MHPS Gas Turbine

J Series


**MITSUBISHI HITACHI POWER SYSTEMS, LTD.**

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# MHPS Gas Turbine
# M501J / M701J


**MITSUBISHI HITACHI POWER SYSTEMS**

MHPS GasTurbine

# M501J/M701J

## Tomorrow's Turbine Technology...Today

**When developing the J-series gas turbine, the main focus was on technology that would enable a higher firing temperature and improved efficiency. Due to the great success of these continuous efforts, the J-series gas turbine is able to operate at a turbine inlet temperature of 1,600°C (2,912°F), 100°C (180°F) higher than the G-series gas turbine.**

### Introducing the air cooled JAC

After validating integrated disciplines of the proven G and J-series technologies, the advanced JAC gas turbine is introduced based on air cooled combustor technology for high efficiency and operational flexibility by eliminating any need for steam cooling from the bottoming cycle.

Current production models are M501J / JAC for 60Hz and M701J / JAC for 50Hz.

### Proven design based on over 40 years of experience

The J-series incorporates basic design features and concepts developed through years of experience, such as cold-end generator drive, single shaft rotor construction and axial exhaust.
These fundamental and proven features are based on our experience of more than 40 years.

### Environmental protection

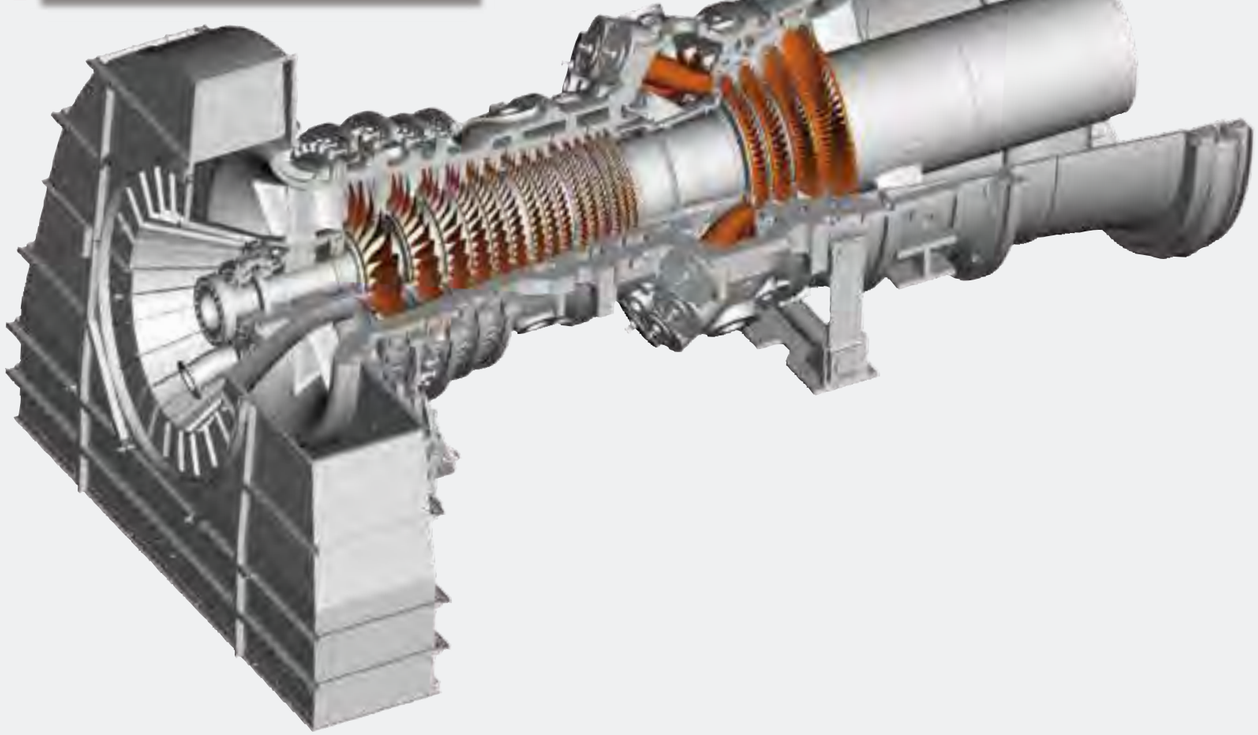
- Most efficient use of fossil fuel resources
- Low $NO_x$, CO, UHC and VOC emissions
- Reduction of $CO_2$ emissions is approximately 70% in combined cycle operation when compared to conventional coal plants

# Longitudinal Section

## Overall Design

The design of J-series gas turbine is based on proven F and G-series features.

- The compressor shaft end drive reduces the effect of thermal expansion on alignment and eliminates the need for a flexible coupling
- The rotor has a two-bearing structure to support the compressor and turbine ends
- An axial flow exhaust structure is used to optimize the combined-cycle plant layout
- The rotor structure has bolt-connected discs with the torque pins in the compressor rotor, and discs with CURVIC couplings in the turbine rotor to ensure reliable torque transmission
- Horizontally split casings that facilitate field removal of the blades with the rotor in place

## Compressor

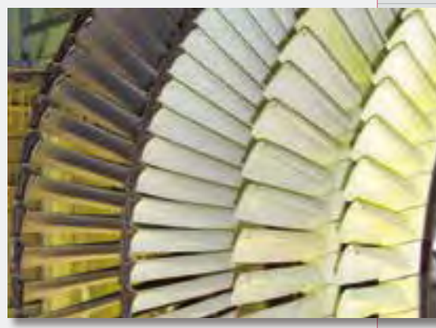
3D advanced design techniques are used to improve the performance and reduce the shockwave loss in the initial stages and frictional loss in the intermediate and final stages. This concept was evaluated by 3D computational fluid dynamics (CFD) software and verified using a full-scale high-speed research compressor.
In addition to variable inlet guide vanes used to modulate air flow, the J-series gas turbine is equipped with three variable vanes at the front stages of the compressor. The four stages operate together to modulate the gas turbine air flow in order to maintain relatively high exhaust temperatures (at part load) for improved bottoming cycle efficiency.

## Combustor

The J-series combustor was based on the proven steam cooling system used in G-series gas turbines.
The turbine inlet temperature of 1,600°C (2,912°F) is 100°C (180°F) higher than the G-series. We are also able to maintain emissions to equivalent levels as that of the G-series.
This is accomplished through the use of low-$NO_x$ technologies including optimization of the local flame temperature in the combustion zone, and by improving the combustion nozzle to produce a more homogeneous mixture of fuel and air.
The advanced JAC with the air cooled combustors adds operational flexibility by eliminating any need for steam cooling from the bottoming cycle.

## Turbine

Turbine rows 1 to 4 blades are cooled by the compressor bleed air, which is cooled by the external air cooler.
Turbine rows 1 to 4 vanes are also air cooled, with row 1 vane cooled from compressor discharge air, and the remaining vane rows cooled by compressor intermediate stage bleeds respectively.
The cooling structure was improved for the G-series turbine, and again for the J-series.
Application of the high-performance film cooling developed from the Japanese National Project further offsets the temperature increase.
The metal temperature is maintained at the same level of G-series by utilizing the 1,700°C (3,092°F) class technology developed in the Japanese National Project. The 100°C (180°F) temperature increase from G-series to J-series is offset in part due to the advanced thermal barrier coating (TBC).



# Combined Cycle Power Plant

**In 1971, MHPS delivered the first combined cycle plant in Japan to a Japanese utility company.
Since then, through the experience in supplying many combined cycle plants,
we have earned an excellent reputation from our customers.
In order to satisfy customers' needs, MHPS offers its expertise
not only in supplying plants systems and equipment,
but also in providing a wide range of after-market services.**

## Gas Turbine Simple Cycle Performance (as of December, 2016)

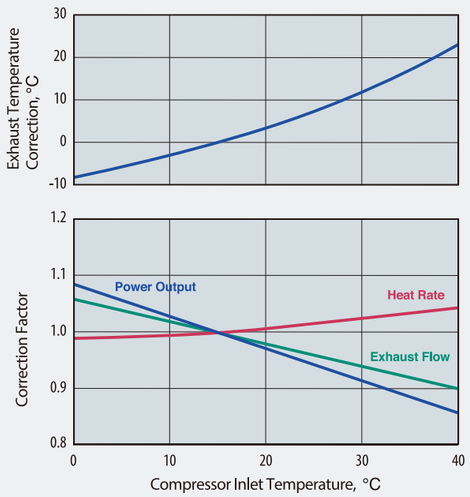
| GT Model | M701J | M701JAC | M501J | M501JAC |
|---|---|---|---|---|
| | 50Hz | | 60Hz | |
| ISO Base Rating, kW | 478,000 | 493,000 | 330,000 | 370,000 |
| LHV Heat Rate, kJ/kWh | 8,511 | 8,392 | 8,552 | 8,451 |
| Exhaust Flow, kg/s | 896 | 896 | 620 | 670 |
| Exhaust Temperature, °C | 630 | 641 | 635 | 655 |

## Combined Cycle Power Plant (as of December, 2016)

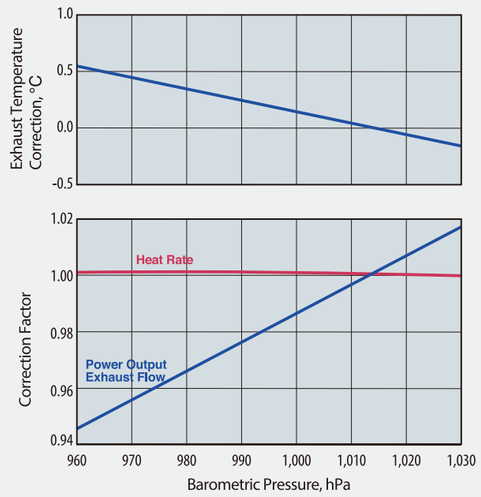
| GT Model | | M701J | M701JAC | M501J | M501JAC |
|---|---|---|---|---|---|
| | | 50Hz | | 60Hz | |
| 1on1 | Plant Output, kW | 701,000 | 717,000 | 484,000 | 540,000 |
| | LHV Heat Rate, kJ/kWh | 5,779 | 5,706 | 5,807 | 5,706 |
| | Plant Efficiency, % | 62.3 | 63.1 | 62.0 | 63.1 |
| 2on1 | Plant Output, kW | — | — | 971,000 | 1,083,000 |
| | LHV Heat Rate, kJ/kWh | — | — | 5,788 | 5,688 |
| | Plant Efficiency, % | — | — | 62.2 | 63.3 |

• All ratings are defined at ISO standard reference conditions: 101.3kPa, 15°C and 60%RH
• All ratings are at the generator terminals and based on the use of natural gas fuel

## Effects of Compressor inlet Temperature on Gas Turbine Performance (Typical)




## Effects of Barometric Pressure on Gas Turbine Performance (Typical)

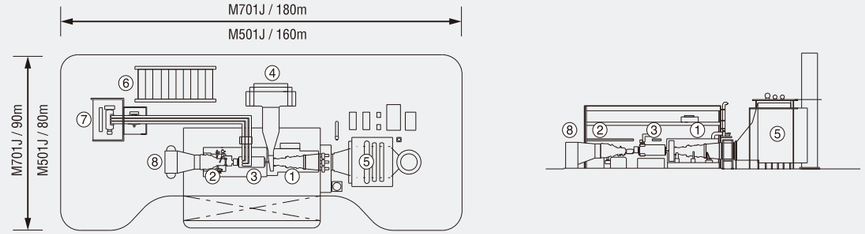



## Flexible Configurations

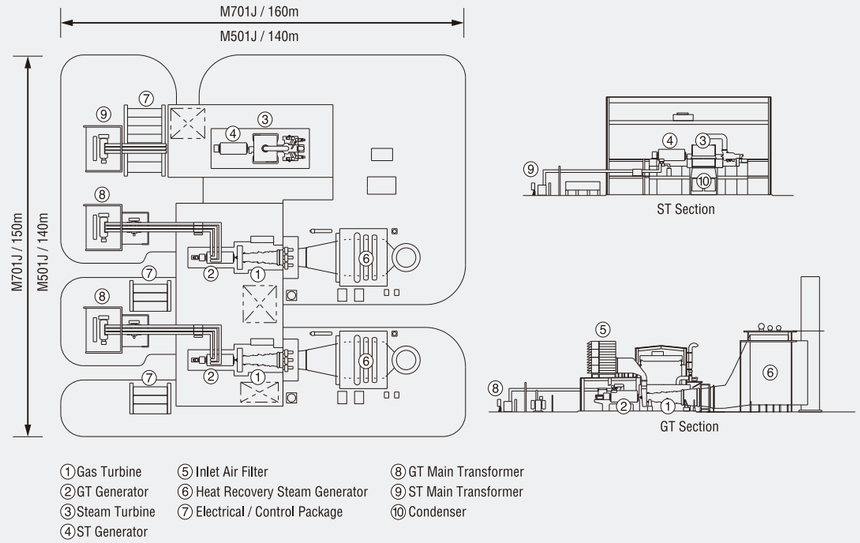
Based on our sophisticated combined cycle plant technology and diverse product application, we can offer our customers not only the multi-shaft arrangement such as 2 on 1 configuration, but also 1 on 1 configuration having the gas turbine, steam turbine and generator connected on the same shaft.

## Typical Plant Layout

1 on 1 configuration, single-shaft




2 on 1 configuration



# T-point at MHPS' Takasago Works

**T-point, located at Takasago Works of Mitsubishi Hitachi Power Systems (MHPS), is the MHPS gas turbine demonstration facility, operating as a commercially dispatched combined cycle power generation plant.**

## Objectives of T-point

- Demonstration of the technologies applied to the gas turbine allowing increased turbine inlet temperatures, improved efficiency, and reduced emissions
- Verification of the performance and reliability of the high efficiency, low-pollution combined cycle power generation plant through long-term operation

## Verification of the G and J-series Gas Turbine

Performance and durability tests for G-series gas turbines have been successfully conducted since 1997. Commissioning tests of the first M501J started in February 2011 were completed in June. The M501J unit has been in commercial operation at T-point since July 2011.

① *Gas Turbine Building*
② *Heat Recovery Steam Generator*
③ *Steam Turbine Building*
④ *Air-cooled Condenser*
⑤ *Cooling Water Cooler*
⑥ *Fuel Gas Compressors*
⑦ *Main Office*


## Gas Turbine Manufacturing Facilities

MHPS is proud of the M501 / M701 gas turbine production capability in Takasago, Japan and Savannah, Georgia, USA. Their capabilities include:

- Gas turbine manufacturing
- Comprehensive inspection and repair
- Complete spares inventory

*MHPS Takasago Works, Japan*

*MHPSA Savannah Machinery Works, Georgia, USA*

# Key Worldwide Gas Turbine Projects

**Based on our continuous research and development in the gas turbine field, all MHPS gas turbines are specially designed to meet power and environmental requirements. Long-lasting performance and high availability of our machines have won the confidence and satisfaction of customers around the world. After commissioning, MHPS offers a full range of support, including comprehensive technical assistance to complete overhaul, as well as maintenance services provided by our field service engineers.**

*T-point, Takasago, Japan*
*389MW, M501J×1*

*Korea Western Power, PTK-2, Korea*
*950MW, M501J×2*

*CGN Yulchon Generation, Yulchon 2, Korea*
*950MW, M501J×2*

*Kansai Electric Power, Himeji No.2, Japan*
*2,919MW, M501J×6 (Courtesy of KEPCO)*

*Dongducheon Dream Power, Dongducheon, Korea*
*1,900MW, M501J×4*

*Korea East-West Power, Ulsan 4, Korea*
*950MW, M501J×2*

*Kansai Electric Power, Himeji No.2, Japan*
*2,919MW, M501J×6 (Courtesy of KEPCO)*

## Remote Monitoring Center

- Technical support (24/7/365)
- Combustion dynamics tuning support
- Real-time trend and historical data analysis
- Diagnostic and root-cause evaluation

*Takasago, Japan*

*Orlando, Florida, USA*