Synchronous Condensers Service Offerings
Eaton's Electrical Engineering Services & Systems

A changing landscape

Grid stability, reliability, inertia and short-circuit strength are key factors in the operation of an electrical grid. The challenges facing system planners, operators and maintenance personnel are amplified by an ever-changing landscape of generation sources and regulatory requirements. As old, large synchronous generators are retired and replaced by renewable energy sources, transmission and sub-transmission lines are stretched to capacity. Regulatory agencies are also adding more stringent requirements. Power switching devices such as circuit switchers and tap changers are being called upon to operate beyond their expected life cycles. Steady-state and dynamic reactive power compensation is a critical factor in system operation. System planners are faced with a wide variety of modern solutions to the grid stability problem.

Powering Business Worldwide

An old solution

One of the oldest power system support technologies has made a resurgence in this area—the synchronous condenser. Synchronous condensers have been around since the beginning of ac electrical power systems. Modern power electronics have been designed to replace the synchronous machine for dedicated dynamic reactive power support. In recent years, the old technology has seen a renaissance due to several key factors:

Dynamic voltage control—The synchronous machines equipped with modern day digital excitation systems are capable of supporting high-level adaptive voltage control strategies.

Inertia—Power electronics are not capable of supplying inertia, while the rotating mass of a synchronous condenser can offer inertia to the transmission system.

Short-circuit capacity—Synchronous (ac) machines supply fault current to the grid, lowering system impedance and improving transient response during faults.

Reactive power compensation—Can be utilized alone or in junction with other devices such as switched capacitor banks and SVCs to regulate and control reactive power flows.

Short-term overload—Due to relatively long thermal time constants, synchronous condensers can supply many times their rated output for short-time durations.

Eaton's engineering services

Eaton has experience managing, designing and building turnkey synchronous condenser projects. This experience includes greenfield facilities that are purpose built to customer requirements and conversion of existing steam-driven turbine generators to operate in support of transmission facilities. Our approach is to assemble a highly experienced project team to address all aspects of a synchronous condenser application. All aspects of facility design, including mechanical systems, electrical systems and advanced protection and control systems are included. Eaton's team of project and construction managers, design engineers and application specialists work together to deliver a quality, fully integrated, working system. The collective experience and knowledge of Eaton's project team ensures quality and applicable regulatory requirements are met while achieving superior performance.

Eaton's team of power system engineers perform studies and analysis to ensure the specific project goals are fully understood and implemented. The design engineering team provides all design documents to produce a fully integrated design package. We work with each customer to understand specific requirements in regards to equipment selection, drawings and design standards, and operator and maintenance personnel training.

Eaton's engineering services (continued)

Our project and construction management teams schedule and coordinate all site activities based on customer and site specific requirements. With a long experience list of designing, building and commissioning power systems, generation stations and reactive power compensation facilities, Eaton develops project specific testing and commissioning plans in conjunction with customer input and cooperation, ensuring all your testing and commissioning requirements are met. Eaton uses a structured commissioning process that incorporates well-defined checkpoints and deliverables.

Case studies

NEW FACILITY

Eaton worked with a power company to design and commission a new synchronous condenser facility. This facility was designed to control system voltage at the delivery point of a 63 MW wind farm, consisting of a single synchronous condenser used in support of the system voltage during peak loading conditions and transmission system contingencies. It also provides fault current capacity to the system to aid in system voltage stability. Built around one TEWAC, +27.5/–14 Mvar synchronous machine, the system uses a variable speed drive and 1000 hp pony motor to provide trouble-free starting and synchronizing. The control system is designed to operate the condenser to control the bus voltage at a 115 kV substation. Utilizing switched capacitor banks, the control system continuously biases the machine output to operate in an under-excited state, allowing for full dynamic response to system faults and contingency events.

NEW FACILITY

This facility consists of two synchronous condensers used in support of system ac voltage during peak loading conditions and transmission system outages and provides fault current capacity to the system to aid in voltage stability. This project was in support of a system reliability project designed to address overloaded transmission lines and frequent voltage excursions. Two water cooled, 16 Mvar synchronous condensers using variable speed drives and 500 hp pony motors were provided. The facility was constructed under strict guidelines to blend with the local community. The two machines effectively stabilized the system by supplying voltage control and short-circuit current strength to the system, ultimately avoiding the need for more costly transmission system upgrades.

GENERATOR CONVERSION

Eaton's project team worked with facility owners of a retiring coal fired generation facility to convert three 165 MW steam turbine generators to synchronous condensers. System planning determined that the reactive capabilities of the transmission system would be adversely impacted by the retirement of the generating assets. Eaton converted the machines by disconnecting the turbine, replacing the excitation and control systems and performing extensive modifications to cooling, lube oil and other auxiliary systems. The machine's stators were rewound, a new pony motor and MV drive were installed and new thrust bearing and extensive power system modifications were performed. Eaton implemented a PLC-based control system to handle all machine startup, synchronizing and dispatch functions. The control system ensures all machines work together to support the 138 kV bus voltage while sharing load equally amongst all online machines.

CONDENSER CONTROLS UPGRADE

Two 60 Mvar rotating synchronous condensers provide voltage control in one of the largest iron ore mining regions of the world. The rotating synchronous condensers are capable of supplying up to 60 Mvar of reactive power under typical operation and absorb 40 Mvar of reactive power at times when the mines are not in operation. The units, installed in the early 1970s, were controlled originally by static exciters manufactured in 1971. The original installation also included relay logic to control a very unique and precise starting and synchronizing scheme for the rotating machines. It was becoming increasingly difficult to maintain the necessary supply of spare parts, for the static exciters in particular. Eaton provided a complete electrical upgrade package for the two synchronous condensers, including digital static excitation, PLC-based unit control and digital protection. The static exciters were designed, constructed and arranged in such a manner as to maintain the footprint requirements.

For more information, visit

Eaton.com/synccondenser

Eaton
1000 Eaton Boulevard
Cleveland, OH 44122
United States
Eaton.com

Printed in USA
Publication No. PA027042EN / Z23260
September 2019

Powering Business Worldwide

Follow us on social media to get the latest product and support information.