

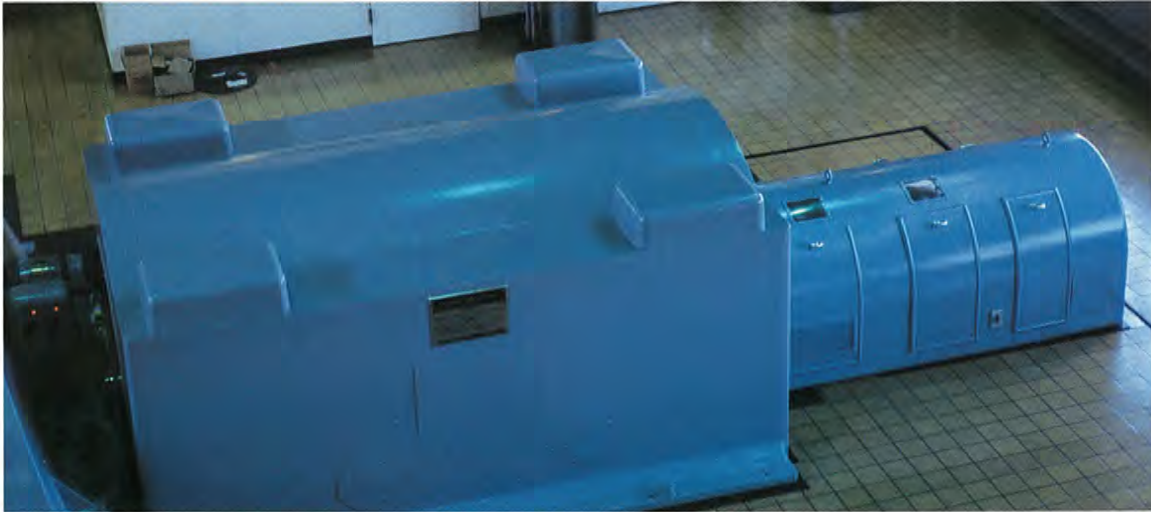


*GE Turbine-
Generator Controls*

EX2000 Retrofits...
The time is now.



Turbine Generator Controls



In today's environment of deregulation in the independent power production industry, availability and reliability are key factors in the decision process with regards to retrofit control systems. The power producer who can not efficiently provide reliable and cost efficient power will soon be faced with the prospect of most large businesses in the nineties: downsizing and layoffs. Those that can maintain a high level of reliability and availability will find an insatiable market around the country for their product.

Energy usage in the United States and around the globe has been forecasted for steady growth through the end of this century and into the next. These increases in growth, coupled with the relatively low number of new large central generating units ordered or planned since the late seventies, place growing pressures on the operators of existing power facilities. They are faced with an aging plant requiring more frequent maintenance while at the same time enduring the constraints of reduced staffing and budgets.

Revitalizing these existing units with retrofit control systems has proven a cost effective way to increase the availability and

reliability of generating units, while at the same time extending the overall life of the plant. By far the most popular retrofits have been on turbine and boiler controls. But today, more and more power producers are finding that generator excitation systems are equally important in a total life extension project.

Just as the arena of turbine controllers has changed from flyball and three arm governors to analog electro-hydraulic controls to state-of-the-art digital control systems, generator excitation equipment has also evolved. GE has provided a multitude of distinct generator control systems since the days of Thomas Edison. Each one was unique in design and hardware, but all performed the same basic function of providing a regulated current source to a rotating DC field. Whether using a carbon pile Diactor regulator and a rotating DC exciter or an analog AlterrexTM regulator and a rotating AC generator; a static compound source SCT-PPT or Busfed single source analog excitation system; or a large GenerexTM or Silco 5 excitation system, they all had the same purpose in life: reliable, cost effective controls for the generator.

EX2000 introduction

Beginning in late 1993, GE introduced the latest evolution in generator excitation controls. Drawing heavily on the proven technology used in the GE DC motor drive controls, production of the digital EX2000 was begun.

From the beginning, the EX2000 was conceived as a "one control fits all" exciter. Using the same hardware for the controls and auxiliaries, only the SCR bridge size is varied dependent on the application. For the first time, it is possible to use the same excitation control system from the smallest application (2 MVA to date) to the largest (1500 MVA). For the end user, this eliminates the need to stock a large variety of spare parts and eliminates the maintenance nightmare of learning multiple control systems. Each plant in the system can have the same control system, regardless of generator OEM or type of exciter.

The EX2000 is a full wave thyristor bridge with inverting capabilities using a fully digital control logic for both automatic (AC voltage) and manual (DC voltage) regulation. All regulation feedbacks such as armature PT's and CT's, generator field voltage and generator field current are electrically isolated through voltage controlled oscillators which convert each signal to counts scaled on a per unit basis. Software libraries of control blocks contained in firmware are linked together to form the "software pattern". Because the scaling of the inputs is done on a per unit basis, and through the use of "max case" patterns, the basic software patterns can remain unchanged from job to job. Different generator applications only require changes in the scaling variables and removal of unwanted options.

The microprocessors in the EX2000 provide self diagnostic capabilities on energization and operation. Combined with the other features of digital controls such as no thermal drift, increased accuracy, and overall system response, the EX2000 provides an excellent platform for retrofit excitation systems.

Operator and plant interfaces simplified

Operator interface is accomplished through the use of an Intelligent Operator Station (IOS) on stand alone retrofits or through an Arcnet data link to a Mark V turbine control on complete controls replacements. The IOS combines the myriad switches, lights, and meters of past system interfaces into a 20" by 30" station with a single coaxial cable connection to the EX2000 simplifying installation and checkout times. More than one IOS can be linked to the system for increased reliability, remote control, or local control and data readouts.

For the first time, the Mark V to EX2000 data link gives a coordinated turbine-generator control system capable of complete, automated control from startup to shutdown including voltage matching, auto synchronization, VAR or PF control, or Power System Stabilizer operation. Local Mark V control with a remote IOS provides simplicity in operations with local maintenance and diagnostic interface for the best of both worlds.

Plant interfacing is accomplished through standard I/O modules. Contact outputs for lockout relays, annunciators and the like are easily provided. Contact inputs from lockout relays, generator breakers, and permissives are electrically isolated from the controls and will accept a variety of voltage inputs on the same I/O card. Additional relay inputs (up to 48) and outputs (up to 42) can be added as needed.

For complete controls retrofits, interface to the DCS is accomplished through the Mark V turbine control. An optional DCS interface using a DOS based PC with Windows 3.1 software is available for EX2000 only change outs.



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Versatile offerings

Because of the variety of existing systems and manufacturers, the EX2000 is available in a number of "flavors". By far the most popular is a single bridge (or power conversion module (PCM)) self fed from the generator terminals. An auxiliary bus fed version of this type exciter is also available as well as a compound source version which provides single or three phase fault support. For either type exciter, no new magnetics (PPT for bus fed, or PPT, PCT's and linear reactors for compound) would be needed, provided there are no turbine or generator upgrades planned. The existing external hardware could be reused, decreasing overall change out expenses.

An optional new feature called a "hot backup" bridge is also available for both of these varieties. The spare or backup bridge provides a completely redundant power conversion module as well as a completely redundant set of controls. In normal operation, the main bridge feeds the exciter field. The backup bridge tracks the primary bridge. A separate monitoring and protection module determines if a transfer to the backup control is warranted. If the transfer

is needed, the protection module will automatically switch the backup into service, while shutting down the primary and preventing any interruption in excitation. The transfer from primary to backup can also be initiated by an operator through the IOS or Mark V interface.

For those requiring or desiring the utmost in reliability and availability, a fully redundant N+1 designed multibrige system is available. Three to five bridges all operate in parallel, simultaneously providing current to the field. Cell firing on all bridges is controlled by one of two active "Masters" while the other "Followers" receive their commands over the local data network or a fiber optic link. Two out of three logic voting on transfers and trips provides maximum fault tolerance and operational reliability. As an option, this design has the additional feature of on-line maintainability.

Because not every user desires a change out to a completely static system, the EX2000 is also offered in a number of regulator versions. One is compatible with the GE SCT-PPT analog system, one for the GE Alterrex analog system, one for any rotating DC commutating excitation systems, and a regulator version for the popular brushless excitation system. A single bridge version of these regulators is currently offered, and each contains the same hardware control cards and software patterns used in the larger systems.

Successful introduction

Since the introduction of the EX2000 in mid 1993, production has been steadily increasing to the current rate of over 200 per year. Many of these systems have been successfully put into service with at least one of each of the systems described above.

The first unit was a single bridge, bus fed system at the City of Jasper Municipal Utility plant in Jasper, Indiana. The EX2000 replaced a rotating DC excitation system using a Diactor carbon pile regulator which

had been in service for 30 years. With the combined resources of GE service engineering and the power generation businesses, a complete excitation system was installed with a turbine upgrade. The rotating exciter was removed and bearing oil feeds and drains were modified. A 75 KVA PPT was installed on the mezzanine level with the EX2000 placed on the turbine deck. Installation and prestart checks of the complete excitation system were accomplished in under 10 days. The digital system has now been in operation for more than 16,000 hours with no outages attributed to the excitation system.

Experience shows that installation and startup times have been reduced 50 to 75% compared to previous analog control systems. The reliability and availability numbers have also been exceeded. To date no startup has been delayed due to the exciter controls.

In the increasingly competitive 90's and into the next century, GE continues to be the leader in cost effective, reliable generator controls. The EX2000 is the right tool for the job and the right time is indeed NOW.

Yes! I would like more information about the GE EX2000 digital exciter!

Name: _____

Title: _____

Company name: _____

Address: _____

Phone number: _____

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