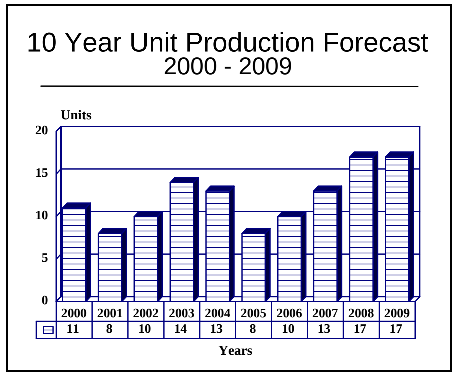
WH Allen Steam Turbines - Archived 7/2001

Outlook

- Strongest experience is in the smaller end of the scale
- Potentially suited to take advantage of emerging trend for distributed power generation
- Power gen products only range up to about 60 megawatts
- WH Allen also makes turbines for mechanical drive applications



Orientation

Description. The Allen line of steam turbines includes single- and twin-cylinder arrangements, with backpressure and condensing models, and with or without extraction or induction.

Contractors/Manufacturers. The prime contractor is:

Corporate/Head Office
Allen Power Engineering Ltd
Allen Steam Turbines
NEI House, Regent Centre
Newcastle-upon-Tyne NE3 3SB, UK
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Note: WH Allen and its predecessors developed the steam turbine line prior to its purchase by Rolls-Royce plc.

Production Locations

Production of the Allen steam turbines takes place in Newcastle-upon-Tyne, UK, and in Calcutta, India.

Associates/Licensees/Packagers. Recent and current Allen-allied firms on the Allen line of steam turbines include the following:

- APE Bellis India Ltd.; Bhadreswar Works; Calcutta, India
- Dedini SA Metalurgic; Rio de Janeiro, Brazil

Total Produced. Most of the Allen steam turbines have been sold to power generation installations. Only part of the machines are in mechanical drive or industrial use. However, it is unknown how many of the generator installations are specifically in combined-cycle use today. While the company's overall production of steam turbines tas of the start of 2001 is estimated at slightly in excess of 500 machines worldwide, no verificable data is available with which to ascertain the number of those machines installed in combined-cycle facilities.

Power Class. The power output of this steam turbine series is 2 MWe to 50 MWe.

Application. Allen steam turbines are used for industrial and process applications, industrial combined heat and power systems, cogeneration systems, and power generation plants associated with either district heating or power generation from waste, non-fossil fuels or gases.

Price Range. No pricing information is available on a general basis, with each application's prices based on the unit's (units') location, use, composition of the equipment, operating cycle, and fuel used.

Design Features

General ("H" Series). The Allen "H" Series of steam turbines has the following basic characteristics and componentry:

- Low-reaction state construction
- Downward or upward exhaust end casing
- Skid-mounted for ease and speed of installation
- Multiple control valves for maximum part load efficiencies
- Turbine thermal growth accommodated through precision axial and radial slides
- Up to 12 states in single-casing units
- Combined stop and emergency valve, produced with on-line trip testing and valve facilities
- Modularized standard lube and control oil system

Specific component availability is as follows:

Component	Availability
Tip Leakage Control	Standard
Nozzle Control	Standard
Pass Out Design	Available
Bleed Connections	Available
Remote/Automatic Starting	Available
Electronic Governing For Load & Pressure Control	Standard
Electronic Overspeed Trip With On-Line Trip Testing	Standard
Shaft Displacement Vibration Probes	Standard
Casing Differential Temperature Monitoring	Standard

An additional feature of the "H" Series in the modular range requires the main turbine assembly to be divided into standard modular elements arranged in a matrix. Standard modular elements in this form of construction are steam-end cylinders, pass-through sections, back-pressure exhaust-ends, high-pressure exhaust-ends, single-flow and double-flow condensing exhaust-ends, and bearing pedestals.

The Allen "H" series of turbine is available in single or twin configurations, and offers the option of controlled extraction, induction and uncontrolled extractions to suit the system requirements. The twin-cylinder designs give the turbines the ability to apply large power station ideology to compact generating stations.

Performance. "H" Series normal operating range output is as follows:

Parameter	Output
Max. inlet steam condition	120 bar / 350ºC
Max. backpressure	15 bar
Speed Range	11,200-4,400 rpm

Casing. Turbine cylinders, the inlet-end castings, backpressure exhaust-end castings, and, where necessary, pass-through sections are welded together before machining. Exhaust ends for condensing turbines are manufactured from cast-iron or SG iron, and are flanged and bolted to the high-pressure end prior to machining the horizontal joint face.

Blading. Allen steam turbine blading uses constant-section low-reaction blades. The development pattern has been to increase the quantity of steam put through a given frame size of turbine. This results in longer blades to accommodate the mass flow, which leads to higher efficiencies because blade losses occur mainly at the tip and root. The use of a smaller frame size for an application also results in lower parasitic losses.

Allen developed quasi three-dimensional flow analysis programs to analyze turbine stages. The result is a more complex blade with extreme changes in profile over the length, low reaction at the root, and a tip section having a larger amount of reaction.

Improved manufacturing processes for static diaphragm vanes compliment blade improvements. The diaphragm assembly is completed by welding together with inner and outer plates, meeting aerodynamic requirements.

Allen uses a standard spring-loaded seal, similar to interstage seals, bearing on specially machined sections of the blade shrouding to achieve this result. A clearance exists between the seal and shroud during normal operation; however, should the fin touch the shroud during start up, the spring-loaded feature ensures that the seal moves away from the shrouding, thereby preventing damage.

Computerized aerodynamic programs were used to develop standard LP blading for condensing turbines that have a 26 percent greater volume flow capacity then previous blades, resulting in larger output within a given modular frame for given exhaust conditions, or efficiency gains by reduced leaving losses.

Modern LP blades for power generation turbines run free-standing. Allen uses computers for stress analyses which also determines changes in twist occurring in large blades under running conditions.

Computer-based development has resulted in blades with fever aerodynamic compromises. The increase in efficiency represents an increase in electrical output of 5 per cent. Use of higher steam conditions further enhances the power generation capability of a given process steam flow requirement.

Twin-Cylinder Turbines. Due to blade-root stress limitations, there is a maximum rotational speed for the exhaust-end blade and its associated blade root. This maximum rotational speed can lead to compromises made in stage design at the high-pressure end of the turbine. If wheel diameters are made relatively large, blade heights will be very small, resulting in reduced efficiency due to losses at root and tip. Alternately, wheel diameters can be made smaller, resulting in taller blades for a given annular area, but any advantage is offset since blade speed is then much too low.

Using standard exhaust elements from the modular range for some applications, Allen incorporated a double-flow exhaust arrangement for condensing turbines. This arrangement enables higher rotational speeds for any given exhaust volume flow capacity. The high-pressure turbine gains efficiency (producing 66 percent of the power) due to the higher running speed and taller blades. A higher number of stages can be employed (typically 19 or 20), compared to a single-cylinder machine (typically with only 11 or 12 stages).

Control Elements. Allen H-type modular turbines have control system components arranged to accept various electronic governing systems, pressure control systems, overspeed protection systems and similar technology. Control valve assemblies are arranged in a straight line across the top of the turbine. This arrangement enables a single power amplifier to lift all the valves through a simple mechanical linkage.

The single amplifier uses medium oil pressures, 25 bar to 30 bar, and control oil pipework is kept to a minimum. Control oil is supplied by motor driven pumps, simplifying the turbine installation. Emergency shutdown of the control valves is through duplicate solenoid valves which are arranged for on-line testing.

Electronic control systems have simplified the auxiliary drive arrangements associated with older types of hydraulic governors. The steam-end bearing pedestal now contains only the journal bearing and thrust bearing, together with the magnetic speed pick-ups for the governor and overspeed trip.

Allen has developed its own electronic governor with electrical load-sensing circuits, which allow changes in speed resulting from load changes to be anticipated, and adjustments made to turbine control valves before any speed change occurs.

Final conversion from an electronic signal to a mechanical force is carried out in a proprietary electronic-input hydraulic actuator.

Remote controls can be fitted to open the combined stop and emergency valves during starting. The controllers allow interfacing with a comprehensive automatic starting controller which Allen can provide. The system can be arranged to control the complete run-up sequence through to automatic synchronization and application of load.

General ("S" Series). Allen "S" series multi-stage steam turbines combine individual steam path designs with standardized mechanical designs and construction. The single-cylinder turbines are designed to produce power for factories/utilities needing heat and power.

Performance. "S" Series normal operating range is as follows:

Parameter	Output
Maximum Inlet Pressure	46 bar abs
Maximum Inlet Temperature	450°C
Maximum Exhaust Pressure	9 bar abs
Power Output	1-13 MWe

Quality Control. The basic quality control standard currently practiced by Allen is BS 5750 Part 1, 1987 (ISO 9001) which is approved by both Lloyd's Register Quality Assurance Limited and the UK Ministry of Defense to AQAP 1, Edition 3.

Variants/Models

The following models are from the Allen Steam Turbine Installation list, with only the highest performance characteristics listed included in the chart below (models are arranged by prefix, and then numerically):

Model	Steam Turbine Type	Bar / °C	RPM	Output MW	Year Installed
H-2 500/500	Condensing	45 / 420	10,364	13	1991
H-2 630/630	Condensing	65 / 430	8,500	14.5	1992
H-3	Backpressure	44.8 / 400	7,750	10.3	1992
H-3 800/800	Condensing	65 / 520	6,500	31	1992
H-3PO	Pass-out	50 / 435	8,500	15.9	1993
H-3PO-800	Pass-out	49 / 435	6,500	17	1993
H-C 1250	Condensing	44.2 / 443	4,750	21.9	1990
HEN 11	Backpressure	44.5 / 381	11,000	1.4	1960
HEN 12	Backpressure	51.4 / 420	11,750	3.25	1968
HEN 14	Backpressure	43.3 / 413	10,250	5	1972
HEN 15/14	Backpressure	61 / 499	9,250	10	1982
HEN 16/19	Condensing	38.5 / 390	10,286	2.1	1979
HEN 17/20	Pass-out	40 / 425	10,250	7.5	1991
HEN 18	Backpressure	63 / 482	7,700	3.5	1970
HEN 18/19.5	Condensing	14.8 / 343	9,500	2.1	1982
HEN 19	Backpressure	31 / 371	7,000	4	1963
HEN 22	Backpressure	31 / 400	7,000	10	1986
HEN 22/24	Condensing	28.6 / 400	7,000	3.5	1978
HEN 22/25	Condensing	20 / 343	8,500	4.4	1981
HEN 24	Backpressure	14.8 / 344	5,000	4.7	1963
HEN 28	Backpressure	18.2 / 344	4,500	1.75	1959
HEN 30	Condensing	13.1 / 620	4,500	6	1965
HEN 630	Condensing	17 / 340	8,500	5	1972
HEN 1250	Condensing	60 / 460	4,750	17.1	1986
HES 12	Backpressure	45.8 / 400	11,500	4.9	1986
HES 14	Backpressure	44 / 456	10,250	5	1967
HES 18	Backpressure	45/ 446	8,000	8.6	1969
HES 350	Backpressure	42.4 / 420	9,500	3.85	1981
HES 450	Backpressure	44.5 / 405	8,500	12	1976
MS 26	Backpressure	17.2 / 260	5,000	0.85	1972
S-350	Backpressure	35.5 / 387	10,250	3	1993
S-450	Backpressure	41 / 410	6,250	2.8	1994
SLC 14	Backpressure	31.2 / 380	10,150	1.6	1976
SLC 18	Backpressure	28.6 / 400	7,000	3.5	1976
SLC 22	Backpressure	30 / 370	6,000	6.5	1979
SLC 450	Backpressure	14.8 / 315	8,500	2.7	1982
SLC 560	Backpressure	29 / 360	7,000	8.7	1987
S-PB14	Backpressure	31.3 / 380	7,083	4	1991
S-PB350	Backpressure	41.8 / 400	9,515	3	1990

Program Review

Background. Allen is going on 90-years-worth of experience in the design, development, and manufacture of steam turbines. Designed to ensure total flexibility in operation, the Allen range includes single- and twin-cylinder arrangements, with backpressure and condensing models, with or without extraction or induction, enabling the optimal, most cost-effective solution to satisfy specific customer operating conditions.

The then W H Allen and its predecessors developed the steam turbine line prior to its purchase by Rolls-Royce.

Bellis India Ltd is a manufacturer of 300 kW single-stage to 8 MW multi-stage steam turbines in India. In a recent agreement with W H Allen (Allen Power Engineering), it has been provided with designs to produce turbines of up to 20 MW.

Reportedly, a 20 MWe condensing turbo-generator has been delivered in just over 12 months from the receipt of the initial order, and installed and commissioned ready for commercial operation in 15 months.

Funding

It is unknown how much, if any, funding is derived from outside sources or generated internally by the then W H Allen (now Allen Steam Turbines).

Recent Contracts

Contractor	Award ($ millions)	Date/Description
Amalgamated Power Engineering (APE) (division of NEI Africa Operations Ltd)	0.2	July 26, 1994 – A 2.5 MW steam turbine delivered through Bellis India subsidiary. The turbine is used to drive a shredder at the Maidstone Sugar Mill in Natal, South Africa.
SEMADCO (Egypt)	12	Late 1996 – Modular II range steam turbine for Talkha II urea plant in Egypt. Service entry in mid-1998.

Timetable

Month	Year	Major Development
Nov	1880	WH Allen established in Lambeth, London, UK
	1894	Company moved to Bedford
	1960	Belliss India Ltd established
	1968	Merger with Belliss and Morcom and Crossley Pielstick Engines accomplished
May	1989	Allen group of companies became part of Rolls-Royce Industrial Power Group
May	1993	Belliss India's production range extended to 20 MW
Thru	2001	Continued production of Allen steam turbines projected

Worldwide Distribution

The majority of the Allen steam turbines have been installed in **Europe**, followed by **Far East/Asia/Australasia** and **Africa**.

Forecast Rationale

WH Allen, although a relatively small player in the steam turbine arena, appears suited to take advantage of the growing demand for combined-cycle applications in today's power generation industry. The company's expertise in turbines under 50 megawatts puts it into a favorable position in a market that is increasingly looking for solutions in distributed power generation.

The big question is, of course, how fast will this trend accelerate in Europe, since a very large number of power generation installations in North America today involve a steam turbine.

This "double-duty" production of both power and steam would seem attractive to places where the price of natural gas is highly competitive and where at the same time there is strong demand for the (hot exhaust) steam produced by the gas turbine. Central heating systems in Central and Northern Europe, as well as in parts of Asia, would seem lucrative niches for such applications.

The numbers presented below for the production of combined-cycle steam turbines are based on estimates that the market will continue its growth for the foreseeable future. The growth projection is based on the promising opportunities in the regions and applications stated above.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR PRODUCTION

			High Confidence Level			Good Confidence Level			Speculative			
Engine	**(Application)**	**thru 99**	**00**	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**Total 00-09**
ALLEN POWER ENGINEERING													
20-49 MW STEAM TURBINES	COMBINED CYCLE	0	10	8	9	12	11	7	8	12	15	15	107
50-124 MW STEAM TURBINES	COMBINED CYCLE	0	1	0	1	2	2	1	2	1	2	2	14
Total Production		0	11	8	10	14	13	8	10	13	17	17	121