

The Utility Edge



Fall 2011

the power to help you succeed.

Making Substation Modernization Pay Off

Substation automation is fast becoming an integral part of many utilities' strategic evolution plans. However, a key to unlocking the full potential of automation lies in modernizing the underlying measurement and control equipment within the substation. This equipment, also known as Intelligent Electronic Devices (IEDs), includes microprocessor-based relays, meters, recloser and regulator controls, and power quality (PQ) sensors. The technology available to utilities today offers tangible benefits to many departments simultaneously: for example, Operations benefits from real-time information retrieval, Engineering can remotely access sequence of event captures for outage diagnosis, and Planning and Maintenance personnel have a depth of data retrieval at their fingertips.

(continued on page 2)

What's New at PSE

Power System Engineering (PSE) is assisting in furthering the electrification of rural Rwanda by hosting an engineer from the Rwanda government-owned electric utility, with the intent of providing training and knowledge to assist this engineer in his work when he returns to Rwanda.

PSE recently provided a two-week training for several engineers from KEPCO, the transmission and distribution utility of South Korea. The training covered a wide variety of topics including distribution automation, communications, advanced metering, meter data management, and emerging SmartGrid technologies.

PSE has added a new office in Cedar Rapids, Iowa.

PSE Webinar: Getting the Most from Your GIS

November 9, 2011 1:00 PM to 2:00 PM CST

PSE is offering a free webinar to help utilities assess whether they are getting the most from their GIS investment. Real-world examples will be used to illustrate topics including data accuracy and completeness, engineering analysis model integrity, enterprise integration (OMS, CIS, staking, AVL, etc.), mobile GIS, and web mapping. Visit our web site or contact Kevin Zamzow for more information via zamzowk@powersystem.org.

PSE's Distribution Line Design Training

January 31 – February 3, 2012

PSE is offering a course on Distribution Line Design for utility staff responsible for designing and constructing distribution OH/UG line and new services. The lectures, discussion, and group exercises will revolve around real-life design situations. The course will be held at the Radisson Hotel in Bloomington, MN. Visit our website or contact Heather Howard for more information via howardh@powersystem.org.

Upcoming Events:



October 24 - 25, 2011

PSE's Chris Ivanov will be presenting "Creating Robust Electric Load Forecasts by Leveraging Data Mining Techniques Using Interval Data" in Orlando, Florida.



November 1 - 3, 2011

PSE's Erik Sonju will be presenting the topic "System Impact Study Considerations for >1MW DG Interconnections" on November 2.



VA, MD & DE Association
of Electric Cooperatives

November 2 - 3, 2011

Rick Schmidt will be presenting "Breakthroughs in Utility Automation & Communication" at the 2011 VMDAEC Engineers & Operations Conference on November 3.



November 29, 2011

PSE's Steve Fenrick will be presenting and sitting on a panel of experts in the "Empowering Consumers; Customer Engagement" section at the Missouri Smart Grid Status Update and Technical Conference.

Email studnerc@powersystem.org
with questions, comments,
or for more information.

Making Substation Modernization Pay Off *(continued from Page 1)*

Utilities find it essential to build their modernization programs on a strong foundation of backbone communications between their substations and office(s). This allows them to realize the benefits of the upgrades and to implement strong redundancy into their systems. Intelligent relays within the substation provide solid protection schemes and a wealth of performance data as well as sequence of events information. Transformer, regulator, and capacitor controls offer detailed information on health and maintenance issues, leading to predictive rather than reactionary maintenance. And the ability to control these devices remotely allows for the system to be orchestrated from a central SCADA system, enabling beneficial programs such as VAR reduction and Conservation Voltage Reduction (CVR).

With many advanced technologies beyond the substation such as Distribution Automation (DA) on feeders and Advanced Metering Infrastructure (AMI), substations are increasingly used as collector points of information, serving as a bridge between the field and the central office. The combination of these programs offers both reliability and economic benefits. Customers benefit from improved power quality and cost reduction from energy conservation programs.

Modernization programs should be scaled to fit the size and needs of the utility. The most effective approach is to create a Technology Work Plan that includes backbone communications, substation equipment upgrades, SCADA integration, and consideration for complementary technologies such as DA, Demand Side Management (DSM), and AMI. This plan would allow the utility to budget appropriately and roll out a modernization program over three to five years in a well-controlled manner with a clear understanding of the expected costs and benefits.

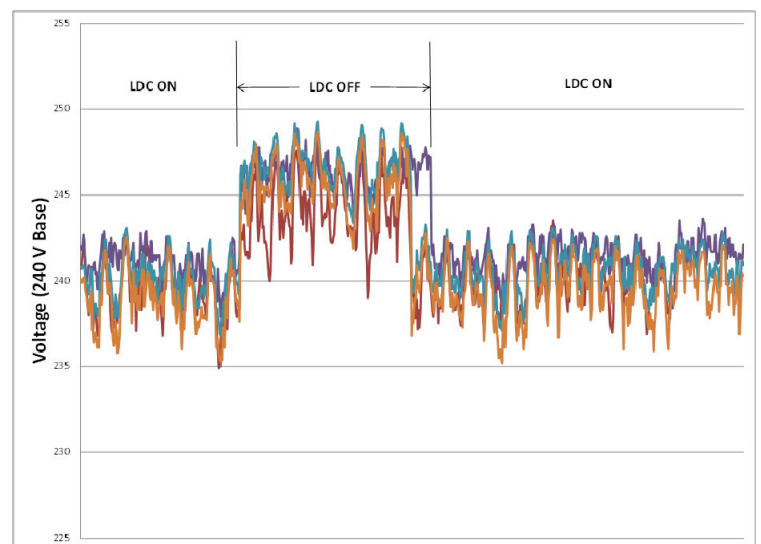
Conservation Voltage Reduction

Conservation Voltage Reduction (CVR) has been a hot topic in the industry for some time, and particularly during the last few years. A number of methods and strategies have been employed on utility distribution systems to effectively lower voltage levels with the objective of decreasing coincident peak demand and/or energy over time. One particularly attractive method used to lower voltage levels on the primary distribution system is the use of voltage regulator Line Drop Compensation (LDC) settings. Since most existing voltage regulator controls have this functionality present, there is typically little additional capital investment required to implement this feature.

The LDC feature available with most voltage regulators has been successfully used for many years to maintain adequate voltage levels at some distant load center on distribution feeders. The LDC feature can also be used to maintain lower voltage levels, within ANSI standard requirements, on a distribution feeder during non-peak times, thus reducing the voltage and achieving CVR benefits.

The graph to the right illustrates an example feeder where this was successfully accomplished. Voltage on the primary distribution system was lowered approximately 5 Volts on a 240 Volt basis (2.5 Volts on a 120 Volt basis) during times when the LDC feature was used, while still comfortably maintaining voltage at the meter level above the required ANSI C84 Range A standard of 228 Volts (on a 240 Volt basis).

To successfully use LDC settings to implement long-term voltage reduction on a distribution system, careful attention must be paid to the settings used against the load and electrical characteristics of the distribution system. An engineering analysis should be conducted to determine the most effective settings during peak and minimum load times, as well as various seasons with unique load characteristics. Voltage monitoring is then typically done on an ongoing basis to confirm that the LDC settings are working as planned and to determine if setting adjustments are needed.



Also, keep in mind that as with any new policy, the expected benefits and possible drawbacks associated with implementing a CVR program must be carefully considered before a decision is made to move forward.

2012 National Electrical Safety Code – What’s New?

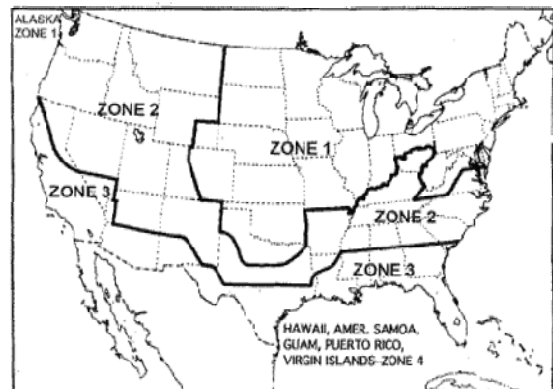
The National Electrical Safety Code (NESC) covers basic provisions for the safeguarding of persons from hazards arising from the installation, operation, or maintenance of (1) conductors and equipment in electric supply stations, and (2) overhead and underground electric supply and communication lines. It also includes work rules for the construction, maintenance, and operation of electric supply and communications lines and equipment. As such, it is imperative that utility industry personnel have an understanding of what the code entails.

As a background, work began on the NESC in 1913, and it has been published in its present form on a five-year cycle since 1997. The 2012 edition of the code was published in August 2011 and has an effective date of February 1, 2012. New installations may still be governed by previous versions of the code if either the design or approval of such facilities begins prior to the effective date.

Generally, several additions, revisions, or updates accompany each edition of the NESC, and the 2012 publication is no exception. While many of the changes to the 2012 edition were minor – such as reworking a definition, changing the wording of a rule, or updating a figure for clarification – several rules were impacted. The following describes five areas of significant change that appear in the 2012 NESC.

Clearance Zones and Loading Districts

Sections 23 and 25 of the NESC are largely dependent upon the figure at right. The various zones shown on the map govern the applicable wind, ice, and temperature loading applied to overhead conductors and cables when determining required clearances, creep characteristics, and structure strength. Previous versions of the code contained only three zones: Hawaii was included in Zone 3 – Light Loading District. The 2012 NESC, however, introduces Zone 4 – Warm Island Loading District, which now includes islands located from 0 to 25 degrees latitude, north or south, such as American Samoa, Guam, Hawaii, Puerto Rico, and the Virgin Islands. The loading parameters of the Warm Island Zone are similar to Zone 3 for altitudes between sea level and 9,000 ft., but they are similar to Zone 2 for altitudes greater than 9000 ft. The exception to this rule is temperature. The Warm Island Zone requires a “loaded” temperature of 50°F below 9,000 ft., while Zone 3 requires 30°F.



Source: NESC 2012

Signs

All signage – temporary and permanent – required by the NESC must comply with ANSI Z535 Safety Alerting Standards. Signs are to be used to inform line workers and members of the general public of specific hazards or conditions to be avoided. Revisions to the ANSI Standard made between 2006 and 2007 did not apply to the previous NESC. These revisions included the addition of a new Z535.6 standard to address the use of safety information in training manuals and collateral information. The 2007 revision also stated the preference of using “Notice” to alert users to potential equipment damage. Situations resulting in personal injury are typically denoted with “Danger,” “Warning,” and “Caution.”



Ungrounded Guys

All anchor and span guys must be effectively grounded as specified in Rule 92C2. Previous editions of the NESC make no reference to this specific rule. Essentially, guys must be connected to a grounded metallic supporting structure, an effective ground on a nonmetallic supporting structure, and/or a line conductor with at least four ground connections per mile. Connection of an anchor guy to an anchor rod is not considered an acceptable ground. Guy strain insulators may be used as an alternative to grounding as long as several provisions are met. The insulators must be installed so that (1) no portion of the

(continued on page 4)

2012 NESC — What’s New? *(continued from Page 3)*

guy that may become energized falls within 8 ft. of ground level if the guy breaks below the insulator, (2) the insulator is positioned so that a guy cannot become a conductive path in the event that the guy goes slack, and (3) the insulator is positioned so as to not become ineffective in the event that any guy sags into another anchor guy, span guy, or span wire. All references to ungrounded guys in the NESC have also been removed.

Conductors of “Greater than 300V”

Several references to conductors of greater than 300V have been removed from various rules throughout the 2012 NESC. For example, previous exceptions were made for the grounding riser guards exposed to conductors of voltages below 300V. These guards must now be effectively grounded in order to be in compliance.

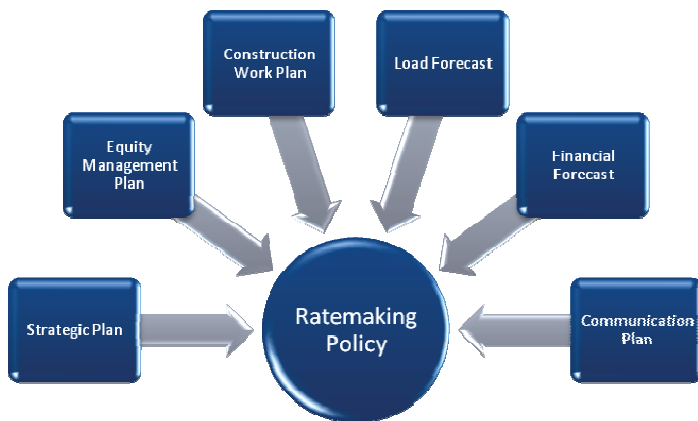
Communication Antennas in the Supply Space

The rules governing clearances between supply conductors and communication antennas have been updated and refined due to greater proliferation of communication facilities on power structures. Clearance to communication conductors within Table 235-6 is now specifically noted rather than being represented in a footnote. Changes have also been made to Rule 238 to clarify required clearances to communication supports and antennas.



Source: Laminated Wood Systems

The 2017 edition of the NESC is to be published August 1, 2016. Revisions may be submitted by the public. Any change proposals must be received by the Secretary of the National Electrical Safety Code Committee no later than July 15, 2013.



Developing a Ratemaking Policy

Electric utilities around the country have various policies to address strategic, operational, financial, and engineering issues. One such policy your utility may have or may consider developing is a Ratemaking Policy. The policy should not be a step-by-step manual; rather, it should provide the goals and parameters that will be used to guide and direct future ratemaking activities.

For example, a ratemaking policy should support strategic planning goals such as technology investments, economic development efforts, energy efficiency, rate competitiveness, customer satisfaction, and capital

structure. This should not result in duplicating strategic planning efforts; rather, the purpose is to integrate the established goals into one document that can guide and inform future ratemaking activities. We have found that ratemaking policies are helpful during the process of completing rate and cost of service studies as they provide clarity and continuity on important rate change questions such as how and how much.

For additional information, please contact us or refer to “Rate Strategies for 21st Century Challenges” released by the National Rural Electric Cooperative Association and the Cooperative Finance Corporation, 2010.

Consider including the following in your ratemaking policy:

1. Purpose Statement
2. Definitions
3. Key Elements Affecting the Plan
4. Rate Design Goals and Principles
5. Targets and Goals
6. Implementation and Communications Plan
7. Monitoring and Review Schedule

Using Well-Designed Surveys to Optimize Demand-Side Management Programs

Many utilities are leaving millions of dollars of savings on the table because they are not optimizing their demand response and other DSM programs. Because of this, utilities have begun to enhance these programs by developing strategic implementation strategy that targets customers who are most likely to produce positive program results and offer word-of-mouth referrals. This paves the way for cost-effective program expansion.

The strategic implementation helps a utility understand its customers and accurately anticipate their reactions to programs such as dynamic pricing, load control, or customer engagement. Studies and load research have found that individual customers will react differently to DSM programs based on socio-economic level, education level, housing footprint, and household characteristics (e.g. family size and composition). One tool a utility can use to gather this information is a survey. Although research shows that a poor survey design can lead to misleading results and comprised conclusions, if the survey is done correctly, this approach to DSM programs can add considerable value while lowering the chances of possible negative customer feedback.

A focused implementation strategy maximizes program results immediately through a strong initial return on investment, minimizes future marketing costs, and can even double or triple the overall benefits and value of a demand response program. This strategy is developed through conducting a robust program pilot with an adequate sample size and diversity of participants, analyzing pilot demand impact results, and incorporating survey information into the analysis and strategic implementation process.

PSE is currently helping dozens of utilities across the country develop demand-side management (DSM) pilot programs. If you would like further information, please contact us for a whitepaper on the subject.

Ask PSE a Question

What is a capacitor?

This issue's topic is elementary but lays a foundation for understanding ferroresonance, which will be addressed in the next issue.

Two-Part Series

What is a Capacitor?.....

What is Ferroresonance?.....

A capacitor, sometimes called a condenser, first appeared as a Leyden Jar. It consisted of a glass bottle which was wrapped with metal foil and filled with impure water. A probe reached into the water, and a terminal connector was placed at the top. When a direct current source was connected to terminal and foil, an electric charge could be stored in them. Connecting an electric wire or path from the foil to the top terminal equalized and eliminated the charge. Close spacing of the foil and inner conducting media makes the charge capacity greater with thinner insulation. Modern capacitors for utility line applications are pressed together tightly in metal rectangular cans with a very thin insulator film between the two metallic foil conductors.

Connecting alternating current (AC) allows current to pass through the capacitor. Alternating current works by charging the conducting media in one direction, reverse discharging stored energy, and then receiving a charge in the other direction. It is similar to water being tilted in a trough first in one direction and then in the other; the water, like current, flows back and forth through the center point.

When applied to an AC circuit, the described action results in a sine wave plot in which current leads the voltage by a certain amount. This is because when the voltage wave rises, the capacitor charges, but when the voltage wave descends, the capacitor discharges dumping current onto the system before the main source reverses direction. This condition is called a *leading power factor*.

Machines such as motors that use coils wound on iron are called *inductors*. An inductive type load causes the current to lag behind the voltage rather than lead it because an inductor tends to resist any change current. This causes a *lagging power factor*.

Whenever the voltage and current waves are not "in phase," the voltage and current waves are not aligned, (the power factor is less than 100 percent) and the amount of work delivered by the system is reduced. Thus, more current is required.

Applying capacitors and inductors in conjunction with each other helps bring the relationship of voltage to current into better balance, reducing current and thus reducing line and transformer losses and voltage drop.

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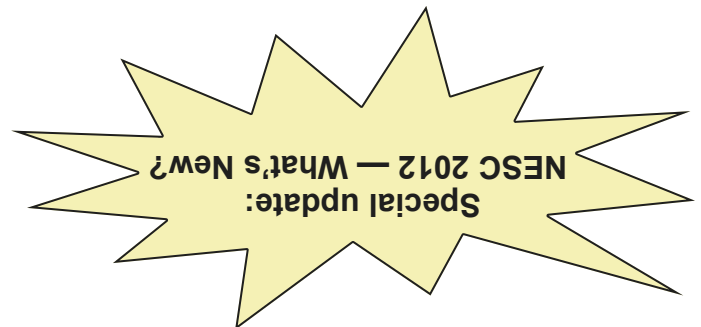
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PSE provides a full range of engineering, economic, and planning services to utilities nationwide. Some of our services include:

- Communications (Fixed and Mobile)
- Technology Work Plans & Strategic Plans
- Transmission & Distribution Studies and Planning
- Transmission & Distribution Line Design
- Daily Operations & Engineering Support
- Rates and Cost of Service Studies
- Time of Use and Dynamic Pricing
- DG Rates and Contracts
- Energy Efficiency & Demand Response Evaluation
- Load Forecasting with & without Demand Side Management
- Substation Engineering & Design
- Consulting on AMI, SCADA, IVR, OMS, GIS, CIS, etc.

Please be sure to give the PSE team the opportunity to present our ideas on how we can work together. We are confident that our full range of services can meet your needs. Visit our website for a full list of services and additional contacts.



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