Turbines. Condensing steam turbines are used widely where there is no requirement for process steam. The total steam flow passes through the turbine and is exhausted to a condenser, either built into the turbine baseplate or external.

Extraction Turbines. Extraction condensing turbines are preferred when there is a need for process steam at relatively low pressures. Those turbines often have a large operating envelope within which the demands for electricity and steam can be balanced.

Backpressure Turbines. Backpressure turbines are normally used when process steam is needed, at a specific pressure, as well as electricity. In many applications, backpressure turbines can replace the function of a pressure-reducing valve when boiler pressure is much higher than the process pressure.

Extraction Backpressure Turbines. Extraction backpressure turbines are used to produce at two levels, and are thus excellent where manufacturing processes require steam at both high and low pressures.

Program Review

Background. Established in 1867, Peter Brotherhood Ltd designs, manufactures, and packages a wide range of gas compressors and steam turbines for power generation, the sugar industry, the oil and gas industry, the petrochemical industry, and the marine sector. Applications for these steam turbines span the gamut from energy-from-waste, district heating, and combined-cycle to renewables and FPSOs. In 1983, Peter Brotherhood was acquired by Thermo Electron Corp.

In 2003, Thermo Electron sold Peter Brotherhood to a group consisting of a company team, Barclays Bank and Thermo Electron, which is continuing to support the business by retaining a stake in the new company. There were no changes to the company's management or workforce as a result of the new ownership.

Peter Brotherhood's industrial turbine offers a modern plant and systems, a compact turbine, an advanced turbine blade, and overall turnkey plant responsibility. It uses high-end computer-aided design (CAD), finite element analysis, and computation fluid dynamics (CFD) packages during the design process, reportedly to ensure the high performance and high standards of its products.

In addition to steam turbines, Peter Brotherhood's products and services include gas compression systems, wind turbines, special-purpose machinery, special gearboxes, plant re-engineering and refurbishment, plant and machinery maintenance and spares, cogeneration of heat and power (CHP) solutions, and subcontract manufacturing services and machining.

In 1975, an agreement was signed with Thermo Electron of Boston, Massachusetts, to supply the U.S. market.

As environmental concerns continued to mount during the 1970s, the company repositioned itself to offer its expertise in broader markets. Since that time, it has supplied steam turbines to exploit the energy potential of mine, refuse, sewage, and waste gases from offshore and petrochemical installations and other alternative fuels. The company has also produced gas compressors for use in refinery, petrochemical, and offshore installations, capitalizing on concern over protecting the environment.

The steam turbines include both single- and multi-stage machines, with the single-stage units – backpressure and condensing machines – available in power ranges of up to 2.5 MW. The larger turbines are of the multi-stage type, offered in a backpressure, condensing, extraction and mixed-pressure configuration, and are available up to 40 MW.

The turbines are manufactured to certified ISO 9001 and ISO 14001 standards, as well as common industry and API quality standards. The company states that its products are in compliance with DNV, Lloyd's, Bureau Veritas, and other international organizations of quality verification.

It should be noted that Peter Brotherhood purchases its steam turbine alternators from a variety of leading suppliers. In the compressor arena, it has teamed with Sullair of the United States and Mannesmann Demag of Germany.

Peter Brotherhood Southern Africa (Pty) Ltd was established to serve most of the countries that make up the SADC (Southern African Development Community) region. Those countries include Angola, Botswana, Congo, Lesotho, Malawi, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia, and Zimbabwe.

Applications and Experience. PBL has considerable experience in steam turbine systems for combined-cycle and cogeneration, district heating, industrial processes, sugar mills, oil and gas production, refineries, petrochemical plants, heat recovery, and energy-from-waste installations.

In the vast majority of those applications, the prime requirements are high reliability, low maintenance, efficient performance, and a rapid return on the capital investment.

Combined Cycle and Cogeneration. Significant energy savings can be achieved from systems designed for the cogeneration of heat and power. It is possible to

achieve a thermal utilization of over 80 percent with a well-matched, optimized system.

In Australia, the Bulwer Island Energy Partnership (BIEP) selected PBL to improve the overall efficiency of its cogeneration scheme at BP's Brisbane oil refinery. BIEP contracted the company to design, manufacture, install, and commission a 7-MW mixed-pressure turbine generator set with its own condenser and control panel.

Power Generation. Slough Trading Estate, founded in 1920, was the U.K.'s first business park, and now encompasses over 700,000 square meters of business premises.

At the Slough Trading Estate, PBL was chosen to supply an 8.1-MW turbine generator to replace a 40-year-old 6.0-MW machine because it could engineer the set to fit into the space of the old unit. The company was also able to install and commission it quickly, despite needing to modify the existing foundations and pipe work and install new cooling water pumps.

Following the success of that project, PBL was awarded a follow-on contract to provide a 12.7-MW turbine generator for Slough Heat and Power to supply electricity to the national grid.

Funding

It is unknown whether Peter Brotherhood Ltd wholly developed its steam turbine line with internal resources or whether outside funding was also utilized.

Contracts/Orders & Options

Contractor	Award (in millions)	Date/Description
Peter Brotherhood Ltd	GBP2 million ($3.95 million)	Dec 2006 – Portuguese company Energetus has placed a GBP2 million order with U.K.-based engineering company Peter Brotherhood Ltd. to design and manufacture a 10.75-MW turbo-generator set for the Central Biomassa Terras de Santa Maria biomass-fired power plant in Portugal.

Timetable

Month	Year	Major Development
	1867	Company established as an engineering and millwright business
	1906	Company moves from London to Peterborough
	1914	Military equipment production taken up for the Army
	1947	New range of turbo-alternator sets developed for the marine industry
	1958	New range of horizontal, balanced-opposed reciprocating gas compressors introduced
	1975	Agreement concluded with Thermo Electron for penetration of U.S. market
	1983	PBL becomes part of Thermo Electron group
Aug	2000	20-MW PBL steam turbines ordered for sugar mill in Zimbabwe
Nov	2000	PBL awarded contract for steam turbine in France
	2004	Thermo Electron sells Peter Brotherhood to a team consisting of Barclays Bank and Thermo Electron
Thru	2017	Continued production/aftermarket support of PBL steam turbines projected

Worldwide Distribution/Inventories

As of 2008, Peter Brotherhood Ltd had installed more than 700 steam turbines worldwide, including machines in combined-cycle installations. At least 525 machines were installed in sugar mills worldwide. The number of steam turbines of 20 MW and larger manufactured by PBL for combined-cycle installations has not been released.

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Forecast Rationale

Although Peter Brotherhood Ltd (PBL) continues to market its steam turbines to a number of different industries for power generation purposes, we believe that only a small percentage have gone into combined-cycle installations. Its overall steam turbine line has sold in relatively modest quantities, not only in Asia and Australasia, but also in the Middle East and even Central/South America.

Since Peter Brotherhood's traditional strength is in multistage steam turbine machines up to 40 MW, independent power producers (IPPs) continue to consider PBL's steam-turbine-equipped combined-cycle machines for inclusion in their portfolios, especially because PBL's ability to quickly tailor steam turbines to customers' needs will continue to be an appealing sales tool. Additionally, its ability to provide a total package of turbine, generator, and control systems, as well as undertaking all necessary installation and commissioning work, should continue to generate interest on the part of potential customers.

Although PBL's steam turbines have gained a foothold in the FPSO arena, the machines have tended to be less than 20 MW, generally between 3.75 and 12 MW. It is conceivable, however, that orders could arise for FPSO machines between 20 and 25 MW.

Our forecast for 2008-2017 calls for production of 13 PBL steam turbines in the power band 20 to 49 MW for use in combined-cycle installations. It should be noted that while the company will manufacture a much greater number of steam turbines under 20 MW, it is unlikely that many of those smaller machines will be for traditional gas turbine/steam turbine combined-cycle installations.

We expect that all 13 PBL steam turbines will be for operation in Europe and Africa.

Note: *PBL's steam turbines represented in the chart below have a maximum power output of 40 MW.*

Ten-Year Outlook

ESTIMATED CALENDAR YEAR UNIT PRODUCTION

Designation or Program	High Confidence					Good Confidence			Speculative			
	Thru 2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
Peter Brotherhood Ltd												
Peter Brotherhood Steam Turbine Series <> MW 20.0 to <50.0 <> Combined-cycle Generation												
	700	2	1	2	1	1	0	2	2	0	2	13
Total	700	2	1	2	1	1	0	2	2	0	2	13