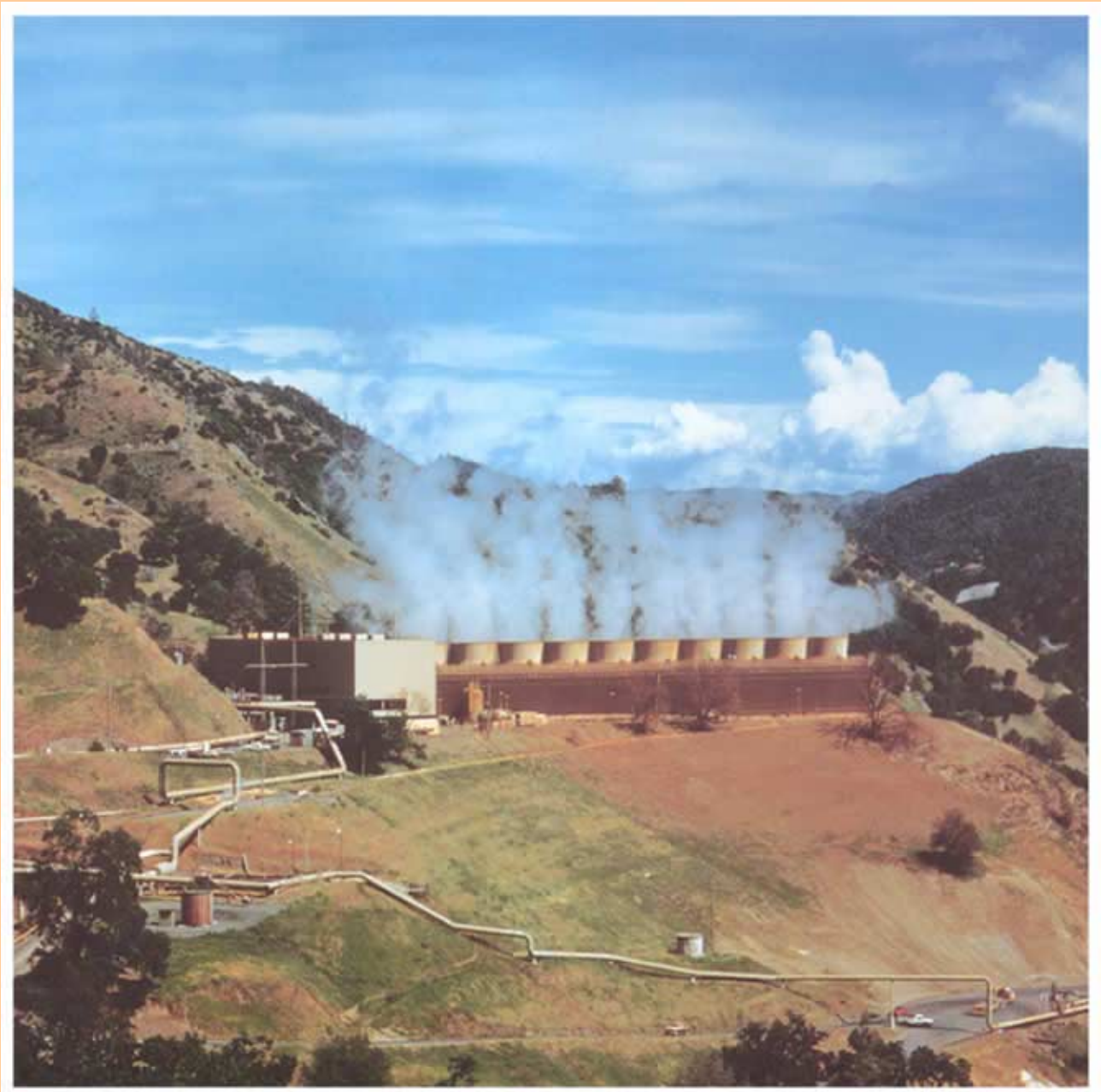


TOSHIBA

GEOHERMAL POWER PLANT



In 1965 Toshiba manufactured, for the first time, a 22,000 kW turbine-generator for the Matsukawa geothermal power plant in Japan. Since then, we have delivered a large number of geothermal turbines to power plants in the USA, Mexico, the Philippines and Japan. These geothermal turbines have almost all established records in output power, performance, turbine type, etc.

In 1976, Toshiba was awarded a prize by the Japan Society of Mechanical Engineers for the design of a 110,000 kW geothermal turbine delivered to the Geysers Power Plant, Pacific Gas & Electric Co., in the USA. Furthermore, Toshiba participated in a national project called the "Sunshine Project", and manufactured binary-cycle power generating equipment which uses hot water.

Today, Toshiba as a leading manufacturer of geothermal power has contributed to a major part of the world's geothermal development.

Toshiba geothermal turbines are designed, manufactured and constructed on the basis of such abundant experience. We are ready to supply turbines of any specification to our customers.



ACTIVITIES OF TOSHIBA IN THE PAST

ASSURE RELIABILITY

Year	Activity	Note
1965	•20MW unit for Matsukawa GPP (Japan)	•First geothermal power plant for commercial use in Japan •Steam dominated type •Capacity was increased to 22MW in 1973
1966	•Commissioned Matsukawa GPP	
1967	•55MWx3 units for Geysers GPP (USA)	•First exported geothermal turbine generator •Double flow type
1968	•37.5MWx2 units for Cerro Prieto GPP (Mexico)	•Largest hot water dominated GPP at that time
1970	•55MW x 3 units for Geysers GPP (USA) •110MW x 2 units for Geysers GPP (USA)	•Tandem compound 4 flow, 2 casing turbine •Largest capacity of steam dominated type at that time
1974	•55MW x 4 units for TIWI GPP (Philippines) •114MW unit for Geysers GPP (USA) •Start R & D program of binary cycle power plant under Agency of Industrial Science and Technology, the Ministry of International Trade and Industry, Japan.	•Double flash type •Altered to single flash type in 1982
1975	•1.3MW turbine generator for TIWI GPP (Philippines)	•For supplying electric power during construction and at black out start of the GPP
1976	•50MW unit for Kakkonda GPP (Japan) •37.5MW x 2 units for Cerro Prieto GPP (Mexico) •Awarded a prize by the Japan Society of Mechanical Engineers (JSME) for the design of 110MW geothermal turbine	
1977	•124MW x 2 units for Geysers GPP (USA)	
1978	•Succeed in operation of 1 MW binary cycle plant in Nigorikawa, Japan	•Maximum output of 1090 kW was attained. (Largest at that time)
1979	•55MW x2 units for TIWI GPP (Philippines) •Awarded Prize by Prime Minister of Japan for design, manufacturing and construction of Kakkonda GPP •50MW unit for Mori GPP (Japan)	•Large capacity non-condensable gas blower is directly coupled to the main turbine because of high N.C.G. content in steam (10% by weight)
1980	•124MW unit for Geysers GPP (USA) •110MWx4 units for Cerro Prieto GPP (Mexico)	•Largest double flash turbines
1981	•48.5MW x 2 units for Oxy GPP (USA)	•Dual rating machine
1984	•5MW unit for HE (Mexico)	•Portable wellhead type
1984	•66.2MW x 2 units for Coldwater Creek GPP (USA)	

Note: Unless otherwise stated, the year in the above list shows the year when order was placed.

FEATURES OF THE TOSHIBA GEOTHERMAL TURBINE

TOP SUPPLIER

Up to now, Toshiba has received orders for 45 units, which total 2,444.8MW in capacity. Toshiba holds 44% of world's market share and is the top supplier in the world.

ABUNDANT EXPERIENCE

Toshiba has abundant experience in designing, manufacturing, erecting and operating geothermal power plants all over the world. Because of this, Toshiba is the best geothermal power generating equipment supplier.

HIGH RELIABILITY

Toshiba's geothermal power plant has a high reliability backed by well proven design and abundant field experience.

VARIOUS TYPES

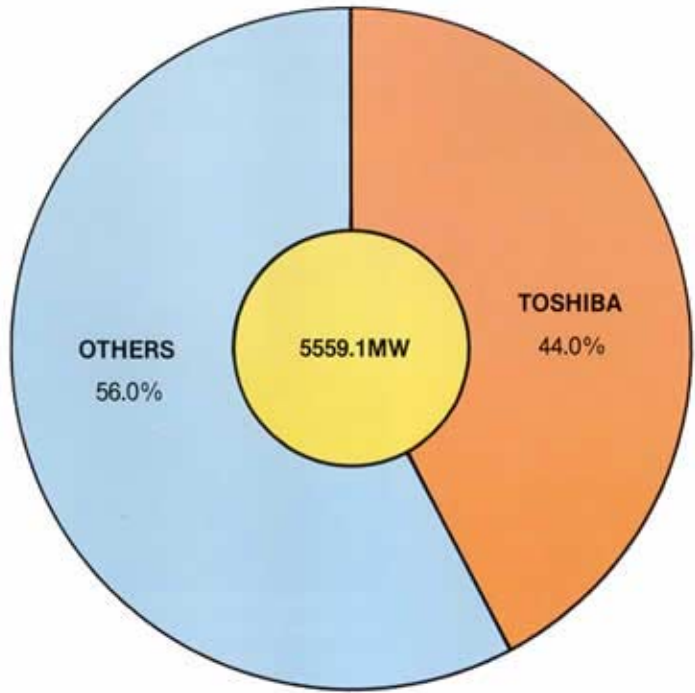
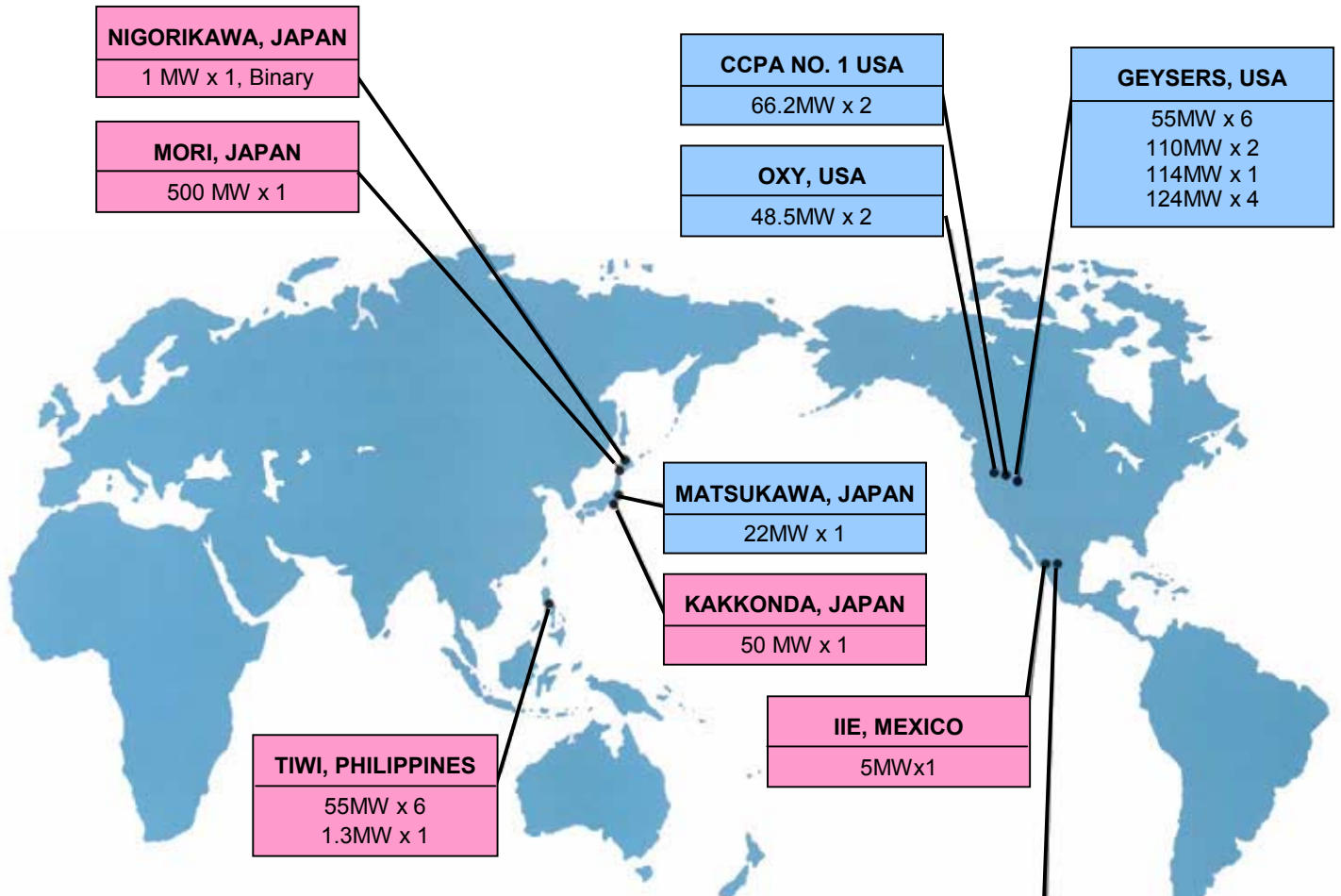
We have a wide variety of geothermal power plants, which range from a 500 kW class portable type to a large capacity 150 MW class for central power station use.

SYSTEM ENGINEERING

Toshiba can carry out system engineering not only for turbines and generators but also for entire geothermal power plant including the supply of-

- Separators
- Flashers
- Condensers
- Non-condensable gas removal system
- Pumps
- Piping and valves
- Station electrical equipment
- Instrumentations and controls

WORLDWIDE DISTRIBUTION OF TOSHIBA GEOTHERMAL POWER PLANT



; Dry Steam Type
 ; Hot Water Type

TOSHIBA'S GEOTHERMAL POWER PLANT IN THE WORLD



Matsukawa Geothermal Power Plant
Tohoku Electric Power Corp., Japan
1 x22MW

First geothermal power plant commercially operated in Japan.



Cerro Prieto Geothermal Power Plant
Commission Federal de Electricidad, Mexico
4x37.5MW, 4x110MW

World's largest 110MW double flash geothermal power generating units.



Geysers Geothermal Power Plant
Pacific Gas & Electric Co., USA
6x55MW, 2x110MW, 1x114MW 4x124MW

The largest geothermal power generating field in the world. Toshiba supplied 13 turbines and generator units.



Tiwi Geothermal Power Plant
National Power Corp., Philippines
6x55MW

Total power plant is supplied by Toshiba.



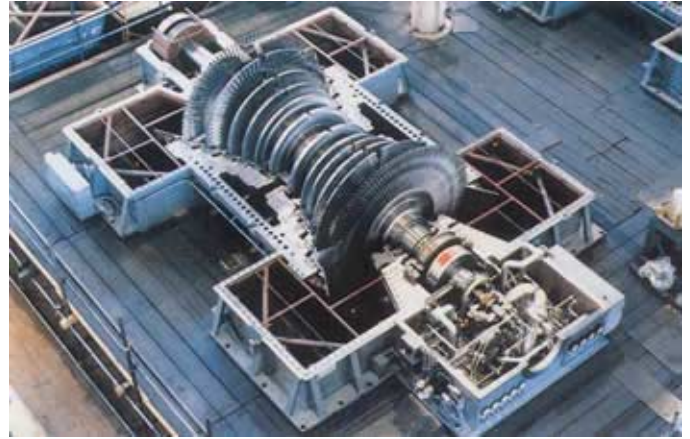
Mori Geothermal Power Plant
Hokkaido Electric Power Corp., Japan
1 x 50MW

Large capacity gas compressor directly coupled with the turbine is used to remove high noncondensable gas content.



Kakkonda Geothermal Power Plant
Tohoku Electric Power Corp., Japan
1 x 50MW

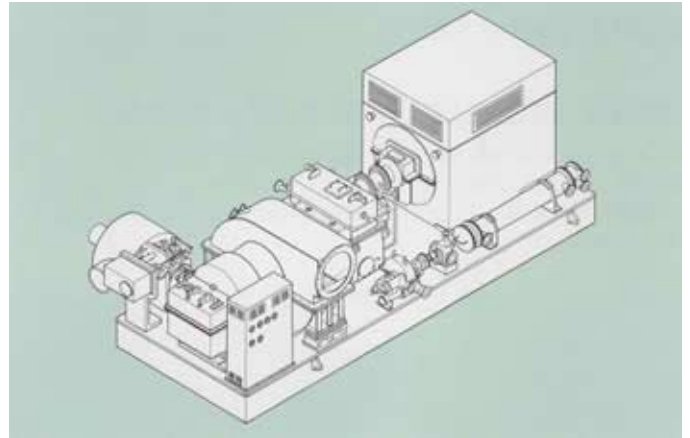
First geothermal power plant, which attained actual power output over 50MW in Japan.



Occidental Geothermal Inc., USA
2 x 48.5MW
Dual rating unit.



Nigorikawa Geothermal Power Plant
Agency of Industrial Science and Technology, MITI, Japan
1 x 1000kW
Binary cycle.



Mexico
Institute De Investigations Electricas, Mexico
1 x 5MW
Portable, wellhead type geothermal turbine and generator unit.

DESIGN AND CONSTRUCTION FEATURES OF THE TOSHIBA GEOTHERMAL TURBINE

HIGHLY EFFICIENT AND STRONG STEAM PATH

The steam path is designed on the basis of massive results of tests and studies and by means of the most advanced computer techniques so that the maximum stage efficiency can be obtained. The impulse type design, in which the diaphragm type nozzles are combined with strong cross section blades, is strong enough against foreign matter.

EFFECTIVE SEPARATION OF MOISTURE AND DUST

Moisture and dust in the steam path are satisfactorily shaken off by centrifugal force toward the outside wall. The wall is covered with a stainless steel impingement shield to prevent erosion.

HIGHLY RELIABLE LONG BLADE SERIES

12Cr steel blades backed up by close calculation and ample experience are adopted. Special care is given to determine blade width and blade tip shroud band construction.

STABLE AND LOW-FATT ROTOR

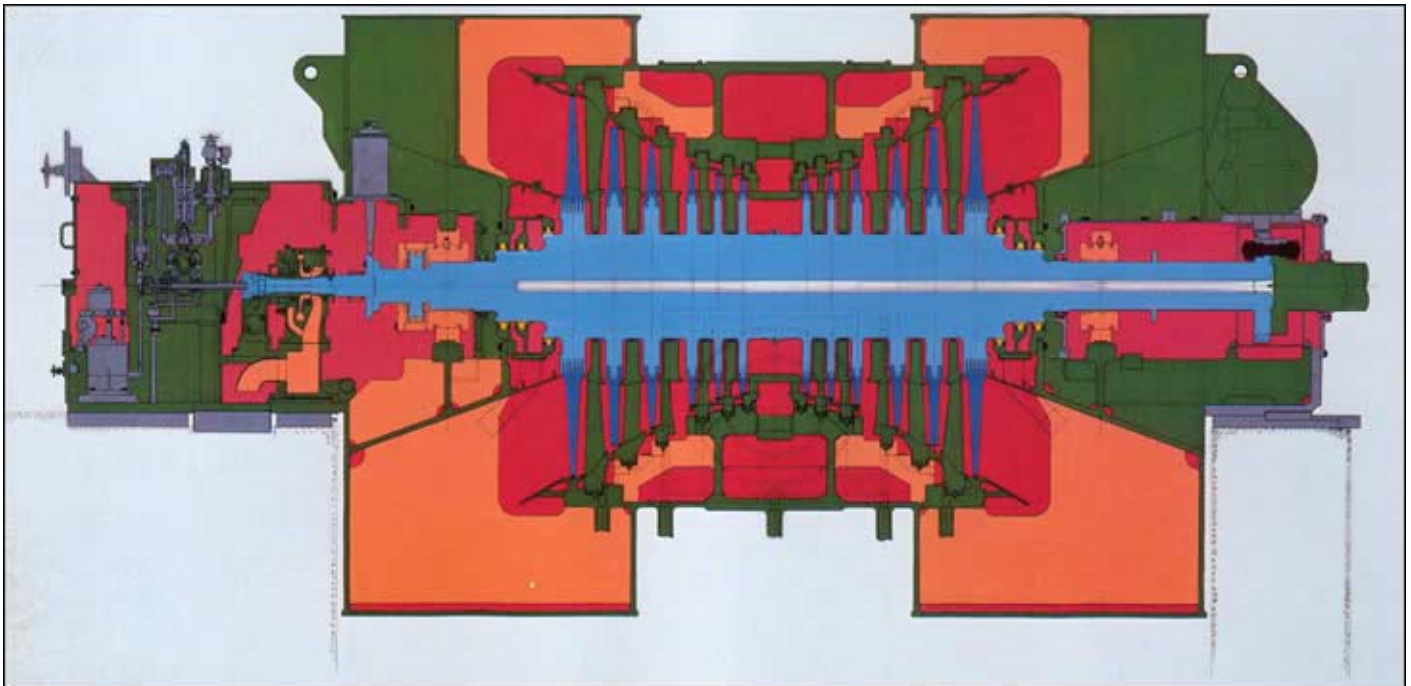
The turbine rotor which rotates in erosive steam is made of highly corrosion-proof Cr- Mo-V steel. This rotor is a low-FATT type, which has been used for many high and intermediate-pressure united rotors of fossil fuel turbines.

SIMPLE SINGLE-SHELL CONSTRUCTION

Simple single-shell construction without internal casing makes maintenance work easy. Furthermore, careful consideration is given to minute details including the dust-and-drain preventing and disposal structures, corrosion-resisting protector, and the inspection manhole.

SIMPLE AND RELIABLE STEAM VALVE

Butterfly type control valves are used to regulate a large voluminous steam flow and a poppet type main stop valve is provided to assure accurate shutting off of the steam flow when the turbine is stopped. An internal bypass valve, assembled in the main stop valve, stabilizes control in the low steam flow range.



REFERENCE LIST OF TOSHIBA GEOTHERMAL POWER PLANT

Purchaser	Station and Unit No.	Rating (kW)	Status
Pacific Gas and Electric Co.	Geysers #16	124,000	4/83
Pacific Gas and Electric Co.	Geysers #17	124,000	12/82
Pacific Gas and Electric Co.	Geysers #18	124,000	2/83
Pacific Gas and Electric Co.	Geysers #20	124,000	Order(12/84)
Pacific Gas and Electric Co.	Geysers #14	114,000	9/80
Mexico, Commission Federal de Electricidad	Cerro Prieto II #1	110,000	4/82(FOB)
Mexico, Commission Federal de Electricidad	Cerro Prieto II #2	110,000	9/82(FOB)
Mexico, Commission Federal de Electricidad	Cerro Prieto III #1	110,000	2/83(FOB)
Mexico, Commission Federal de Electricidad	Cerro Prieto III #2	110,000	3/83(FOB)
Pacific Gas and Electric Co.	Geysers #11	110,000	11/75
Pacific Gas and Electric Co.	Geysers #12	110,000	3/79
USA Customer	CCPA	66,270	Order (5/86 FOB)
USA Customer	CCPA	66,270	Order (5/86 FOB)
Pacific Gas and Electric Co.	Geysers #5	55,000	9/71
Pacific Gas and Electric Co.	Geysers #6	55,000	9/71
Pacific Gas and Electric Co.	Geysers #7	55,000	7/72
Pacific Gas and Electric Co.	Geysers #8	55,000	9/72
Pacific Gas and Electric Co.	Geysers #9	55,000	9/73
Pacific Gas and Electric Co.	Geysers #10	55,000	11/73
Philippines, National Power Corporation	Tiwi #1	55,000	5/79
Philippines, National Power Corporation	Tiwi #2	55,000	8/79
Philippines, National Power Corporation	Tiwi #3	55,000	4/80
Philippines, National Power Corporation	Tiwi #4	55,000	7/80

Purchaser	Station and Unit No.	Rating (kW)	Status
Philippines, National Power Corporation	Tiwi #5	55,000	2/82
Philippines, National Power Corporation	Tiwi #6	55,000	4/82
Hokkaido Electric Power Corp.	Mori #1	50,000	11/82
Tohoku Electric Power Corp.	Kakkonda #1	50,000	5/78
Occidental Geothermal Inc.	Oxy Geothermal Plant #1	48,500	5/84
Occidental Geothermal Inc.	Oxy Geothermal Plant #2	48,500	5/84
Mexico, Commission Federal de Electricidad	Cerro Prieto #1	37,500	4/75.3
Mexico, Commission Federal de Electricidad	Cerro Prieto #2	37,500	7/75.3
Mexico, Commission Federal de Electricidad	Cerro Prieto #3	37,500	4/79
Mexico, Commission Federal de Electricidad	Cerro Prieto #4	37,500	4/79
Japan Metals and Chemicals Co., Ltd.	Matsukawa #1	22,000	10/66
Institute De Investigations Electrics	(Mexico)	5,000	Order (8/85 FOB)
Philippines, National Power Corporation	Tiwi #1 (house T/G)	1,300	12/78
Japanese Government	Nigorikawa	1,000	7/78
Mexico, Commission Federal de Electricidad	Cerro Prieto II #1 (for compressor)	750	Order (4/82 FOB)
Mexico, Commission Federal de Electricidad	Cerro Prieto II #1 (for compressor drive)	750	Order (4/82 FOB)
Mexico, Commission Federal de Electricidad	Cerro Prieto II #2 (for compressor drive)	750	Order (8/82 FOB)
Mexico, Commission Federal de Electricidad	Cerro Prieto II #2 (for compressor drive)	750	Order (8/82 FOB)
Mexico, Commission Federal de Electricidad	Cerro Prieto III #1 (for compressor drive)	750	Order (12/82 FOB)
Mexico, Commission Federal de Electricidad	Cerro Prieto III #1 (for compressor drive)	750	Order (12/82 FOB)
Mexico, Commission Federal de Electricidad	Cerro Prieto III #2 (for compressor drive)	750	Order (3/83 FOB)
Mexico, Commission Federal de Electricidad	Cerro Prieto III #2 (for compressor drive)	750	Order (3/83 FOB)
Total	45 Units	2,444.8MW	

TOSHIBA HEAVY ELECTRIC APPARATUS GROUP

The Toshiba Heavy Electric Apparatus Group is making contributions to promote industrial expansion and improve living the conditions of the general public.



Keihin Product Operations

Tsurumi Works

4, 2-chome, Suehiro-cho, Tsurumi ku, Yokohama 230, Japan
Tel. (045)-511-1351

- Main Products
Nuclear reactors and related equipment, nuclear-power turbine generators, steam turbine generators, water turbines, pump turbines, water turbine auxiliary equipment, valves, water turbine generators, diesel generators, DC generators, DC motors, 3-phase induction motors, synchronous motors, and motor-generator sets



Keihin Product Operations

Turbine Works

4, 2-chome, Suehiro-cho, Tsurumiku, Yokohama 230, Japan
Tel. (045)-509-3461

Keihin Product Operations

Turbine west Branch Works

9, 1-chome, Suehiro-cho, Tsurumiku, Yokohama 230, Japan
Tel. (045)-509-3631

- Main products
Nuclear power turbines, steam turbines, gas turbines, condensers and other accessory equipment



Fuchu Works

1, Toshiba-cho, Fuchu City, Tokyo 183, Japan
Tel. (0423)-66-1111

- Main products
Control systems/equipment used in electric power, industry, public utilities, and traffic systems



Hamakawasaki Works

(Power Transmission and Transformation Equipment)

2-1 Ukishima-cho, Kawasaki-ku, Kawasaki, Japan

Tel. (044)-277-2111

- Main products
Large-scaled transformers, air blast circuit breaker, gas circuit breakers, enclosed switchgears, lightning arresters, instrument transformers, on-load voltage regulators.

TOSHIBA

TOSHIBA CORPORATION

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