

S&C's Power Systems Services offers a variety of Smart Grid project services that promote the successful design, implementation, and operation of distribution automation strategies, including the S&C IntelliTEAM II® Automatic Restoration System, S&C High-Speed Fault-Clearing System, and SCADA systems. These services can be provided individually or on a complete turnkey basis. Dedicated training is available for S&C's IntelliRupter® PulseCloser and other S&C equipment for distribution automation.

Power Systems Services additionally offers services relating to other S&C Smart Grid solutions, including the S&C Distribution VAR Management System, S&C Smart Grid Storage Management System, and S&C PureWave® Power Quality Products.

Appropriate system engineering studies are highly recommended prior to launching any type of Smart Grid project. S&C's Power Systems Services engineering staff is exceptionally well qualified to perform such work.

System Engineering Studies

Reliability Study

S&C can perform a reliability study to maximize the reliability, efficiency, and safety of the electrical power system. The assessment of system reliability—based on reliability indices such as SAIDI, SAIFI, and CAIDI—will be performed using software such as CYMDIST for Windows®. Factors that are assessed generally include:

- Location and placement of surge arresters.
- Protection and coordination design guidelines.
- Equipment operation and maintenance practices.
- Outage response procedures.
- Outage reporting database.
- Primary-fuse sizing practices for pole-top and pad-mounted transformers.
- Transformer sizing and loading data.
- Equipment failure and reliability data.
- Equipment installation and commissioning procedures.
- Construction standards for new and existing equipment.
- Outage restoration and sectionalizing procedures.
- Distribution automation practices and equipment performance data.
- Tree trimming practices.

S&C uses a very effective reliability optimization model that allows systems to be analyzed based on the investment necessary to improve reliability to a required performance level, or to determine the performance improvement for a given investment.

Load-Flow Study

S&C can perform a load-flow study to determine the steady-state operation of the electrical power system. The study calculates the voltage drop in each feeder, the voltage at each bus, and the power flow in all branches and feeder circuits. Losses in each branch and total power losses are also calculated.

The load-flow study determines if system voltages remain within specified limits under various contingency conditions, and whether individual electrical components such as transformers and conductors are overloaded. The study may be used to identify the need for, and location of, capacitive support to maintain system voltage within specified limits. S&C primarily uses CYMDIST for Windows® for distribution system load-flow studies.

Voltage Support Study

Effective VAR management can substantially reduce line losses and help ensure that the distribution system is operating efficiently. S&C can prepare a voltage support study to determine the optimum ratings and placement of reactive-power support devices and reactors, static and adaptive VAR compensators, and inverter-based reactors. These studies are performed using Siemens-PTI PSS/E, GE PSLF, and ATP alternative transient programs.

Short-Circuit Study

S&C can perform a short-circuit study to determine the currents that flow in the power system under fault conditions. System growth often results in increased available short-circuit current; the momentary and interrupting ratings of new and existing equipment on the system are checked to verify that they can withstand the short-circuit forces. Fault contributions from all sources, including motors and generators, are included in the analysis. The results of a study may be used to selectively coordinate electrical protective devices.

S&C uses the latest short-circuit software, including CYMDIST for Windows®, to calculate three-phase, line-to-line, and phase-to-ground fault current at relevant locations on the power system.



Protective-Device Coordination Study

S&C can perform a coordination study to verify that transformers, capacitor banks, electric motors, and cables are protected against damage from short-circuit currents. The study is used to select appropriately rated protective devices and their settings. The objective is to minimize the impact of short-circuit currents in the electrical system by isolating faults as quickly as possible, while maintaining power to the rest of the system.

The coordination study takes into consideration the pre-load and ambient-temperature adjustments on fuse minimum-melt curves, transformer magnetizing-inrush current, full-load current, hot-load and cold-load pick-up, coordination time intervals for series-connected devices, and the reclosing sequences of conventional reclosers and IntelliRupter® PulseClosers. Locked-rotor motor starting curves, thermal and mechanical damage curves for cables and transformers, and generator performance curves are plotted along with protective device time-current characteristic curves for all protective devices on each feeder.

S&C uses the latest software tool, CYMTCC for Windows®, to generate the time-current characteristic curves for all protective devices on each feeder. Coordination studies are based on specific fusing and reclosing practices, including fuse saving or fuse blowing strategies.

Distribution Automation Project Services

Engineering Analysis to Determine the Ideal Automation Strategy

S&C can perform an engineering analysis to determine the best automation approach for your distribution system: the S&C IntelliTEAM II® Automatic Restoration System, S&C High-Speed Fault-Clearing System, or optimization of a new or existing SCADA system.

Distribution System Simulation

S&C can model your distribution system and determine how it responds to disturbances such as faults and voltage losses. The simulation results are captured and can be used for training line persons, technicians, and operating personnel on system performance.

Communication Infrastructure Design

S&C can specify, install, and configure radios, remote terminal units, terminal servers, and networking equipment . . . from the feeder all the way to your corporate LAN.

Radio Site Surveys

To verify that a radio network has been properly designed and that communication between devices is reliable, S&C

can perform an up-front topographical analysis, along with a radio site survey. The latter includes a visit to the location of each switching/fault-interrupting device and repeater radio, plus a report on the results and any recommended changes. SCADA system communication is *not* addressed in the radio site survey; SCADA system integration can be furnished separately if desired.

In the case of S&C's IntelliTEAM II® Automatic Restoration System, robust, reliable peer-to-peer communication is critical to ensure proper feeder reconfiguration. Simultaneous, unsolicited report-by-exception communication between team members is required, so the communication backbone is essentially limited to spread-spectrum S&C SpeedNet™ Radio or UtiliNet® Radio systems or fiber-optics. The radios operate in the 902- to 928-MHz frequency range set aside for unlicensed communication and—like all 900-MHz radios—require line-of-sight connectivity. Repeater radios may need to be sited to attain the required level of connectivity between team members that do not have line-of-sight visibility.

SCADA System Integration

To ensure that the radio network for an IntelliTEAM II® Automatic Restoration System is properly integrated into a utility SCADA system, S&C can provide a SCADA communication site survey, and then specify, install, configure, and optimize the necessary gateways and data concentrators; develop SCADA radio configurations, DNP testing, point mapping, etc.

S&C will work closely with the SCADA database developer, along with the RTU configuration and communication specialists, to ensure that team data is available to the SCADA system, and that control of the teams is functional through the SCADA system.

Device Settings

S&C can work with utility planning and protection engineers to develop and load the settings for each control used in an IntelliTEAM II® Automatic Restoration System, or relay used in a High-Speed Fault-Clearing System.

Review of Device Settings

In instances where the utility develops the settings for each control used in an IntelliTEAM II® Automatic Restoration System or relay used in a High-Speed Fault-Clearing System, S&C can review these settings for obvious issues and errors. This review will *not* validate the settings with respect to upstream protection and coordination; a protective-device coordination study is required and can be furnished separately if desired.

IntelliTEAM II Factory Acceptance Testing— Level 1

This testing of a proposed IntelliTEAM II® Automatic Restoration System must be witnessed by utility representatives. They will need to travel to S&C Electric Company headquarters in Chicago, Illinois.

S&C will develop a model of the proposed IntelliTEAM II Automatic Restoration System, using actual controls. Up to 48 devices can be modeled on the test bed. Using secondary voltage and current injection, plus actual radio communication, faults and loss-of-source scenarios will be simulated, and the response of the model will be captured. Every line section will experience a fault along with loss of every available source.

Once the simulations have been completed, utility representatives will travel to S&C headquarters for a Model Acceptance Test, to witness system performance and create additional scenarios involving variable load magnitude or other parameters of interest. If desired, other utility personnel can participate in the Model Acceptance Test through a webinar.

Once the utility representatives are satisfied with the Model Acceptance Test and all scenarios have been completed, S&C will prepare a DVD training tool for the utility. The DVD demonstrates how IntelliTEAM II reconfigures for each scenario developed. It can be used to train line persons, technicians, and operating personnel on system performance in real time. It is also useful for explaining operation of IntelliTEAM II to utility management, as well as to utility regulators who may be considering allowing the cost of the system in the utility rate base.

IntelliTEAM II Factory Acceptance Testing— Level 2

This testing includes all the features of IntelliTEAM II Factory Acceptance Testing—Level 1 except that utility representatives are not required to travel to S&C headquarters to witness the testing. Utility personnel can participate in the Model Acceptance Test through a webinar.

IntelliTEAM II Factory Acceptance Testing— Level 3

This testing includes all the features of IntelliTEAM II Factory Acceptance Testing—Level 1 except that utility representatives are not required to travel to S&C headquarters to witness the testing and a webinar is not conducted.

Installation

S&C's experts can work with your personnel or contractor to ensure proper installation of all overhead switches/fault-interrupting devices and controls, or underground switchgear, cables, etc.

Turnkey Engineering, Procurement, Construction, and Project Management

S&C can perform all necessary engineering, procurement, construction, and overall project management associated with the overhead switches/fault-interrupting devices and controls or underground switchgear used in an IntelliTEAM II® Automatic Restoration System, or the Remote Supervisory Vista® Underground Distribution Switchgear used in a High-Speed Fault-Clearing System. The work includes permitting, pole installation or reconfiguration to accommodate the new overhead devices or installation of the new switchgear, and all engineering to support these efforts.

S&C can provide contract crews for the hot-line work or, alternately, can provide project management of utility crews if the utility prefers to use their own personnel.

Commissioning

S&C engineers can provide on-site commissioning of the hardware and software used in an IntelliTEAM II® Automatic Restoration System or a High-Speed Fault-Clearing System, ensuring that your automation project start-up goes smoothly.

On-Site Training and Commissioning

To verify that your personnel are adequately trained on an IntelliTEAM II® Automatic Restoration System or High-Speed Fault-Clearing System, and that the equipment has been successfully installed and properly configured, S&C can conduct a two- to three-day field visit to provide in-depth training for engineers, operations personnel, and technicians, plus commissioning of the hardware and software. Typically one full day of classroom training is provided. Sessions cover both operation and engineering topics.

The agenda for an IntelliTEAM II operation session typically covers:

- IntelliTEAM II—what it is, how it works, and examples.
- Operation of IntelliRupter® PulseClosers, Scada-Mate® Switches, Scada-Mate CX™ Switches, Remote Supervisory Vista® Underground Distribution Switchgear, and/or Remote Supervisory Pad-Mounted Gear in an IntelliTEAM II system.
- Real-world examples of IntelliTEAM II operation using IntelliTEAM Designer in Instant Replay mode.

The agenda for an IntelliTEAM II engineering session typically covers:

- A detailed look at how IntelliTEAM II works.
- Explanation of all control settings.
- Software screens useful for troubleshooting.
- Configuration of the radios.
- Creation of a DNP lookup table.

The second day and third day (if required) focus on loading—into the installed controls—configurations developed during the first day of training, and then performing actual transfer tests to verify that the teams function properly. Each switch/fault-interrupting device is bypassed so that customer loads are not affected. A loss-of-source condition is simulated, followed by the service restoration process.

As a point of information, S&C assigns an application engineer to every IntelliTEAM II project. That engineer stays with the project through installation and activation in the field. The application engineer works very closely with utility personnel to develop the team configurations and assist the customer with any questions relative to team assignment.

On-Site Acceptance Testing

S&C can develop a comprehensive test plan and provide the necessary on-site support to prove out an IntelliTEAM II® Automatic Restoration System or High-Speed Fault-Clearing System.

Maintenance Service

To ensure the availability of an IntelliTEAM II® Automatic Restoration System, S&C can provide maintenance service for each switch/fault-interrupting device. This service includes a visit to each device on the third, sixth, and ninth year after the purchase year of the device. Any maintenance work determined to be necessary will be scheduled to avoid peak-load periods of summer and winter.

S&C additionally will perform an operational readiness inspection on each device on an annual basis. This inspection includes the following, as applicable:

- Visually inspection of the control, control cable, antenna and cabling, grounding, arresters, and wire connections.
- Testing of lamps, verification of correct processor lamp operation, verification of the correct position of the Remote/Local switch, and operation of the Remote/Local switch with corroboration from the dispatcher.
- Downloading of a full report from the 5800 Series Automatic Switch Control or IntelliRupter PulseCloser® control, plus review of the data and corrective actions as necessary.

- Replacement of the control battery every three years (if not replaced previously).
- After the utility crew has bypassed all normally-closed switches/fault-interrupting devices, opening of the interrupters locally using the control and also manually.
- While the interrupters are open—and after the utility crew has de-energized the switch/fault-interrupting device by disconnecting the jumpers—opening the visible disconnect, if furnished, and inspection of the jaw contacts. Cleaning and lubricating jaw contacts as necessary.
- Verification that repeater radios, if furnished, are operating properly. Replacement of repeater radio batteries.
- Return of all switches/fault-interrupting devices to their normal operating state.

All field work will be coordinated with the utility's designee. To facilitate the process and ensure consistent and accurate reporting, S&C will develop an inspection checklist in conjunction with the utility, and train utility crews on its importance and use. S&C will provide the utility with reports detailing inspection results, and observations and corrective actions taken by S&C during the operational readiness inspections.

Monitoring Service

To verify that an IntelliTEAM II® Automatic Restoration System is functioning properly, S&C can furnish a cellular modem for one of the team members. The modem includes a port switching device that allows access to all the controls over IntelliLINK® Remote Setup Software, as well as access to the radio network itself.

On a weekly basis, S&C headquarters in Chicago will dial into the modem to evaluate team conditions, analyze any alarms or events, and gauge the health of the controls and the communication links. If anything of concern is found, the utility will be notified. If the issue can be addressed through reconfiguration of a control, the change can be initiated from headquarters with utility approval. Any reconfiguration will be monitored and analyzed to optimize efficiency.

Event Analysis

S&C can provide analysis of events occurring on an IntelliTEAM II® Automatic Restoration System or High-Speed Fault-Clearing System. The analysis will be based on the event logs submitted by the utility to S&C for review and interpretation.

IntelliRupter Training Services

S&C furnishes no-cost training and on-site commissioning with a utility's first purchase of an IntelliRupter® PulseCloser. S&C can provide additional training sessions if desired. This training is conducted on-site and helps ensure that utility personnel know how to properly set up, configure, and operate IntelliRupters. It includes the following:

- Assistance in assuring WiFi capability of all computers used to access and configure IntelliRupter.
- Training on installation and operation of IntelliRupter and IntelliLINK® Setup Software.
- Training on configuring IntelliRupter for use in an IntelliTEAM II® Automatic Restoration System, source-transfer system, or loop restoration system, as appropriate.
- Training on the use of security keys.
- Training on IntelliRupter operation, including PulseClosing™ Technology.
- Training on accessing waveform data and use of the Wavewin data management and analysis system.
- Review of upstream and downstream coordination and recommended IntelliRupter settings.

Other Smart Grid Project Services

Power Quality Monitoring

To evaluate the impact of voltage sags, interruptions, motor starting, or flicker on end-user equipment, S&C can perform on-site monitoring, as well as voltage regulation and voltage control analysis. These studies may include development of detailed equivalent circuits of the power system and the mitigation device under consideration, for simulation using the Alternative Transients Program, Siemens PTI PSS/E, or GE PSLF.

Turnkey Engineering, Procurement, Construction, and Project Management

S&C can perform all necessary engineering, procurement, construction, and overall project management associated with an S&C Distribution VAR Management System, S&C Smart Grid Storage Management System, or S&C PureWave® Power Quality Product.