

Mitsui SB5

Outlook

- All available evidence shows that production of the SB5 ceased years ago
- MES states that around 50 cogeneration packages based on SB5-type gas turbines were produced
- Corporate data reveals that total production of SB series gas turbines was about 100 units

Orientation

Description. The SB5 is a small, single-shaft, axial-flow industrial gas turbine machine of about 1 MW. The SB5 is normally part of the Gas Power 1000 or Gas Power 1000-COPRA packages.

Sponsor. The SB5 was privately developed by the prime contractor.

Power Class. The approximate power output of the Mitsui SB5 is 1.1 MW.

Status. Out of production.

Total Produced. According to Mitsui Engineering & Shipbuilding, more than 50 SB5 cogeneration units have been delivered out of a total of over 100 SB series gas turbines delivered by MES.

Application. Applications include generator drive for electrical generation, including simple-cycle and cogeneration (CHP) installations. No SB5

series-production machines are believed to have been employed in mechanical load duty.

Price Range. The machine's estimated generator set price in current U.S. dollars is \$935,000-\$950,000.

For electrical generation, the genset price covers a basic electric power skid-mounted generator package including one simple-cycle (open-cycle) single-fuel gas turbine, an air-cooled electric generator, a skid and enclosure, an air intake with basic filter and silencer, an exhaust stack, a basic starter and controls, and a conventional combustion system.

Competition. In the electrical generation arena, the SB5 competes against the Solar Saturn 20 and the Turbomeca Makila TI. Other gas turbine machines offering electrical generation of about 1.1 MW are the UTC PWPS ST6L-90, IHI IM150, and Motor Sich-Progress TB3-137.

Contractors

Prime

Mitsui Engineering & Shipbuilding Company Ltd, (Power Systems Department)

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Mitsui SB5**Technical Data****Dimensions.**

	<u>Metric Units</u>	<u>U.S. Units</u>
Length	1,900 mm	6.23 ft
Width	1,400 mm	4.58 ft
Height	900 mm	2.59 ft
Weight	1,000 kg	2,205 lb

Performance.**ELECTRICAL GENERATION**

<u>ISO Base Rating</u>	<u>Heat Rate (LHV)</u>	<u>Power Shaft Speed</u>	<u>Turbine Speed</u>	<u>Exhaust Flow</u>	<u>EGT</u>
1,080 kW	14,127 kJ/kWh 13,390 Btu/kWh	1,500/1,800 rpm	26,600 rpm	4.99 kg/s 11.0 lb/s	492°C 918°F

COGENERATION

<u>Generator Output</u>	<u>Gross Thermal Efficiency</u>	<u>Overall Efficiency</u>	<u>Steam Supply Generated</u>
1,000 kW	25.0%	73.0%	2,721 kg/h

Design Features. The original Mitsui SB5, SB15, and SB30 gas turbine series combined double-shell turbine construction with an outer casing internally lined with insulation and cooled by compressor air, and an inner casing fitted with an insulating liner ring to reduce thermal stress. The machines also featured a center-plane horizontally split casing, allowing ease of inspection and maintenance, and the ability to burn a variety of fuels.

Compressor. The SB5 has a single-stage LP compressor and a single-stage HP compressor. Pressure ratio is 10:0.

Combustor. Single-can reverse-flow combustor design, with combustor mounted directly on the turbine casing. The primary combustion chamber has three fuel nozzles, each surrounded by a swirler on its head. Combustor flame tube is made of Hastelloy X; outer casing is of carbon steel and 18 percent Cr8Ni stainless steel. A series of interchangeable combustors allow a wide range of low-grade fuels to be burned.

The SB5's dry low emissions (DLE) combustion system, dubbed the Super Premix Combustor, can reduce NOx to less than 84 ppm when firing natural gas.

Turbine. The SB5 employs a three-stage axial-flow turbine design.

Bearings. The SB5 has two tilting-pad journal bearings and one tilting-pad thrust bearing.

Accessories. A diesel-electric starter is standard, with electric motor or gas expansion starting optional. The control system is of solid-state design.

Operational Characteristics. The smallest of the Mitsui SB series, the SB5 variant inherited the series' reputation for dependability and reliability; however, it was designed using a different concept. The SB5 is rated at 1,080 kW, with a turbine speed of 26,600 rpm. The SB5 has been employed in cogeneration packages.

The SB5 gas turbine-equipped GP1000 and MPP1000 cogeneration packages satisfy rigid environmental regulations for central Tokyo (with the use of an MES-developed low NOx premix-type burner and an exhaust gas boiler combined with an interior denitrification system). Additionally, their compact design allows for installation in confined spaces.

The Japanese firm has also adopted as standard equipment a water injection system to reduce NOx emissions. When used with the SB5, the machine operates at a much lower NOx value than Japanese regulations require.

Variants/Upgrades

Gas Power 1000 (GP1000). An SB5-based municipal gas-burning cogeneration package.

GP1000-RECSS. GP1000-RECSS is a cogeneration package with a regeneration cycle.

MPP1000. An SB5-based liquid-fuel-burning cogeneration package.

SB5-COPRA. SB5-COPRA is a cogeneration package with adjustable steam and power generation ratio by steam injection into the gas turbine.

Mitsui SB5

Program Review

Background. Mitsui Engineering & Shipbuilding Company Ltd entered the gas turbine marketplace in 1949 with a gas turbine machine of its own design. In 1963, after several years of internal development and redesign, the firm began designing a prototype open-cycle gas turbine machine for industrial use. The early model, the SB15, ran at 1,350 kW and was completed in 1965.

The SB5 extended the lower limit of its product range to 1,080 kW, an output well suited for power generation for small establishments such as hotels and commercial cogeneration applications, as well as for small landfills.

Agreement with Solar. When Mitsui completed a packaging arrangement with Solar Turbines Inc in 1996,

it halted production of its own gas turbine models, including the SB15, SB30, SB60, SB90, and SB120; the exception was the SB5, a model that does not compete against any other Solar machine. The lowest-rated Solar/Mitsui offering is the MSC40 (Centaur 40), which is rated at 3.52 MW.

By the spring of 1997, the company stated that it had delivered 80 SB series machines, of which 64 were in the SB5/SB15/SB30 class. The Solar/Mitsui MSC series machines use Solar's gas turbine and MES's cogeneration technology. In 2016, corporate information stated that over 100 SB series machines had been delivered, of which more than 50 were SB5s.

Related News

SB5 Units For Sale on Secondhand Market – In an August 2016 search, Forecast International discovered that six SB5 gas turbines were for sale on the secondhand market. Of these, four were listed as having been commissioned in 2001 and removed from service in 2016. The seller noted that these turbines were in poor condition and needed repairs. The other two SB5s were delivered in 1992 but never installed and had been in indoor storage before being offered for sale in 2016. These two machines are described as being in as-new condition. (FI, 8/16)

Funding

MES documentation identified sales of the GP1000 and MPP1000 as falling under the Power Systems Sales Department of the Machinery & Systems Headquarters.

Contracts/Orders & Options

No contract data for the SB5 gas turbine has been available for many years.

Timetable

<u>Year</u>	<u>Major Development</u>
1949	Mitsui enters gas turbine OE manufacturing marketplace
1987	SB5 becomes available
1988	First SB5 enters commercial service in Japan
1996	Mitsui signs packaging agreement with Solar; Mitsui drops all machines except SB5
2005	GP1000-RECSS announced

Mitsui SB5**Worldwide Distribution/Inventories**

Country	Year of Installation	Total
Japan	1988 (9), 1989 (19), 1990 (7), 1991 (3), 1992 (2), 1993 (1), 1994 (1), 2001 (4)	46

According to Mitsui Engineering & Shipbuilding corporate literature, the company has delivered a total of over 100 SB series gas turbines. Of these, more than 50 are SB5 cogeneration units. This makes it clear that sales of the SB5 have been far more limited than many reports suggest.

Forecast Rationale

MES's sales activities are focused on gas turbine cogeneration systems. Most of these are very-large-capacity installations with power generation capacities in the hundreds of megawatts, with an increasing number reaching terawatt levels. In this corporate environment, the SB5 stands out as a glaring anomaly. Reinforcing this impression is the commercial agreement between MES and Solar, by which the former sells packaged versions of gas turbines produced by the latter.

MES corporate literature states that it has delivered over 100 SB series gas turbines, of which more than 50 are SB5 cogeneration units. The Forecast International I&M Gas Turbine database has identified 99 SB series installations, of which 42 are SB5s. A further four SB5s are known to exist, but their provenance remains unclear. The significance of these two pieces of information, taken together, is that our I&M Gas Turbine database is essentially complete and only a handful (at most) of installations have not been identified.

The information on completion dates shows that the SB series gas turbines were delivered between 1980 and

1994, with the SB5s being installed between 1988 and 1994. The four known but unidentified installations were commissioned in 2001. The conclusion must be that all of the SB series gas turbines, including the SB5, are long out of production. A detailed search of corporate and Internet resources has failed to show even a single delivery of one of these gas turbines in recent years, adding weight to the above conclusion.

Comparing the MES 1997 SB series sales statement (80 sold) with that of 2015 (100 sold) suggests that 20 SB series gas turbines were sold between 1997 and 2001 (the date associated with the four engines for sale on the secondhand market), breaking down to an average of four engines per year. On the other hand, there is no evidence indicating continued sales activities on any scale, let alone the dozens per year sometimes reported. All the evidence currently available suggests that production had ceased by the early years of this century, and thus no forecast can be offered.

In view of this conclusion, this report will be archived next year unless a major change occurs.

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