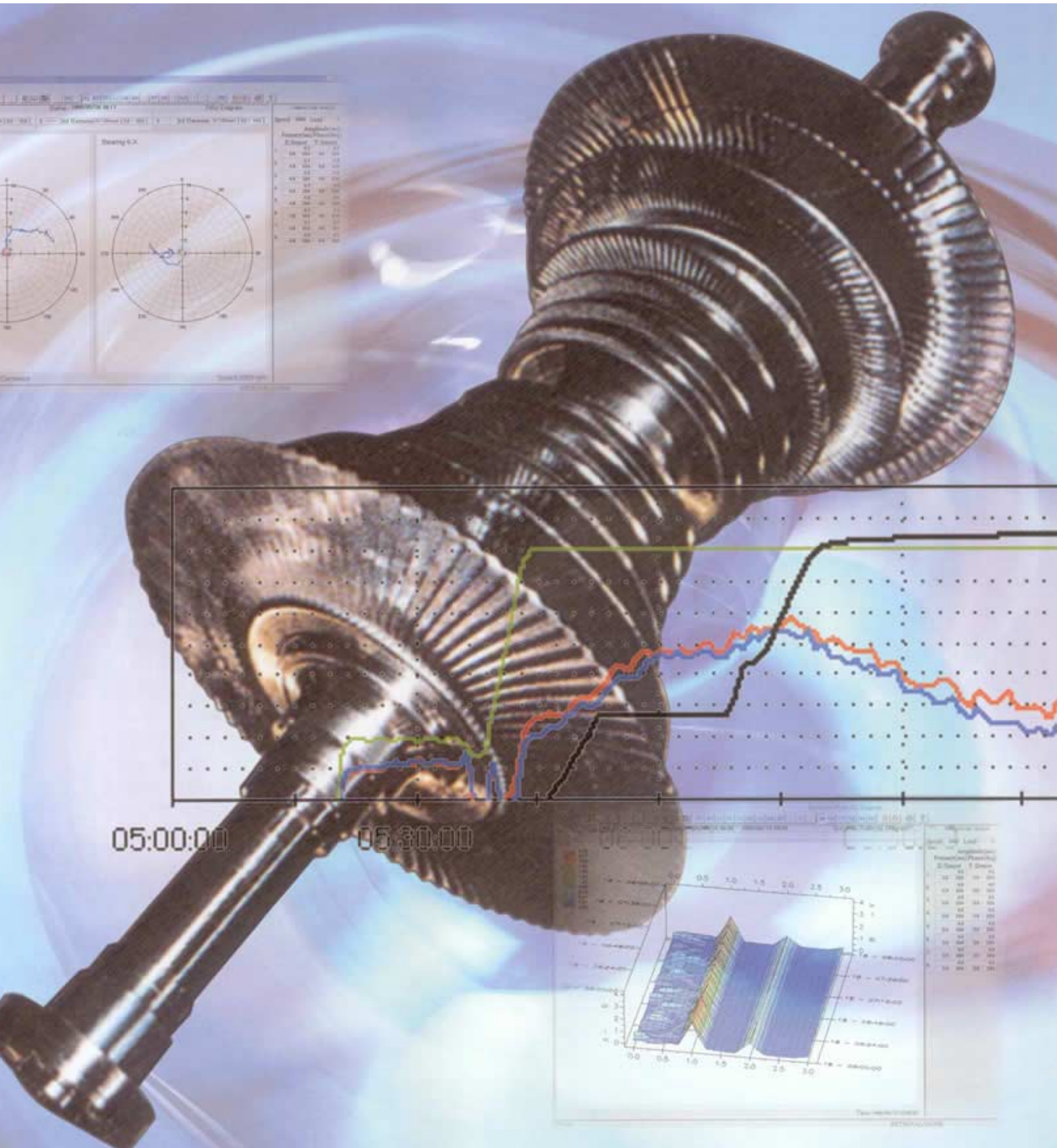
TOSHIBA

VIBRATION MONITORING AND DIAGNOSTIC SYSTEM FOR TURBINE AND GENERATOR



Recently, the need for increased reliability of electric power plants as well as reduction of maintenance costs have increased remarkably, not only in Japan but around the world. In order to achieve such target goals, the following concepts are considered essential.

1. How to avoid unexpected plant outages by means of reliable diagnostic systems that can pinpoint potential problems before equipment failure.
2. How to reduce unexpected and unnecessary maintenance costs by implementation of planned maintenance's systems.

Thus, the vital significance of developing and applying advanced monitoring and diagnostic technologies for power plant equipment has rapidly been acknowledged by the power plant industry and equipment manufacturers.

In response to such needs, Toshiba has developed various technologies such as sophisticated computer-based programs for data analysis and intelligent diagnosis. Based on Toshiba's many decades of experience in the power plant and equipment-manufacturing sectors, the company has supplied numerous and diverse applications to improve the efficiency and reliability of both existing and new power plants.

Now, Toshiba herein proposes that power-plant operators consider our highly reliable, advanced vibration monitoring and diagnostic systems for turbine-generators. Our technologies will enable plant managers to achieve significant time and cost benefits for turbine-generator operation, from the point of view of equipment availability and maintenance costs.

AIMS OE TOSHIBA'S VIBRATION-MONITORING AND DIAGNOSTIC SYSTEMS

ENHANCEMENT OF UNIT'S RELIABILITY AND AVAILABILIT

- ♦Reinforcement of vibration-monitoring during normal operation
- ♦Finding of abnormal symptoms in its early stages, Speedy action and early restoration

REDUCE EQUIPMENT-MAINTENANCE COSTS

- ♦Prevent equipment damage by early detection of abnormal conditions
- ♦Enable application of speedy troubleshooting procedures

REDUCE THE PERIOD OF REQUIRED PERIODICAL INSPECTIONS

- ♦Analyze historical trends of the plant equipment, and incorporate such analysis into future planned inspections
- ♦Reduce the need for plant trial-operation periods by applying Toshiba's more efficient system auto-balancing technologies

REDUCE OPERATORS' WORK LOAD

- ♦Operational improvement by applying more precise monitoring of a wider range of plant operating conditions.

SYSTEM FEATURES

Advanced monitoring and logic-based diagnostic functions that have been developed as a result of Toshiba's decades of international experience as a power plant supplier:

- Man-machine interface offers maximum user-friendly features based on high resolution, full-color, graphic interface of personal computers equipped with Microsoft Windows™.
- Advanced system offers simultaneous monitoring and diagnostic capacity for two power-plant units.
- Combined monitoring of both real-time and historical data
- Constant, automatic storing of system data during diagnosis.
- Easy, compatible interface with the existing TS I Applicable for all types of sensors, gap sensors (one way, two ways), on-shaft sensors and pedestal sensors.
- Interface compatibility with user's existing computer systems and DCS.

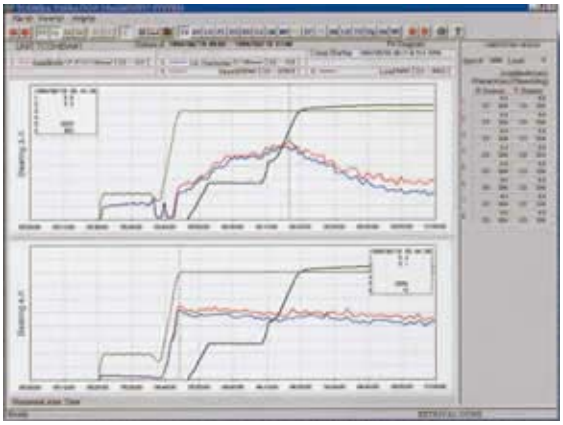
SYSTEM FUNCTIONS

MONITORING

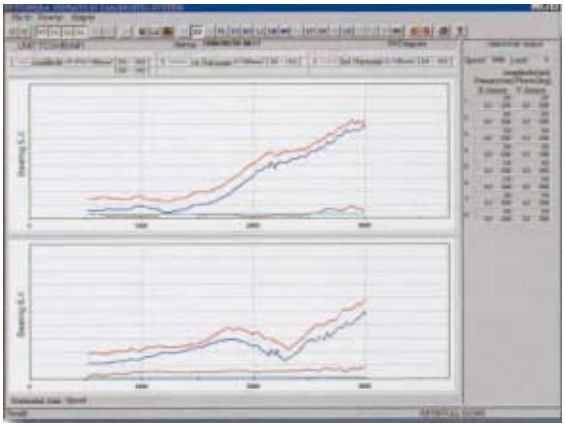
The system enables easy, intuitive operation of turbine-generator's sophisticated monitoring functions-despite any elaborate operating conditions-by use of colorful, high-resolution operator terminals and printer output devices that provide immediate access to real-time online and off-line data (e.g., equipment's historical data). Monitoring via operator's terminals can easily be switched between dual-shaft and eight-shaft monitoring.

- ♦ T-V (time vs. amplitude) diagram
- ♦ S-V (speed vs. amplitude) diagram
- ♦ L-V (load vs. amplitude) diagram
- ♦ Polar diagram
- ♦ Bode diagram
- ♦ Spectrum plot
- ♦ Lissajous plot (option)
- ♦ Waveform plot
- ♦ Excursion plot of shaft center (option)
- ♦ Bar-chart plot
- ♦ List plot
- ♦ Process parameters
  (speed, load, vacuum, metal temperature, bearing-supply oil temperature, etc.)
- ♦ Combined data plot
  (S-V, polar and excursion plots can be displayed using on- line and off-line data only during two-way operation)

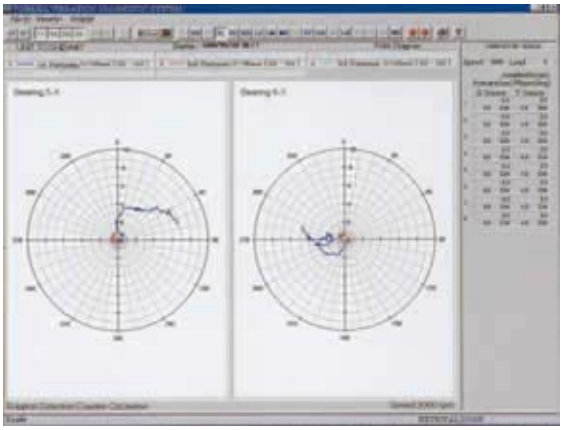
●T-V (time vs. amplitude) diagram



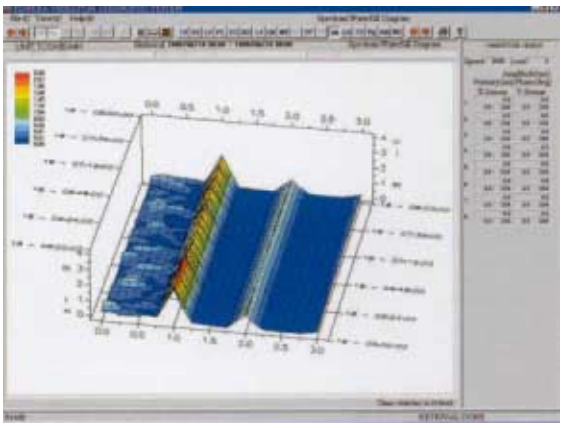
●S-V (speed vs. amplitude) diagram



●Polar diagram



● Spectrum plot

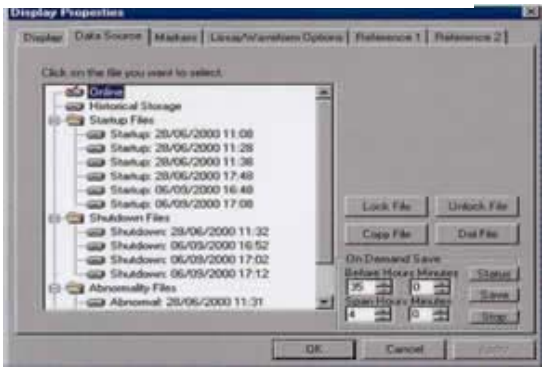


PROCESSING OF HISTORICAL DATA

Storage of all data recorded under various operating conditions is done automatically, enabling thorough and speedy analysis and diagnosis. And also, cope with data storage requirements by manual.

- ♦ Start and stop . . . Data is stored for the unit's previous 30 starts and stops, at shaft-revolution intervals of 25rpm.
- ♦ Normal operation . . .The following plant-system data shall be accumulated and stored: 36hours(at 2-second intervals), three-week (at 1-minute intervals), two years (at 1-hour intervals).
- ♦ Abnormal condition . . . When an abnormal vibration occurs, the system records and presents data from 30 minute before the abnormal event to 30 minutes after, at intervals of 2 seconds.
- ♦ on demand. . According to operator's demand, the system records data for max. 4-hours, at 2 sec. intervals.

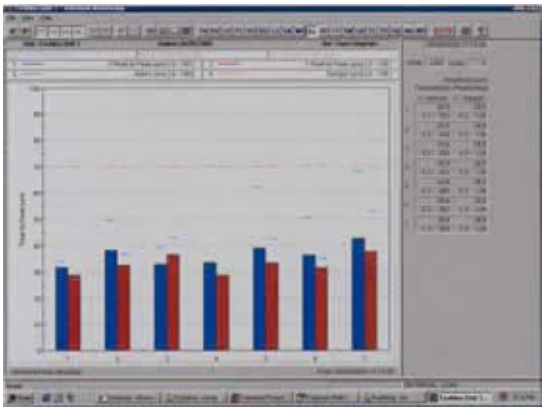
● Selection of historical data



DETECTION OF ABNORMAL EVENTS

- ♦ Detection of abnormal vibrations is assured through real-time analysis data such as amplitude level/change rate, vector change rate ,and spectrum level. Data for such factors are displayed on operator's terminals. And abnormal events are simultaneously announced.
- ♦ Software maintenance.... Various criteria for fault-detection and diagnosis can be set via system software to better suit the particular needs and parameters of individual power plants.

● Example of display in bar chart



ANALYSIS AND DIAGNOSIS

Expert computer and knowledge systems are applied via the system's analysis and diagnostic functions, resulting from Toshiba's decades of experience as a major international supplier of power plants, as well as an industry-leading manufacturer of high-tech electronics.

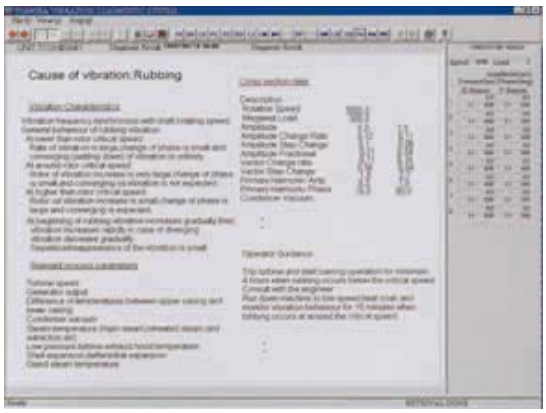
- ♦ When abnormal symptoms are detected, their causes are diagnosed at real-time speed and a probable cause is presented to the system operator.
- ♦ Based on the system's real-time analysis of potential faults, the plant operator is presented with a recommended procedure of action.

◙ High correlation
○ Correlation

		Vibration frequency				Time dependence				Speed dependence	
		Synchronous	Energy value	Fractional harmonic	Second harmonic	Long term change	Short term change	Step change	Load dependence	Run-up	Run-down
Unbalance	Loss of rotational part	◙						◙			
	Aging bend of rotor	◙				◙					
	Thermal characteristics of rotor	◙				○					○
	Coupling center misalignment	◙			○			◙	◙		○
	Residual unbalance	◙									
	Coupling eccentricity	◙									
Rubbing		◙	○	○	○						
Alignment change		◙				○					
Unstable Vibration	Oil whirl			○							
	Oil whip		◙								
	Insufficient oil supply		○	○							
	Steam whirl		◙								
	Internal friction		◙								
Support rattle				◙							
Rotor crack		○									

Characteristics of causes and phenomena of vibration (sample)

● Diagnosis and guidance display



BALANCING SUPPORT (Option)

Outline

A function to support a field balancing work for a turbine power generator at a power plant.

System Features

- A weight effect can be checked in a graphic form on a S-V diagram and polar diagram.
- Vibration data stored in a vibration monitoring diagnostic unit can be read in a CSV format.
- An excellent man machine interface utilizing Windows PC.

Effects

- An optimum balancing weight can be calculated quickly.
- Human errors in weight calculation can be avoided.
- A study time for vibration adjustment can be shortened.

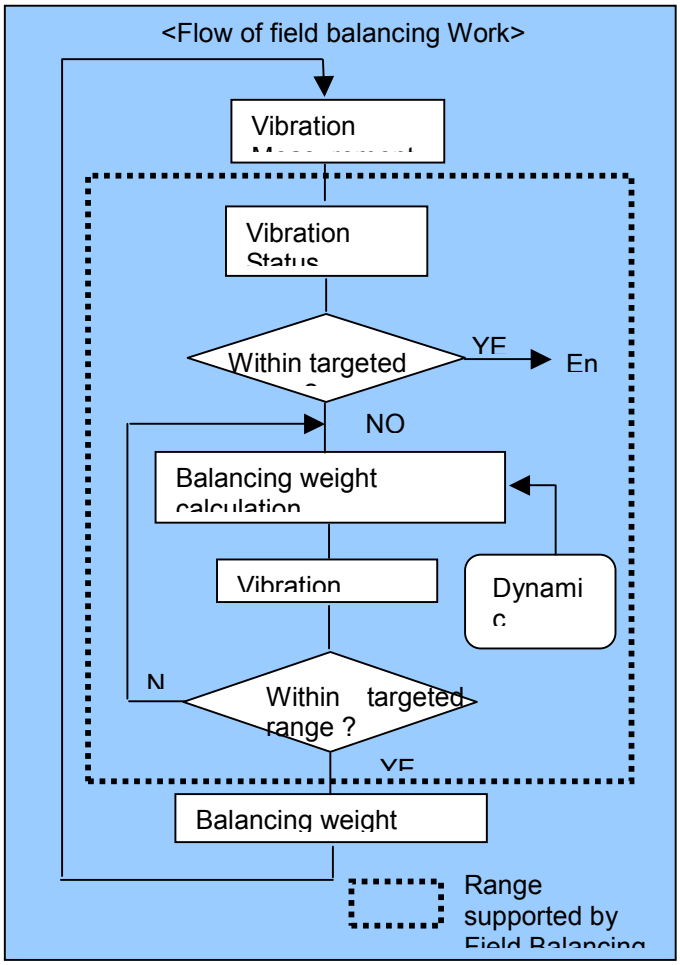
System Functions

(1) Registration/conversion function
- ①Registration of plant specifications
- ②Registration and editing of shot data
- ③Auto creation, registration, and editing of dynamic response
- ④Conversion of CSV-format file to shot data

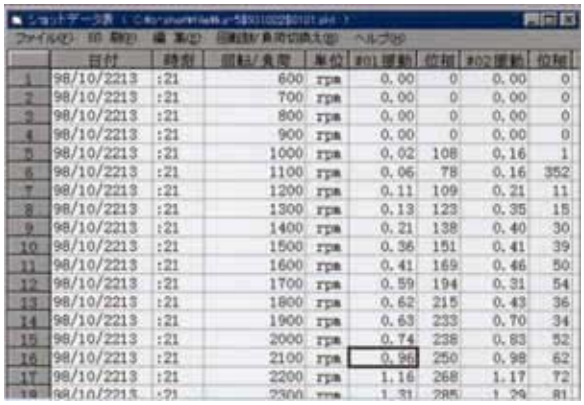
(2) Weight calculation and balancing prediction function
- ① Weight calculation by least square method and balance prediction following adding a weight
- ②Residual vibration prediction by weight specification

(3) Data display/output function
- ①Shot data is displayed on a S-V diagram and polar diagram and printed out.
- ②Response data is displayed on a S-V diagram and polar diagram and printed out.
- ③Predicted vibration data is displayed on a S-V diagram and polar diagram and printed out.

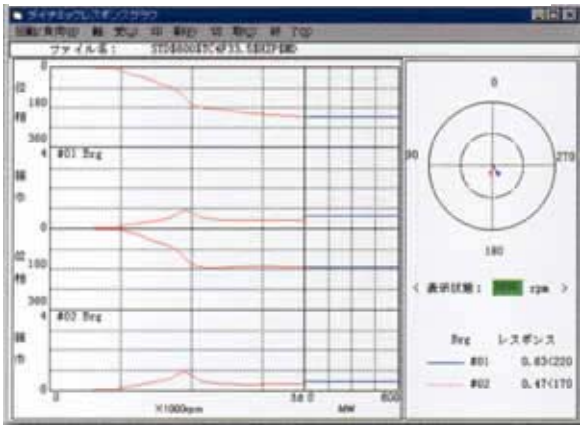
(4) Drawing function
- ①A ball bearing mark, arrow line, comment column, etc. can be drawn arbitrarily on a polar diagram.
- ②A polar diagram drawn is stored.
- ③A balancing report is created.



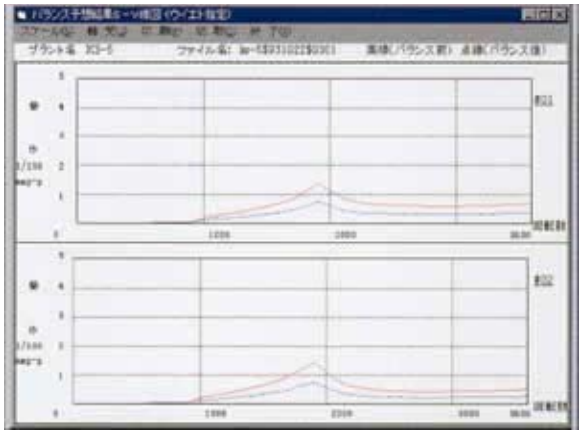
●Shot data editing



●Auto creation of dynamic response



●Residual vibration prediction following taking



Remote Monitoring Support (Option)

Outline

Vibration data is sent us via public telephone line to support an evaluation work of vibration status.

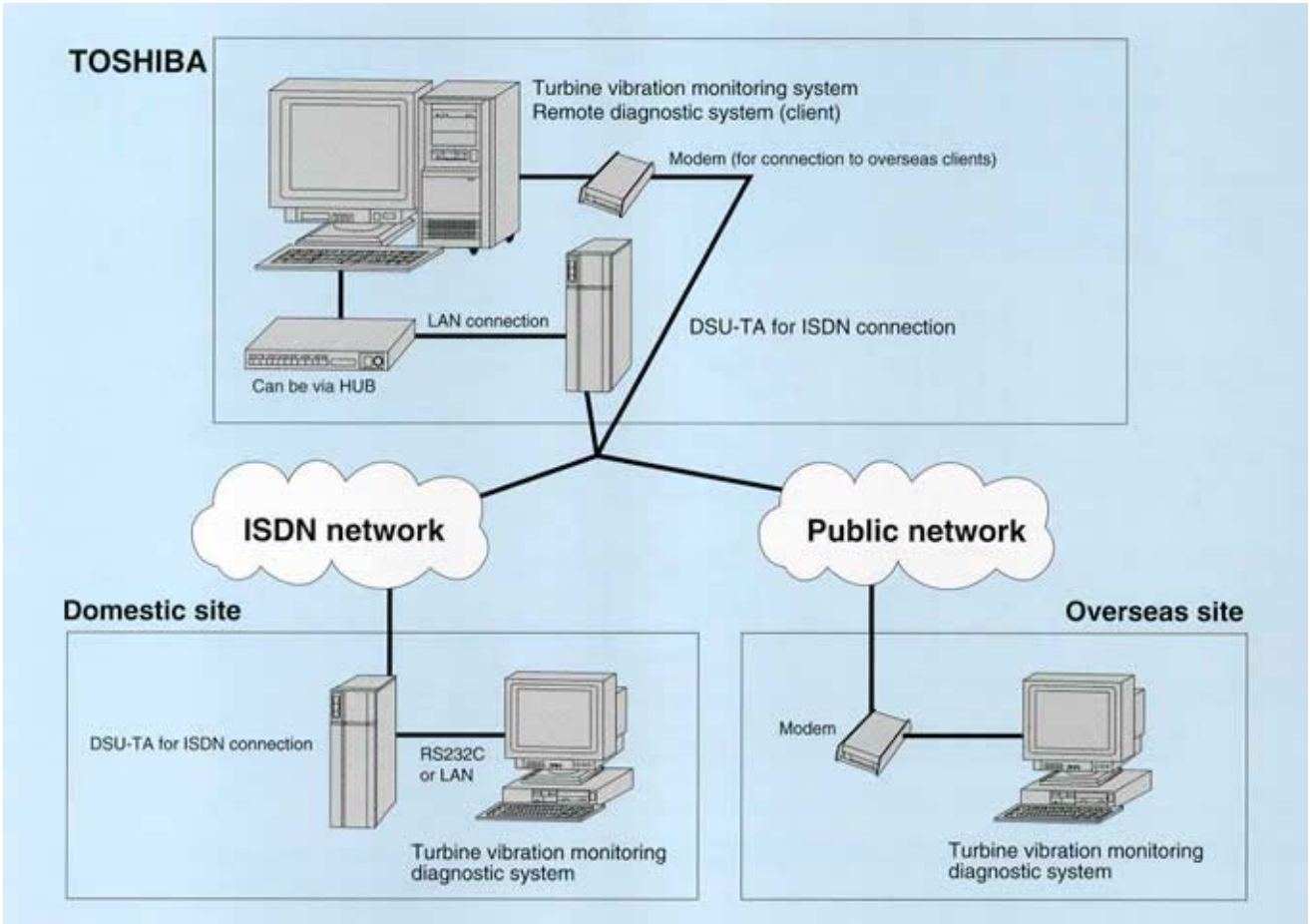
System Features

- Evaluation of the State of Vibration
  Evaluation reports for the state of vibration are offered by remote vibration-monitoring from Field service department, TOSHIBA.
- Operation Guidance l
  The system timely offers adequate guidance and advice for abnormal vibration..

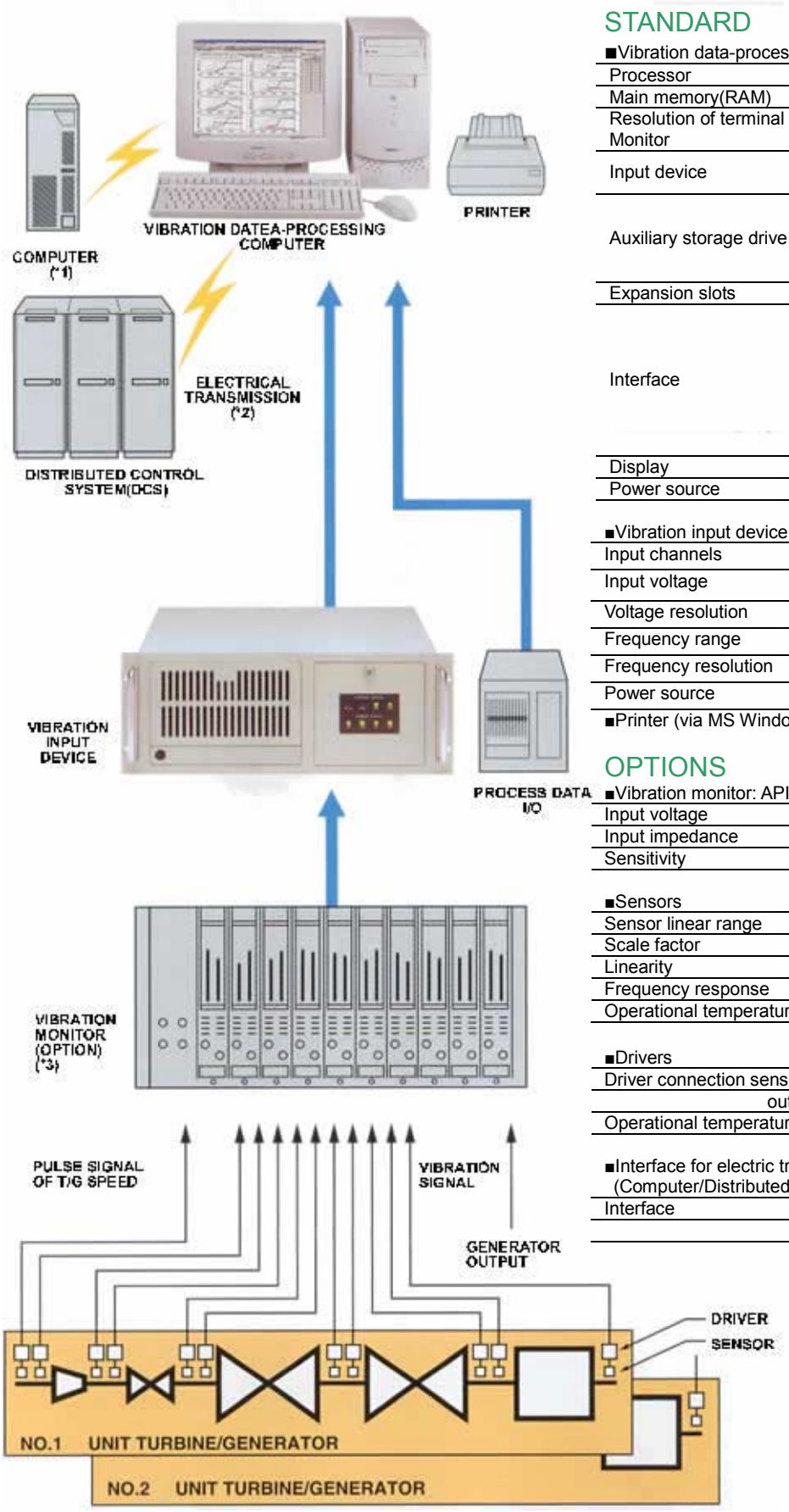
System Functions

(1) Can be connected to our remote diagnostic system via ISDN or public telephone generally used.
(2) If connected online at the time of turbine start/stop, vibration status can be monitored real time by the remote diagnostic system.
(3) Vibration variation in terms of time can be evaluated by comparing it with the past vibration status by looking at history data remotely. Balancing support by comparison with shot data can be done.

- Implementation status of remote monitoring



SYSTEM CONFIGURATION



*1:Assured compatibility with various computer and network systems.
*2:All necessary process parameters for plant-system monitoring and diagnosis are input from the DCS via hard-wired boards or by electronic transmission (option).
*3:Vibration signals can also be input from a plant's existing turbine supervisory equipment (TSI). However, the plant's existing system must first be enhanced through installation of a date-processing computer and a vibration-input device.

SYSTEM SPECIFICATIONS

STANDARD

■Vibration data-processing computer

Processor	:Intel*Pentium*Pro 200MHz(minimum)
Main memory(RAM)	: 128MB(minimum)
Resolution of terminal Monitor	: 1024 X 768 pixels
Input device	: Standard 109-key keyboard
	PS/2 mouse
Auxiliary storage drive	HDD: 6.4GB X lunit(minimum)
	FDD: 3.5-inch (1.44MB/720MB) X l unit
	CD-ROM X 1 unit
	M0:640MB X l unit
Expansion slots	ISA/PCI slot X 1 (minimum)
Interface	Serial(RS-232C)
	Parallel
	CRT interface
	PS/2 interface
	Keyboard interface
	Lan interface 10BASE5 or IOBASE-T/100BASE-TX
Display	XGA
Power source	100V AC(50/60Hz)

■Vibration input device

Input channels	24ch(maximum)
Input voltage	0,⁓±22V
Voltage resolution	16bits
Frequency range	DC -200Hz
Frequency resolution	0.5Hz
Power source	AC85V- 132V(50/60Hz)

■Printer (via MS Windows interface)

OPTIONS

■Vibration monitor: API standard 670

Input voltage	-0.8--22Vdc
Input impedance	: 50K S2
Sensitivity	:7.87V/mm

■Sensors

Sensor linear range	: 2mm
Scale factor	: 7.87V/mm
Linearity	: within±20 u m for 7.87V/mm linear signal
Frequency response	: DC- 10,000Hz
Operational temperature range	-40-+177°C

■Drivers

Driver connection sensor	: Miniature coaxial connector
output	: 4mm terminal fastener
Operational temperature range	-30-+80'C

■Interface for electric transmission (Computer/Distributed control system)

Interface	Ether-net
	MOD-BUS

TOSHIBA

TOSHIBA CORPORATION
POWER SYSTEMS 6 SERVICES COMPANY
36-5, TSURUMICHUO 4.CHOME, TSURUMI-KU, YOKOHAMA E30-005'1 JAPAN
FAX:81-45-500-1592 PHONE:81-45-500-1553

Overseas Office:
Mexico City, Caracas,
Rio de Janeiro, Buenos Aires,
London, Wien, Berlin,
Hong Kong, Bangkok, Manila,
Jakarta, Sydney, Wellington,
Johannesburg, Beijing
Toshiba International Corporation:
San Francisco, Houston,
Toshiba International Corporation Pty, Ltd.: Sydney
Toshiba International Company Limited: London

●For further information, please visit our website at http://www,toshiba.co.jp/index.htm and contact your nearest Toshiba Liaison Representational Operations-Producer Goods.
●The data given in this brochure are subject to change without notice.

3051-4	99-9TD1