

TOSHIBA

MEDIUM/SMALL CLASS
STEAM TURBINE GENERATOR



TOSHIBA

More Efficient and More Friendly to Environment

Since 1928, Toshiba has been supplying thermal power plants for its many customers around the world. Day and night, these plants continue to provide safe, reliable and efficient source of electrical energy to the many nations they serve.

In February 1997, Toshiba Corporation reached the rare milestone of having produced turbine-products whose total generating capacity exceeds 100,000,000kW (100 gigawatts). Such products include a wide range of steam and gas turbines, as well as gas expanders. The total number of units produced to achieve the 100GW mark was 1,671, manufactured during the company's 70year history as an industry leader.

Toshiba's turbine product range is vast - from several megawatts back pressure turbines to over 1,000MW supercritical turbines: Included in the above accumulated experience, Toshiba has supplied some 400 small and mid range turbines over the years for utilities and industrial applications.

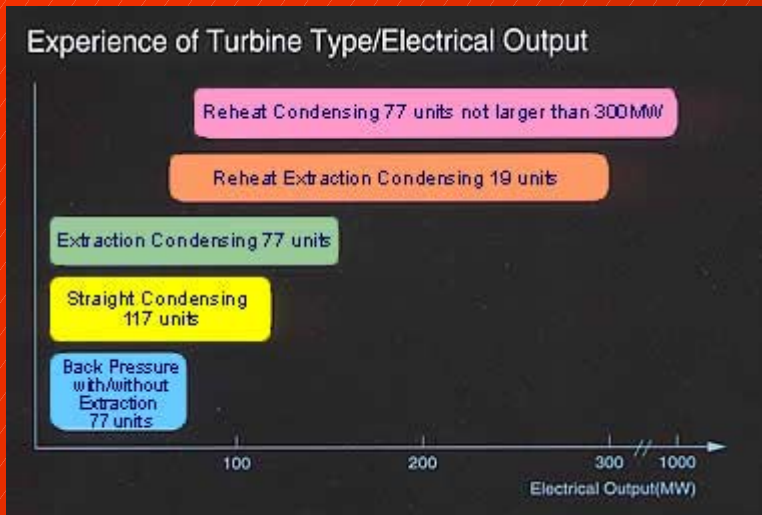
Toshiba has focused on the utilization of energy resources and in optimizing the conversion of energy resources to electrical power, by supplying non-condensing or extraction turbines, which simultaneously produce electricity and steam for industrial processes.

To utilize the waste heat from gas turbines and the process heat from industry, Toshiba has developed heat recovery systems including condensing steam turbines for combined cycle power plant and industrial applications.

Toshiba's advance technology in the field of industrial steam turbine-generator is the two-fold of our intensive research and development efforts and out extensive design, engineering and manufacturing experience.

TOSHIBA's Cumulated Output and Number of Units





Engineering Quality – Management System



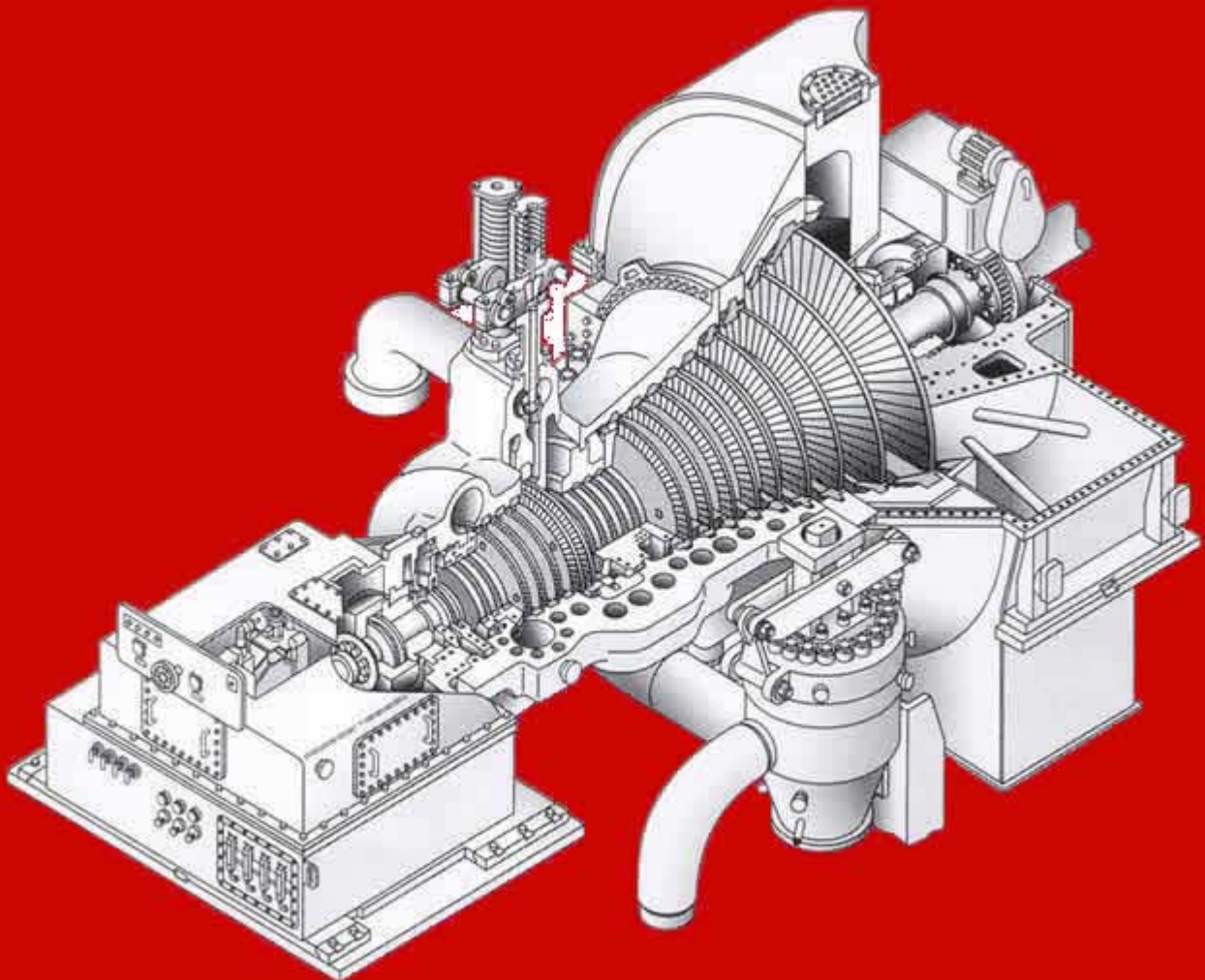
Toshiba can provide power-station equipment - manufactured at our state-of-the-art plants - that is fully compliant with ASME requirements and other international quality-control standards. We can also provide reliable quality management systems for the engineering from the start of a project to a plant's completion.

As of January 1994, Toshiba's quality management system has been certified by Lloyd's Register Quality Assurance Ltd: as 'being fully compliant with ISO 9001 standards for turbine generators and their auxiliaries, and since April 1994 for control and substation equipment. As such, Toshiba is the first company in Japan to have been awarded ISO 9001 approval for all power-station equipment.

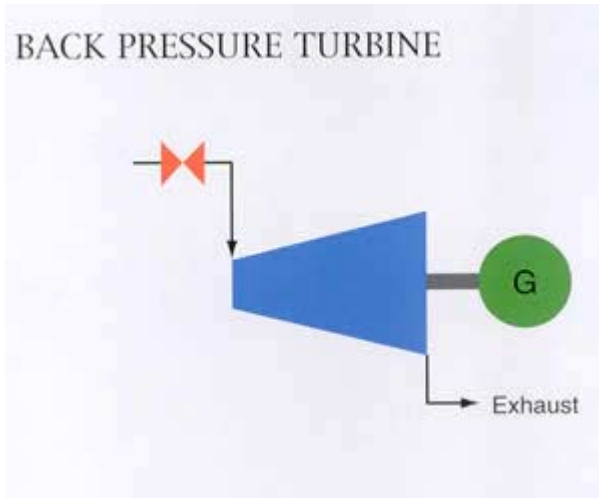


TOSHIBA Steam Turbine Design Features

- HIGH RELIABILITY with Proven Design
- HIGH EFFICIENCY with Latest Technology
- COMPACT MACHINE SIZE based on Impulse Stage Design
- OPERATING FLEXIBILITY with Modern Control System
 - Condensing/Back Pressure
 - Internal Control Extraction, External Control Extraction
 - Reheat/Non-reheat
 - Mix Pressure
- GOOD MAINTANABILITY with Horizontal Split Structure
- QUALITY ASSURANCE(ISO9001)

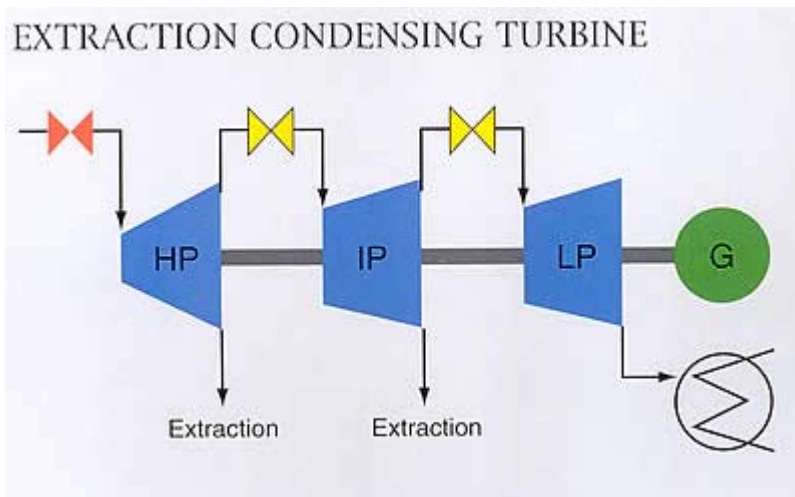


BACK PRESSURE TURBINE



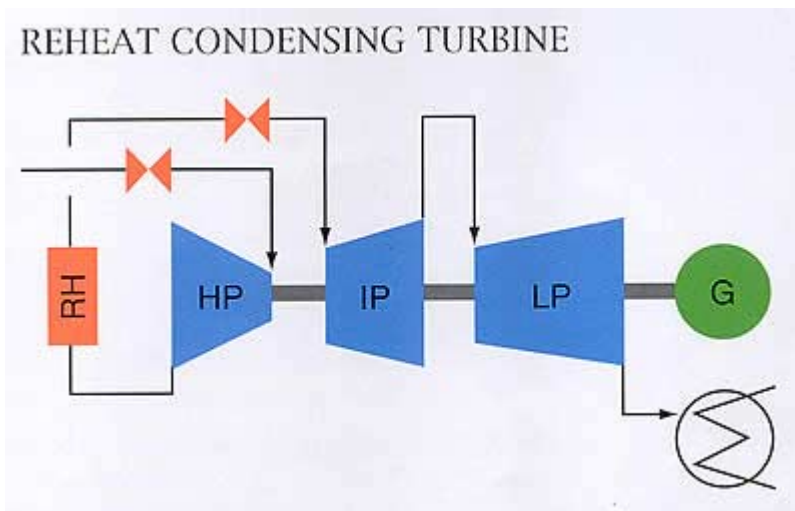
- For small electrical output and large thermal output
- Exhaust is applicable for process steam, district heating etc.
- Low initial cost without condenser

EXTRACTION CONDENSING TURBINE



- Wide variety of electrical / thermal output combination to meet the demand of clients.
- One or plural internal pressure controlled extraction is applicable for process steam, district heating etc.
- External control and non-controlled extraction is also applicable for process and feedwater heaters.

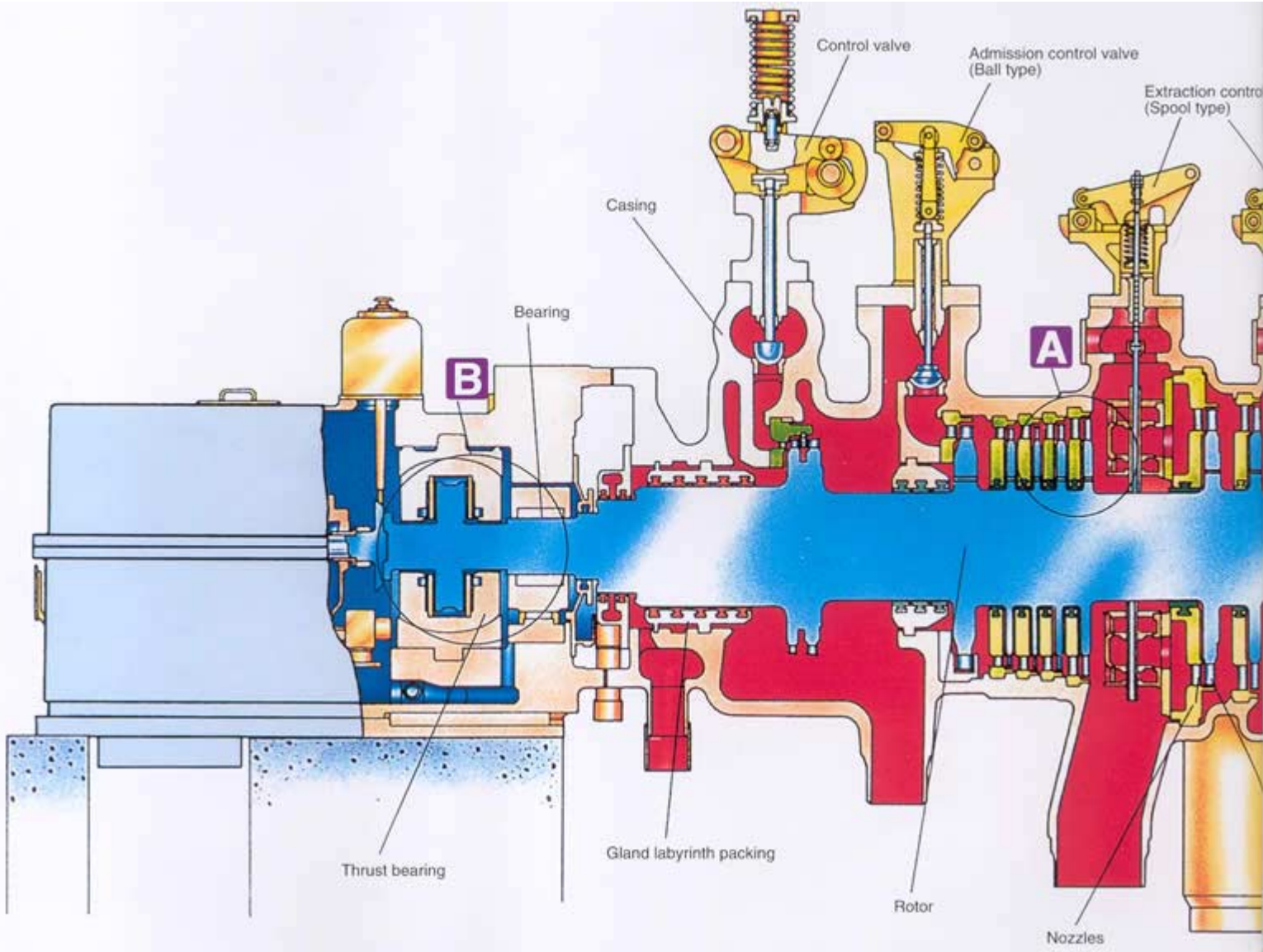
REHEAT CONDENSING TURBINE



- For larger electrical output
- Tandem compound or Single cylinder
- Internal / external control extraction and non-controlled extraction applicable for process and feedwater heaters.

High-reliability, High-efficiency Steam Turbine

Triple-automatic-admission-extraction Condensing Turbine



Turbine Design Features

- **Impulse design and inherently rugged compartment-type construction**

To minimize damage from foreign matter and to be less sensitive to performance reduction due to increased leakage caused by packing rubs during operation.

- **Compact shell-mounted control valve construction in high-pressure section**

To permit ease of maintenance because all parts are mounted on the high-pressure casing and require no special space around high-pressure turbine.

- **High-pressure steam inlet construction**

To reduce distortion and thermal stresses in the first stage region (High-pressure inlet construction will be selected according to steam conditions).

- **True center support construction of the casing and nozzle diaphragms**

To prevent distortion and misalignment and to maintain proper packing clearance.

- **Spring-backed shaft packing**

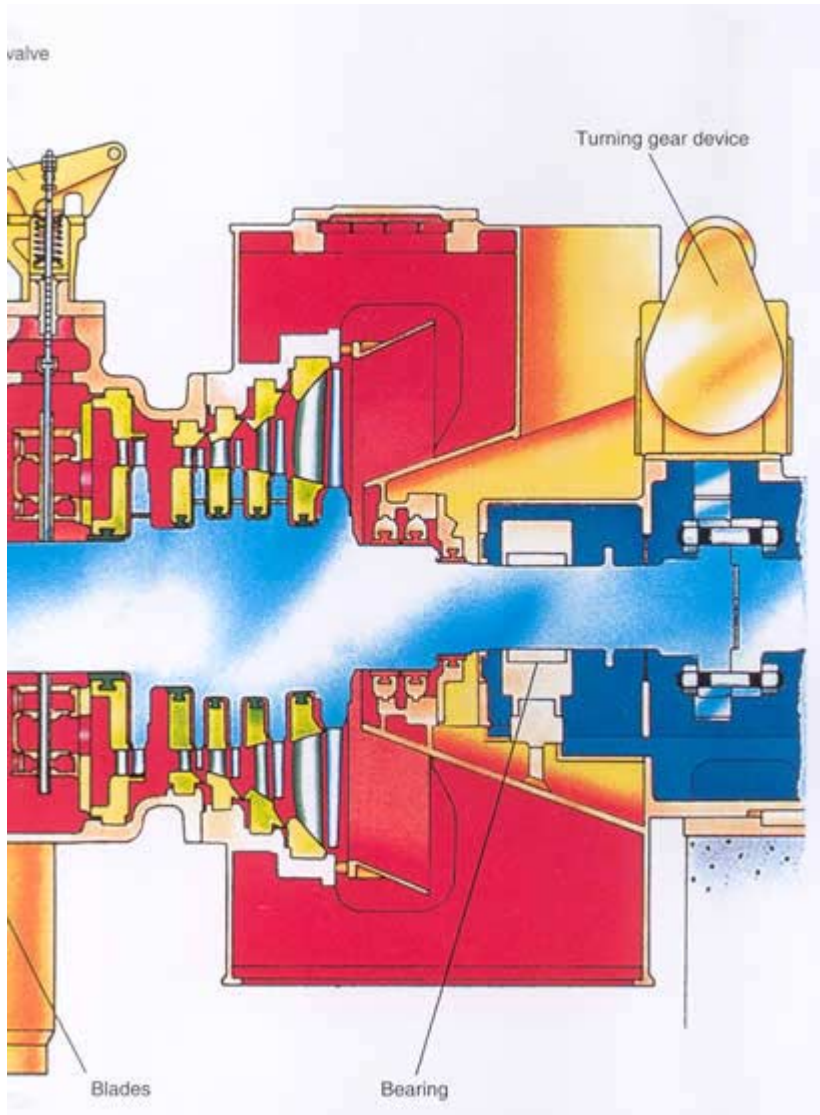
To maintain proper clearance at the shaft packing.

- **Double-sheet spool-type extraction control valves**

To handle low pressure steam and large volume flow.

- **Solid rotor, flexible shaft construction**

To ensure even material properties and provide for excellent performance of the rotor during starting and loading transient.



- **Tilting pad journal bearing**

To maintain excellent stability to the low load bearings.

- **Tapered-land type thrust bearing**

To simplify construction, occupy little space, and offer high load carrying capacity.

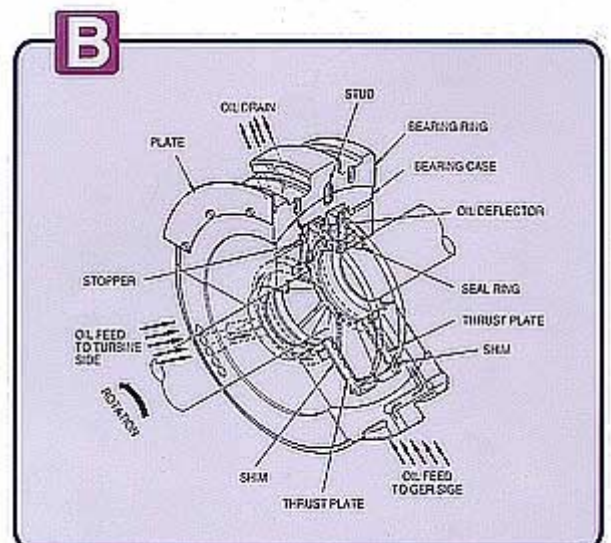
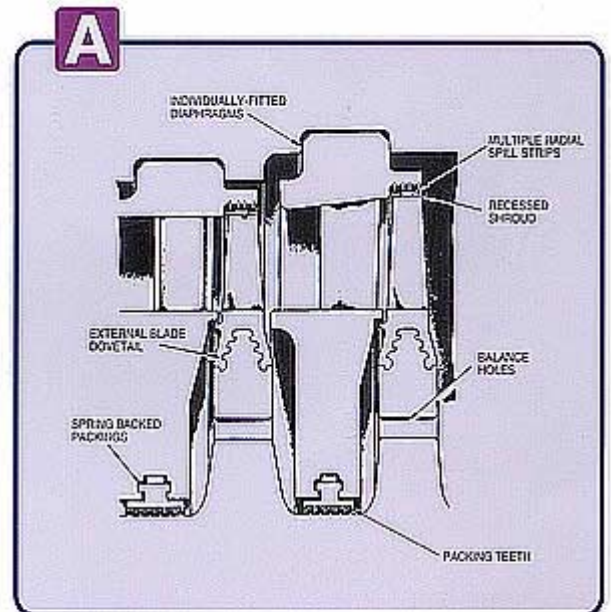
- **Horizontal split, casing, nozzle, and gland packing construction**

To sustain high maintainability.

- **LP and HP EHC control system with high control accuracy**

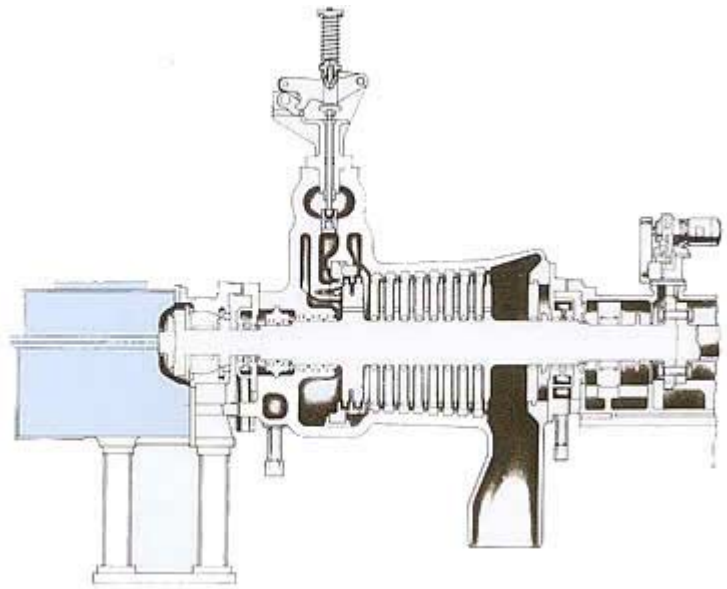
- **Standard block design**

To ensure high reliability.



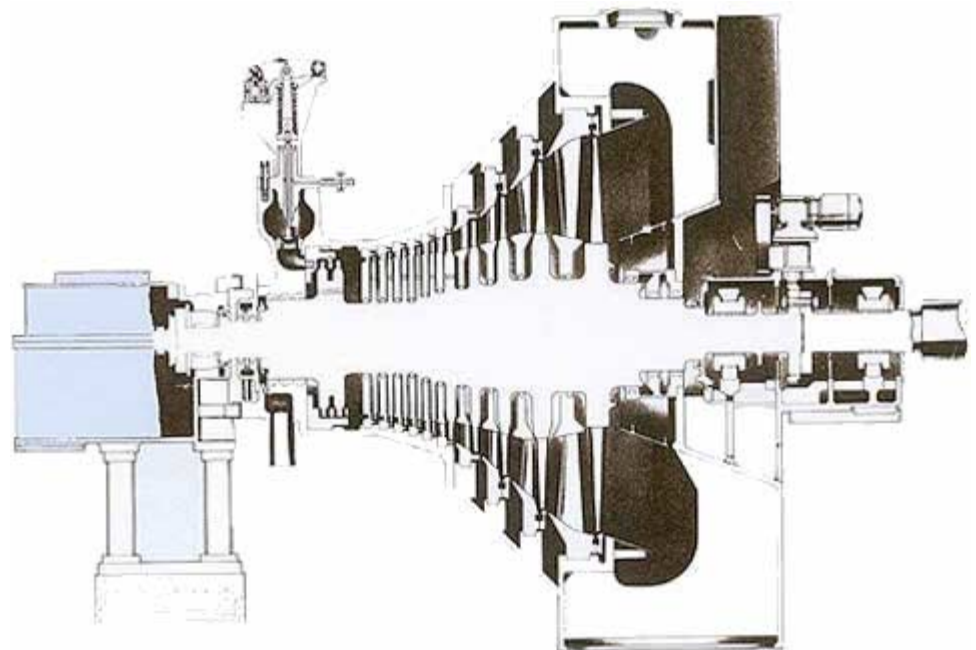
Back-pressure Turbine

- Rated output : 25,000kW
- Main steam pressure : 11.3MPag
- Main steam temperature : 538°C
- Back pressure : 1.27MPag



Condensing Turbine

- Rated output : 38,000kW
- Main steam pressure : 2.9MPag
- Main steam temperature : 390°C
- Exhaust pressure : 5.07kPa abs.

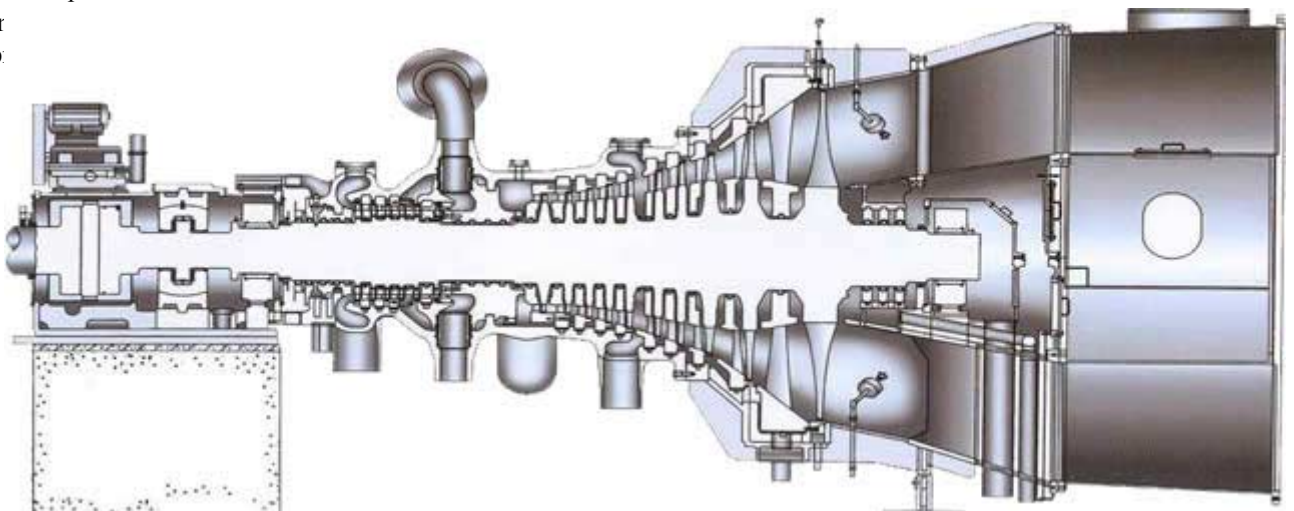


Reheat Turbine (axial-flow)

Suitable for combined cycle and low-floor installation plants

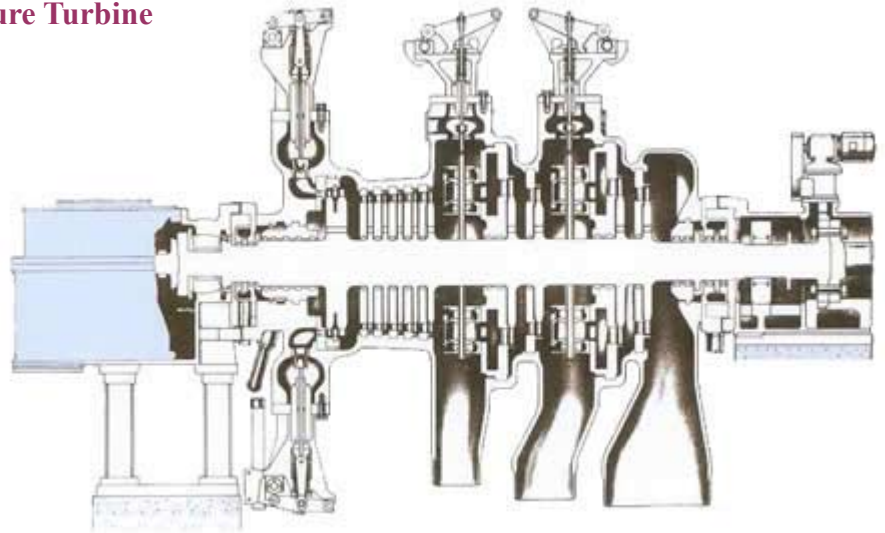
For HP-EHC application

- Rated output : 200,000kW
- Main steam pressure : 12.7MPag
- Main steam temperature : 538°C
- Reheat temperature : 538°C
- Exhaust pressure : 1.27MPag



Automatic-double-extraction Back-pressure Turbine

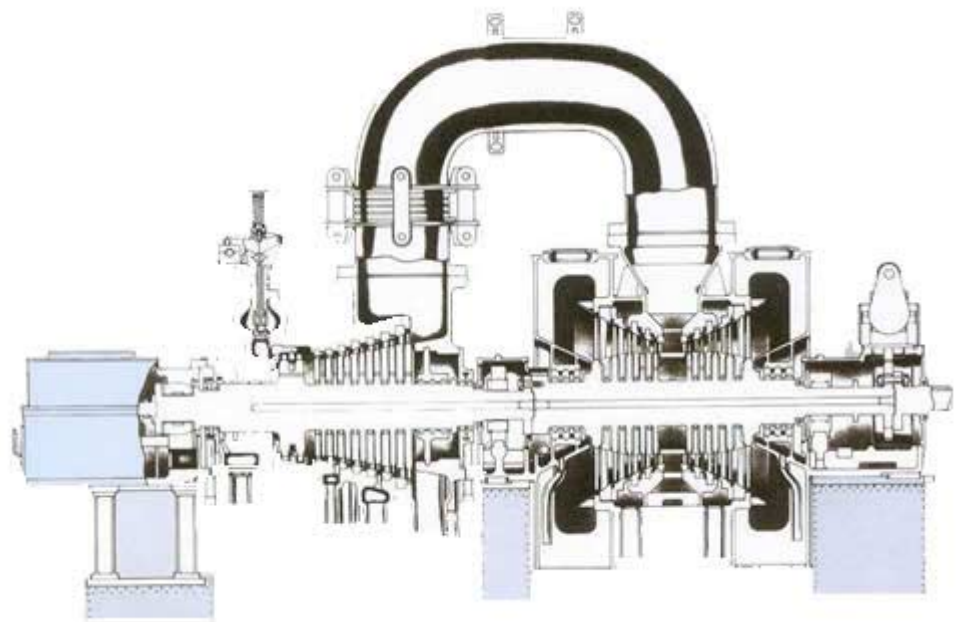
- Rated output: 35,000kW
- Main steam pressure : 5.9MPag
- Main steam temperature : 440°C
- Extraction pressure : 1.23 / 0.69MPag
- Back pressure : 0.27MPag



Condensing Turbine (2-using type)

For large-capacity condensing turbine

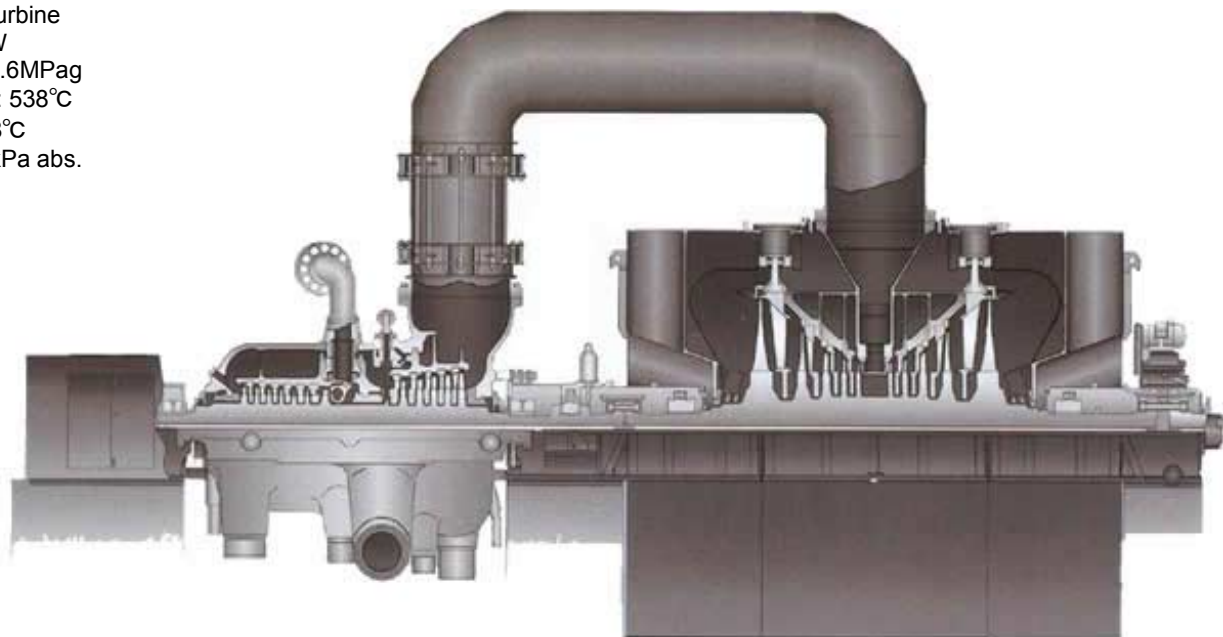
- Rated output : 100,000kW
- Main steam pressure : 8.6MPag
- Main steam temperature : 510°C
- Exhaust pressure : 8.00kPa abs.



Reheat Turbine (2-casing type)

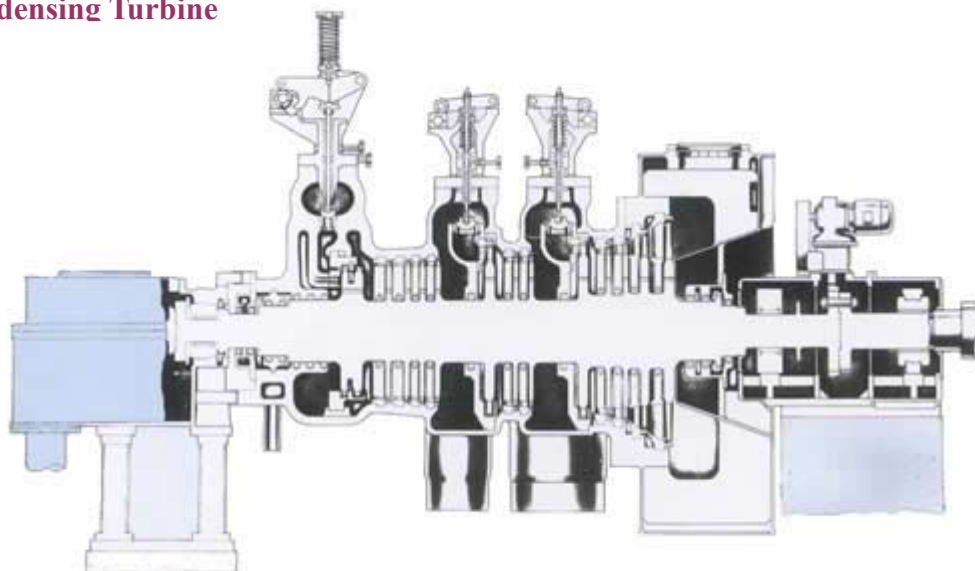
For large-capacity reheat turbine

- Rated output : 500,000kW
- Main steam pressure : 16.6MPag
- Main steam temperature : 538°C
- Reheat temperature : 538°C
- Exhaust pressure : 10.2 kPa abs.



Automatic-double-extraction Condensing Turbine

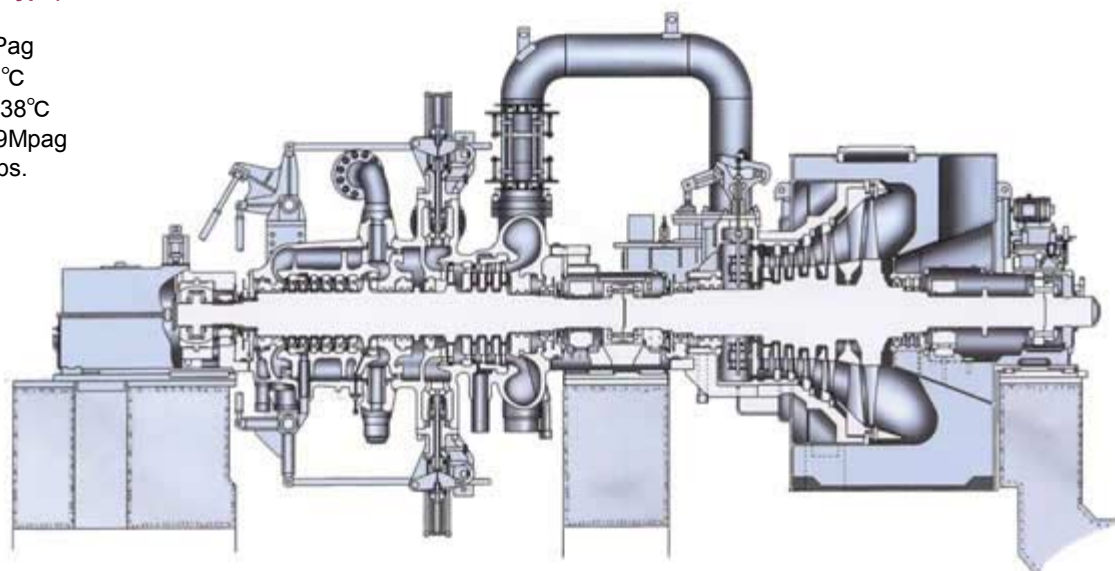
- Rated output : 30,000kW
- Main steam pressure : 10.0MPag
- Main steam temperature: 538°C
- Extraction pressure : 1.18/0.59MPag
- Exhaust pressure : 6.00kPa abs.



Automatic-double-extraction Reheat Turbine

(2-casing single exhaust flow type)

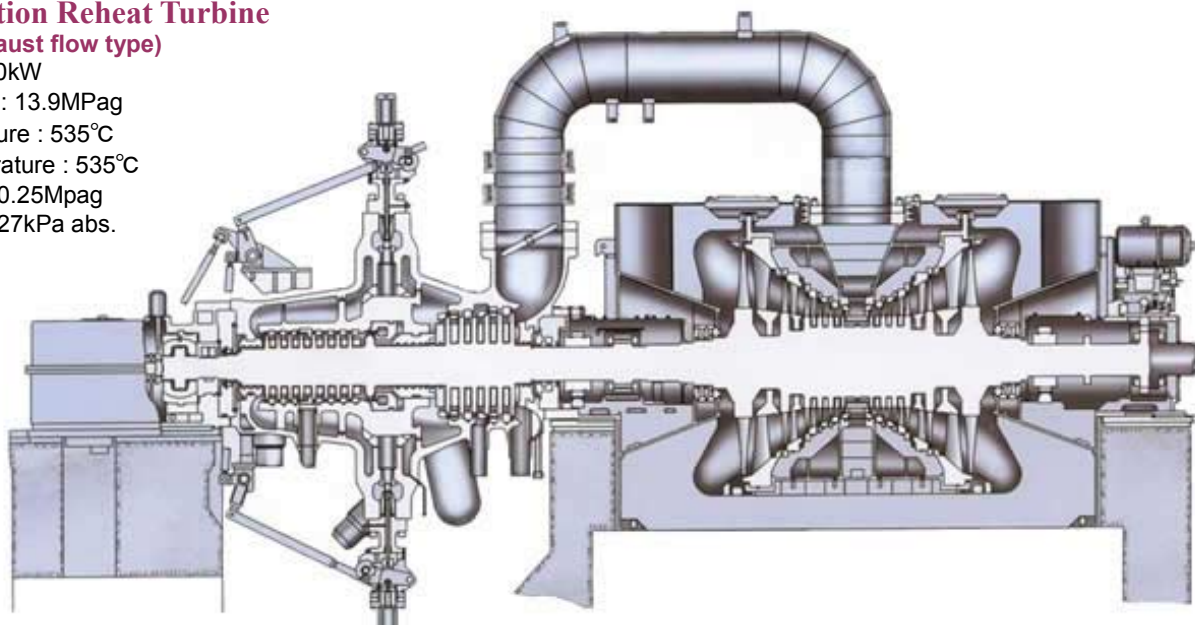
- Rated output: 149,000kW
- Main steam pressure : 16.6MPag
- Main steam temperature : 566°C
- Reheat steam temperature : 538°C
- Extraction pressure : 3.5 / 0.69MPag
- Exhaust pressure : 5.07kPa abs.



Automatic-extraction Reheat Turbine

(2-casing double exhaust flow type)

- Rated output: 300,000kW
- Main steam pressure : 13.9MPag
- Main steam temperature : 535°C
- Reheat steam temperature : 535°C
- Extraction pressure : 0.25MPag
- Exhaust pressure : 6.27kPa abs.



Improvement of Performance for Steam Turbine

Toshiba has conducted a great deal of research and development with the purpose of enhancing the internal efficiency of the steam turbine. The resulting technology improvements are as far as possible, built into each Toshiba machine, resulting in significant contributions towards improvement in overall plant thermal efficiency.

Advanced Techniques for Higher Efficiency

High Performance vane sections

A. Compound lean nozzle



Nozzles



Blades

B. Advanced flow pattern



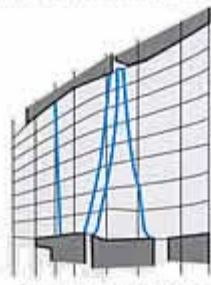
Nozzles



Blades

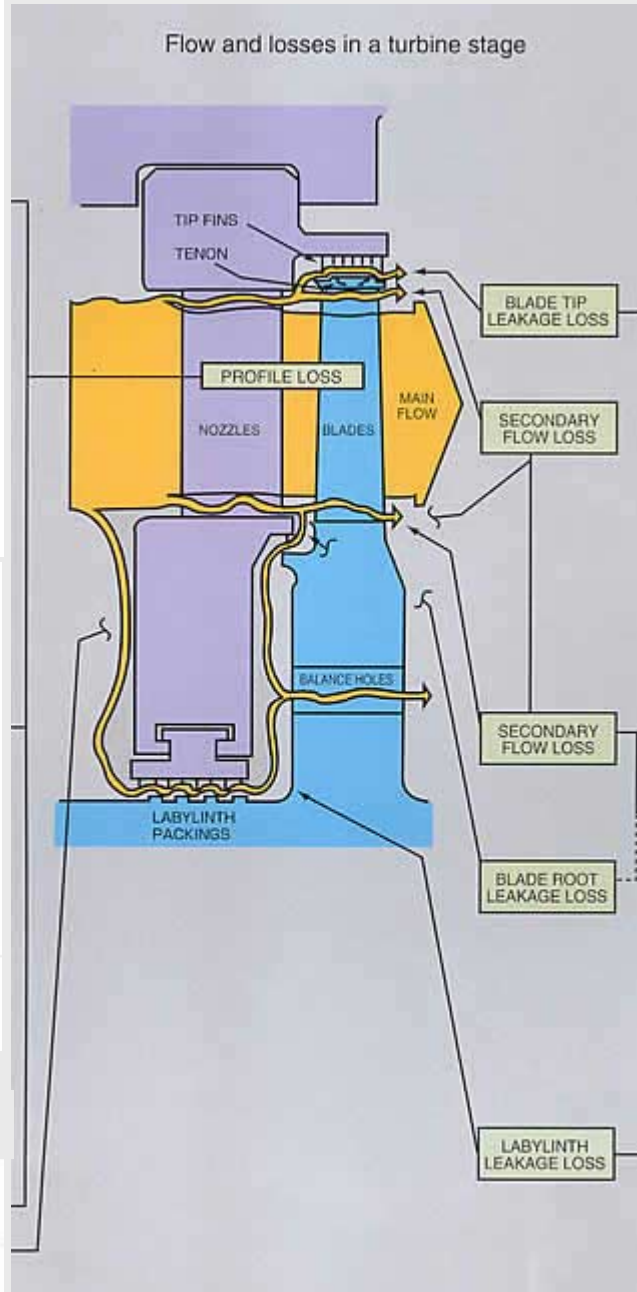
Improved flow pattern analysis

C. Three dimensional design



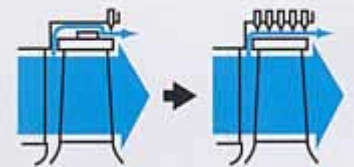
Stream lines by 3D design

Twisted blades with multiple profiles to meet actual stream line reduce secondary and profile losses.



Reducing and control of leakage

D. Multi-tip fins



Multi-tip fins accompanied with recessed tenon reduce the tip leakage flow.



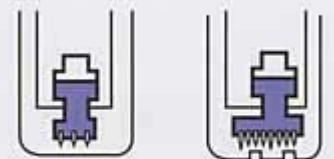
Multi-tip fins

E. Leakage control at root



Adequate root clearance and size of balance holes minimize the secondary flow losses.




F. Improved labyrinth packings



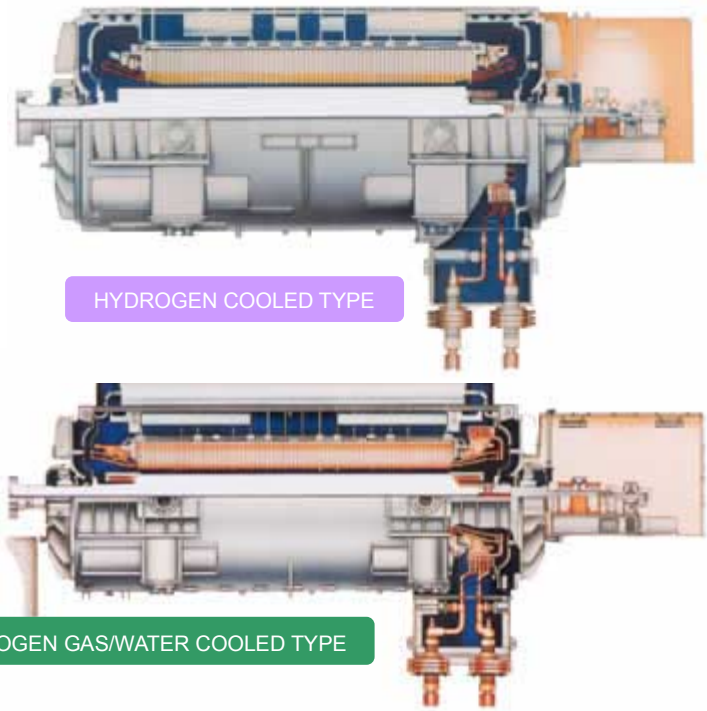
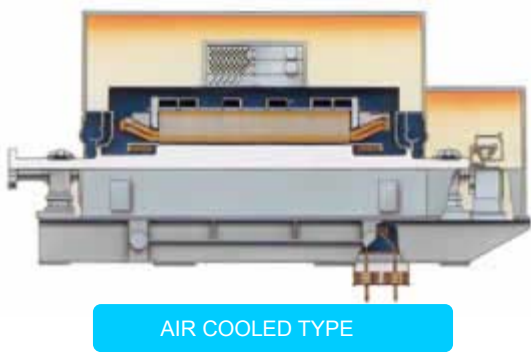
Modified nozzle labyrinth packings reduce the leakage flow.

Generator and Excitation System

Generator Output and Cooling System

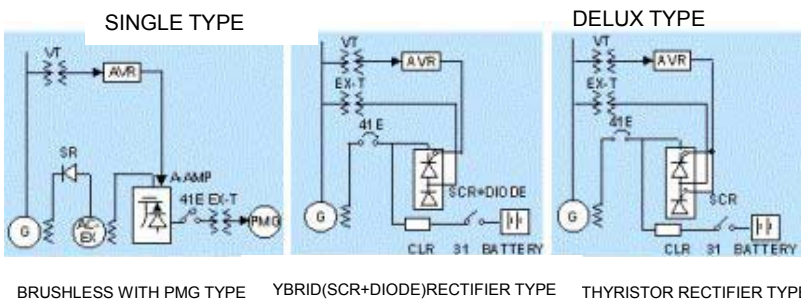
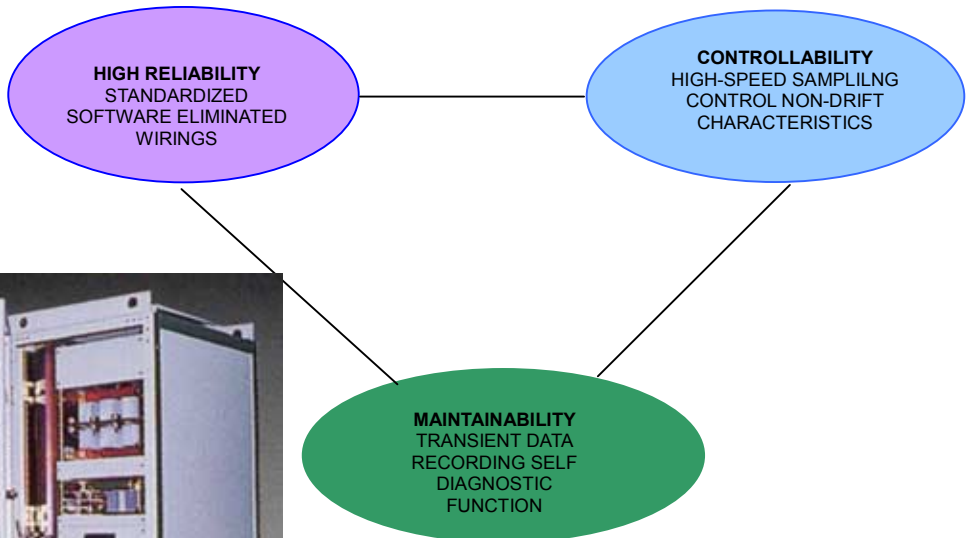
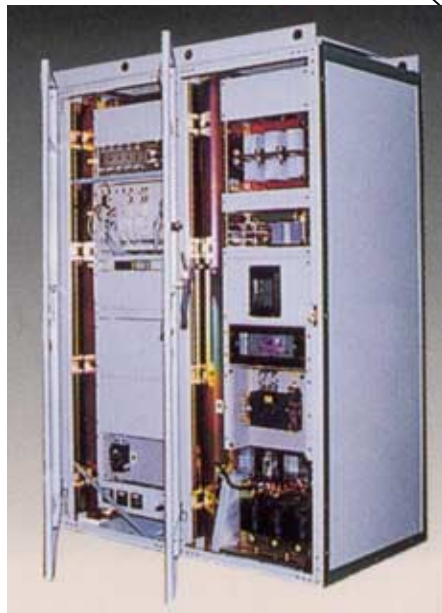
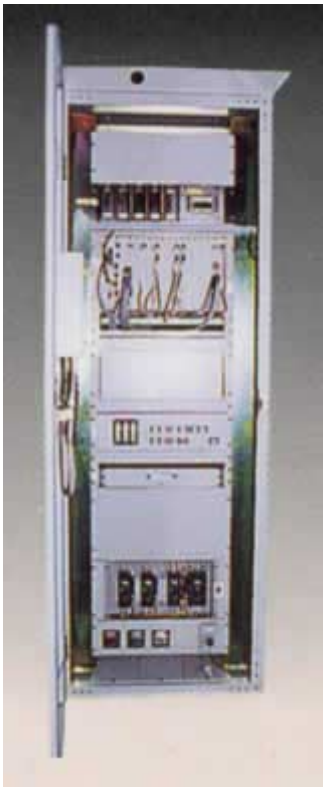
RATED OUTPUT (MVA)	100	200	300	400	500	Features
<p style="text-align: center; background-color: #00AEEF; color: white; padding: 5px;">AIR COOLED TYPE</p> 	■					<p>HIGH RELIABILITY ●Class F insulation is highly resistant to moisture and chemicals.</p> <p>SHORT DELIVERY ●Modular design and standardized components offers short delivery.</p> <p>EASY INSTALLATION AND MAINTENANCE ●Generators are shipped in the completely assembled style so as to reduce site erection period. ●Brushless exciters are free from inspection and replacement of brushes.</p>
<p style="text-align: center; background-color: #9933CC; color: white; padding: 5px;">HYDROGEN GAS COOLED TYPE</p> 	■	■	■	■		<p>HIGH RELIABILITY ●Class F insulation is highly resistant to moisture and chemicals.</p> <p>HIGH PERFORMANCE ●High performance is provided by effective cooling and loss reduction techniques.</p> <p>EASY MAINTENANCE ●Less auxiliary equipment provides easy maintenance.</p> <p>EXCITATION SYSTEM ●Brushless or static type excitation system is applied.</p>
<p style="text-align: center; background-color: #008000; color: white; padding: 5px;">HYDROGEN GAS/WATER COOLED</p> 	■	■	■	■	■	<p>HIGH RELIABILITY ●Class F insulation is highly resistant to moisture and chemicals.</p> <p>HIGH PERFORMANCE ●High performance is provided by effective cooling and loss reduction techniques.</p> <p>COMPACT MACHINE SIZE ●Machine size is reduced by application of hydrogen and water as cooling medium.</p> <p>EXCITATION SYSTEM ●Static type excitation system is applied. Control and Instrumentation System</p>

Generator Sectional View



Excitation System

Features of Digital AVR



CONTROL FUNCTIONS

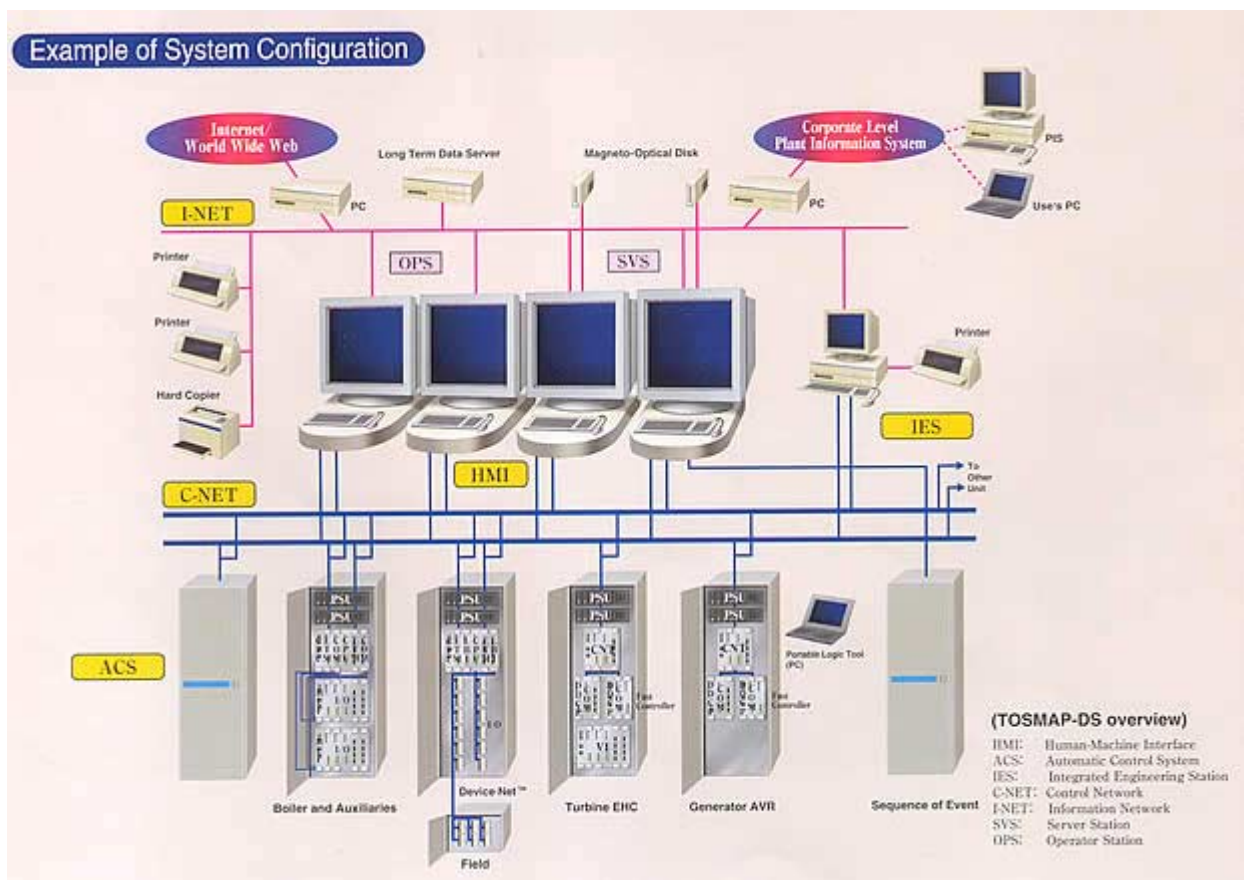
FUNCTION	STANDARD	OPTION
AUTOMATIC VOLTAGE REGULATOR	•	
MANUAL EXCITATION CONTROL	•	
AUTOMATIC FOLLOW UP	•	
CROSS CURRENT COMPENSATOR	•	
UNDER EXCITATION LIMITER	•	
OVER REACTIVE POWER LIMITER OR OVER EXCITATION LIMITER	•	
VOLT/FREQUENCY LIMITER	•	
AUTO REACTIVE POWER REGULATOR		•
OVER CURRENT LIMITER		•
LINE DROP COMPENSATOR		•
POWER SYSTEM STABILIZER		•

Control and Instrumentation System

Distributed Control System (DCS)

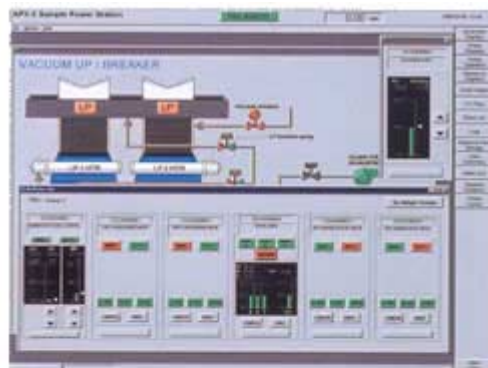
Electricity is a vital commodity for maintaining and improving the living standards of society today. To ensure adequate and reliable supplies of electric power whenever and wherever needed, Toshiba now offers a dynamic stream for the 21st century, the TOSMAP-DS, Toshiba Microprocessor Aided Power system control-Dynastream, which is a state-of-the-art Distributed Control System (DCS) developed for total power plant control. To satisfy customer needs, TOSMAP-DS features:

- Comprehensive integration of plant control
- Open and flexible system
- Easy and unified engineering environment
- Fully independent Human-Machine Interface stations
- Powerful and reliable controller

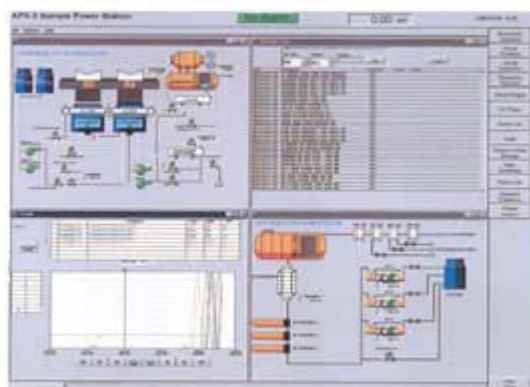


Standard Functions

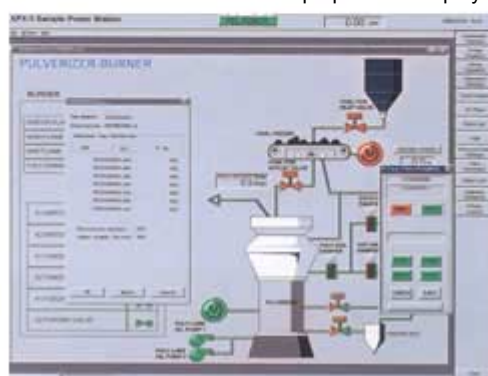
- Schematic display
- Group display
- Group operation
- Sequence display
- Trend graph
- X-Y plot
- Event list
- Log service
- Historical data storage
- Data summary
- Alarm list
- Operator guidance
- TAG information



Group operation display



Multi-Window display



Graphic display with Face Plate & TAG information

Digital Electro-Hydraulic Control System (D-EHC)

Features

- High speed control to enable fully digitized control
- Redundant system
- Easy connection to DCS
- Easy maintenance with logic loader
- CRT based operation (option)
- Open interface to other systems: RS232C/Modbus, etc..(option)

Functions

- Turbine speed control
- Load control
- Load limiting
- Line speed matching
- Automatic turbine start-up
- Back-up overspeed governor
- Turbine overspeed test
- Initial pressure regulation (option)
- Load limit/reference follower (option)
- Automatic frequency control (option)
- Automatic load regulator (option)
- Turbine bypass valve control (option)
- Hard wired logic emergency trip system (option)
- Auxiliary equipment control (option)
- Turbine valves test (option)



CRT(option)



D-EHC CUBICLE



145MW Industrial Power Station



149MW Double Extraction Turbine Generator



149MW Steam Turbine Rotor



166MVA Air Cooled Generator



Single Cylinder Type Turbine Casing

TOSHIBA

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