1992 IN PERSPECTIVE

Both domestic and international activities expanded in 1992. The ongoing pressure to increase the loadability of existing bulk power systems continues to require more sophisticated system studies and software methods. Optimal Power Flow (OPF), for example, has seen a very significant increase in applications and installations. The need for far more accuracy in system studies has also prompted major emphasis on precise measurement and rigorous modeling of both machine and load characteristics. The Dynamic System Monitor (DSM) with PSS/E installed, has been very valuable in these efforts. A PTI/client team performs the measurements, verifies the accuracy of the models while at the test site and trains the clients for future measurement/modeling projects - all on a very cost effective schedule.

A major 1992 software effort to integrate a comprehensive graphic user interface (GUI) in both PCs and workstations is complete and will be distributed at the beginning of 1993. The platforms for software were also expanded to include the HP 9000. In recognition of the need for large system studies, the PC load flow version of PSS/E was extended to 12,000 buses.

A significant project to optimize the economics of both steam and electric dispatch in a very complex multi-unit industrial cogenerating facility will be fully operational early in the year. At the other end of the power system - distribution - PTI is developing, for EPRI, a facility in Florida to conduct a series of rocket triggered lightning tests. Tests will start in time for the summer lightning season.

A major milestone was reached when the world's first operating High Phase Order (six phase) line was energized on the New York State Electric & Gas system. PTI engineers were involved in the analysis and design of this system and have been in the forefront of High Phase Order development since PTI's founding president patented the concept in 1967.

In 1992 approximately 950 engineers attended PTI courses taught in Schenectady and throughout the world. Several courses of a new computer based series, the "Advanced System Operation Courseware," were completed and the entire 15 courses will be available in 1993. This new educational medium promises to significantly enhance the efficiency of high-level technical training.

Early in the year, a new PTI function was formed - the "Integrated Planning and Power Marketing Services Operation." The Operation addresses transmission access, third party transactions, wheeling, and those issues associated with the economics and reliability of the transmission/generation system. In-house software has been developed to support these activities.

It has been a rewarding year. To all of our clients and friends, we extend sincere appreciation for a successful 1992. We look forward to working with you in the new year.

President

---

TRANSMISSION ACCESS - NOT 'IF' BUT HOW MUCH, HOW SOON?

W.H. Smith, Manager, Southeastern Office Manager, Integrated Planning and Power Marketing Services

The New Year brings with it the most significant changes to the transmission segment of the utility industry since the advent of HVDC. The type of legislation that largely deregulated the generation sector of the utility industry has now targeted transmission with the intent of re-regulation if not deregulation; witness the restructuring of many utilities to include transmission business units. These units have been formed to identify and assign value to transmission services. They will compete for internal funds and will be evaluated on performance. That internal "competition" will encourage creativity, will foster more ambitious goals, and will benefit all utility stakeholders.

(continued on page 2)

FIVE CRITICAL ISSUES IN PRIVATIZATION

H.M. Merrill, Senior Consultant

Bob Dylan put it to music: "The times, they are a-changin'." As many governments look at selling their power companies to private investors, they face a number of critical issues. Five of them are:

- Risk assessment,
- Determining objectives,
- Pricing of services,
- Organization restructuring, and
- Training.

(continued on page 3)
TRANSMISSION ACCESS - NOT "IF" BUT HOW MUCH, HOW SOON?  
(Continued from page 1)

Outside competition is also gaining strength. Non-utility generation is accelerating to the point where, in recent years, more cogeneration and independent production has been added in the U.S. than has been utility generation. Meanwhile, demand side management (DSM) has begun significantly to reduce peak demands. Utilities or their cogeneration subsidiaries compete for each others' load. The transmission grid lies in the middle of the battle for generation markets.

The 1992 U.S. Energy Bill, for the first time, begins to sort out some of the implications for the transmission grid. FERC, the Federal Energy Regulatory Commission, will have considerable leverage in establishing the detailed rules for transmission access but a number of points become clear based on the premise that transmission access is an economic issue. Utilities must:

1) Provide transmission access to all Exempt Wholesale Generators (EWGs). However, they may recover all legitimate, verifiable, and economic costs of providing the service.

2) Document and make available their reliability criteria in a form that is understandable, objective, and quantifiable, and avoid any perception of being arbitrary.

3) Project and assess the reliability of the system on an hourly basis and identify all constraints to a specific transaction.

4) Identify the costs associated with relieving each of these hourly constraints. Costs may include both real and reactive losses, the cost of redispatching the generation system to alleviate flows on critical corridors, the costs of foregoing transactions that would otherwise provide benefits to the utility's own ratepayers, and the costs of constructing new facilities. The sum of these costs may be the basis of time-of-use pricing for use of the grid. The pricing will not only be a function of time but of the source and the destination of the power to be wheeled as well.

The basic mission for transmission system planners and operators will be to establish markets for transmission services. Doing so will require new attitudes, new approaches, and analytical tools. For example, PTI's new Bulk Operation and Resource Integration Software allows the user to examine the production system and the transmission system simultaneously. By doing so, the user can calculate all of the costs cited above. By folding together the value of generation resources with the costs of transmission, the engineer can establish both a market-based and a cost-based value for use of the transmission grid between any two points on an hour to hour basis.

While no method is perfect, comprehensive analytical evaluation can dramatically improve initial negotiation leverage and provide the documentation of constraints and costs required under the new Energy Bill. PTI is working closely with utilities to identify and implement further refinements in the analytical methods supporting responsible and profitable allocation of transmission services.

USING PHASOR MEASUREMENTS TO EVALUATE POWER SYSTEM PERFORMANCE

S.J. Baliar,  
Manager, Simulator, Control and Instrumentation Department

Direct measurements have long been an accepted practice for evaluating the performance of power system components. Oscillographic and continuous tape recorders have been installed as standard equipment in substation and generating plants for at least thirty years, monitoring equipment such as relays, breakers, and transmission lines. The introduction of digital fault recorders enhanced the sensitivity, selectivity, accuracy, and usability of the data, but the emphasis continued to be on monitoring equipment performance. The increasing reliance on utility interconnections has presented planning and operations engineers with the need to evaluate not only equipment performance, but also overall system performance. More specifically, the need to evaluate dynamic system performance is becoming increasingly important.

With the interconnection of systems and the increased loadings on those interconnections, concern with low frequency oscillations within and between the interconnected systems has increased. In many cases, studies and operating experience suggest that these oscillations are poorly damped, and in extreme cases, negatively damped. Where dynamic instability occurs, direct measurements can be an important aid in determining the underlying cause and in taking corrective action to improve system performance. While conventional measurement techniques have proven sufficient for monitoring equipment, their use in recording system dynamic disturbances have not proven adequate in many cases.

Dynamic system oscillations occur in the range of a few tenths of a hertz to several hertz; their fundamental characteristics are most conveniently defined in terms of the magnitude of the system voltages and currents, watt and var flows, and frequency excursions. Most of these oscillations last from several seconds to a few minutes. Conventional digital recording equipment, which today is predominately the digital fault recorder (DFR), normally sample the input quantities at a high rate compared to the slowly changing nature of dynamic oscillations. As a consequence, practical limits on memory available in the DFR restrict the recording period to the point where it is too short to capture the complete dynamic disturbance. In addition, the captured data is point-on-wave information rather than the desired envelope or derived quantity. Extensive post processing is then required to convert to the desired quantities. Transducers can be used to measure rms quantities, watts, vars, and frequency but recording times are often too short even at the lowest sampling rate. Even if recording times can be lengthened, transducer response times and noise characteristics often limit the accuracy of the resulting information.

A more direct approach is to record the input voltages and currents as phasors (magnitude and angle or real and imaginary components). Phasors provide a direct measure of the primary quantities of voltage and current and, with straightforward calculations, provide secondary quantities such as real and reactive power.

Consider the difference in calculating watts from point on wave data versus phasor data. Mathematically, real power, watts, is the
FIVE CRITICAL ISSUES IN PRIVATIZATION
(Continued from page 1)

Risk Assessment

The British privatization is the world’s boldest and, apparently, most successful. But it would have sunk because of a key uncertainty: investors were not able to absorb the cost risks associated with decommissioning nuclear plants. The privatization had to be redesigned, with the government retaining ownership of the nuclear plants.

What uncertainty causes the most risk? Often, it is load growth -- the uncertainty in market. In a recent PTI study for the national utility of Costa Rica, sponsored by the World Bank, uncertainties in plant construction costs did not affect planning decisions and could be ignored, while oil price uncertainty was only of minor importance. But the load growth uncertainty was critical, and ways to hedge against it had to be found.

Determining Objectives

Why privatize, and how? The answer to the second question is critically dependent on the first. For example, in another study for a company that wanted to build power plants in one country and sell the electricity in another, we found that seemingly-minor modifications to the pricing scheme changed the plants from electricity factories to tax collectors. (Which would you rather be? It depends on your situation.)

It is surprisingly hard to set objectives. Often, they conflict -- but conflicting objectives can be resolved. For instance, the Hungarian Electricity Board and the World Bank did a strategic study using our Trade Off/Risk method. Figure 1 shows a classical conflict and trade-off relationship between loss of load probability (LOLP) and present worth of cost of electricity, both of which were to be minimized. The plan with the lowest LOLP is very expensive, and some of the lowest cost plans are unreliable. But there is a plan, at the knee of the trade-off curve, which has both low LOLP and low cost.

Figure 1. Conflicting Objectives (Reliability vs. Cost)
Source: Hungarian Electricity Board, 1991

In conducting multi-dimensional trade-off analyses, which cannot be conveniently displayed graphically on two-dimensional paper, capital can play a key role. With capital available, things can be done that are better in terms of all objectives than what could be done without capital.

Pricing of Services

Utilities traditionally price on the basis of embedded costs. But other cost bases are superior in some ways -- for example, prices equal to short-run marginal costs can make the system run more efficiently, and market-based prices may be better if the utility is privatized and deregulated.

Some transmission "have-nots" want free access to the transmission system. Their argument: when the system has excess capacity, the only cost their use imposes is the cost of losses (which they are willing to pay). This is like expecting hamburgers to be free, since the cow is already dead -- with the unlucky person who orders last having to buy the next cow. The reasoning gets more tortuous as you get into it, but it boils down to a mis-application of the principle of ignoring sunk costs in decision-making.

Organizational Restructuring

Figure 2, from a World Bank study, shows that utility staffing varies wildly from country to country. Three countries (of a sample of 62) had less than 21 consumers per employee, while nine had more than 160 -- eight times as many!

Many state-owned utilities are required to provide jobs as well as electricity. When a utility is privatized, this obligation may or may not continue. Either way, it is important to look at job functions and possible improvements in efficiency. PTI has been active in using the Introspect technology to analyze organization functions and recommend restructuring. We have done several Introspect studies with ESKOM, one of the world's largest and most progressive utilities. A smaller company in a developing country identified partial savings from an Introspect restructuring at US$16 million per year.

Figure 2. Distribution of Public Power Utility
Consumers per Employee
Source: The World Bank, 1991

Training

When all is said and done, a newly-privatized company succeeds or fails because of its people. Sometimes privatization causes job functions to change; at other times, a newly-privatized company needs enhanced skills to compete or interact in a broader market.

Many utilities avail themselves of courses, such as taught by PTI, ranging from "Utility Economics and Finance" to "Transmission Access and Power Wheeling," from "Least-cost Planning" to "Fundamentals of Protective Relaying," and many more.

Volumes can be written -- and have been -- on the perils and prospects, purposes and pitfalls, of privatization. Here, we have just scratched the surface. But successfully addressing these five issues goes a long way toward successful privatization.
time integral of the product of the instantaneous values of voltage and current. However, as simple as it seems, the calculation requires many samples every cycle. The same calculation using phasors can be done once per cycle as the product of the real parts of voltage and current plus the product of their imaging parts. As an equation,

$$\text{Real Power} = V_{\text{real}} \cdot I_{\text{real}} + V_{\text{imag}} \cdot I_{\text{imag}}$$

Likewise, reactive power (vars) is computed as,

$$\text{Vars} = V_{\text{imag}} \cdot I_{\text{real}} - V_{\text{real}} \cdot I_{\text{imag}}$$

The use of phasors to analyze power system behavior is certainly not new since it is the basis for all load flow and stability calculations in widespread use.

Recognizing the simplification provided by direct phasor measurements on power systems, PTI developed the Dynamic System Monitor (DSM). The DSM converts input ac voltages and currents to phasors in real time using a synchronous sampling technique. A direct measure of frequency is a by-product of the technique and is available simultaneously with the phasors. The phasor (and frequency) conversion occurs each cycle of the fundamental frequency. DC inputs such as control signals are averaged over the cycle and can be compared with the ac inputs on a cycle, by-cycle basis. The phasors and averaged dc quantities can be directly recorded or can be used in user definable transducers and digital filters for triggering.

While the DSM has been used extensively by utilities for evaluating dynamic system performance, they also find the concept of using phasor measurements to be extremely useful for a number of other applications.

1. Generator parameter estimates - Direct measurement of generator response coupled with simulation capability has greatly simplified the identification of generator electrical parameters used in transient and dynamic stability programs.

2. Control performance analysis - Many of the new class of controllers being applied to power systems, operate in the power frequency bandwidth. Evaluation of their performance is closely tied to the system phasor voltages, phasor currents, frequency, and related quantities. Governors, generator regulators, power system stabilizers, HVDC controls, and SVC controls have been monitored and evaluated using phasor measurements coupled with critical dc control signals.

3. Load modeling analysis - Much of the damping associated with dynamic oscillations is determined by the reaction of loads to changes in the rms value of the applied voltage and frequency. Load response may be directly measured using phasor measurements.

4. Load shedding application - Utility load shedding is critical to preserving system integrity during periods where frequency decays beyond acceptable limits. Shedding sequences are normally preset and the exact amount of load shed during an event is unknown until the shed is activated. Using direct phasor measurements at key load shedding locations provides a direct measure of the effects of load shedding.

While most applications in use today only require locally referenced phasor measurements, future applications may include the need for a system-wide common reference for phasor measurements. The most promising method for achieving a common reference is to use a synchronizing signal or precise time measurement from a Global Positioning Satellite (GPS) receiver. Since the GPS signal generated by any one receiver is synchronized within a few microseconds to any other receiver, absolute phase angle measurements to within one degree can be achieved across an entire power system.

Industry researchers are currently investigating the use of absolute phase angle measurements for relaying and state estimation applications, but more sophisticated system-wide control using synchronized measurements would be a natural progression. The emerging interest in synchronized phasor measurements was anticipated in the initial design of the DSM. Recent testing on the DSM has confirmed the ability to simply and accurately measure phasors using a common reference from GPS receivers and this capability is included in a recent controller design.
# 1993 SHORT COURSE SCHEDULE

<table>
<thead>
<tr>
<th>COURSE</th>
<th>DATES</th>
<th>TUITION</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SYSTEM PLANNING</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power System Dynamics</td>
<td>Mar. 8-12</td>
<td>$1540</td>
<td>Atlanta, GA</td>
</tr>
<tr>
<td></td>
<td>Nov. 29-Dec. 3</td>
<td>$1540</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td>Power System Stability and Stabilizer Tuning</td>
<td>Apr. 5-7</td>
<td>$1270</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td>Disturbance Monitoring and Analysis</td>
<td>Apr. 13-15</td>
<td>$1270</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td>Voltage Control and Reactive Power Planning</td>
<td>May 3-5</td>
<td>$1270</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td></td>
<td>Sept. 27-29</td>
<td>$1270</td>
<td>Sacramento, CA</td>
</tr>
<tr>
<td>Transformer Concepts and Applications</td>
<td>May 10-12</td>
<td>$1270</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td></td>
<td>Nov. 8-10</td>
<td>$1270</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td>Increasing Power Transfer Limits</td>
<td>Sept. 8-10</td>
<td>$1380</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td>Optimal Power Flow Techniques</td>
<td>Oct. 19-21</td>
<td>$1270</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td>Transient Analysis Using EMTP</td>
<td>Oct. 25-29</td>
<td>$1440</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td>Overvoltages and Insulation Coordination</td>
<td>Dec. 6-10</td>
<td>$1440</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td><strong>PSS/E AND PSS/U USERS'</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Introduction to PSS/E Power Flow and Steady State</td>
<td>Mar. 22-26</td>
<td>$1440</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td>Analysis</td>
<td>Sept. 13-17</td>
<td>$1440</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td>Advanced PSS/E</td>
<td>Mar. 29-Apr. 2</td>
<td>$1440</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td></td>
<td>Sept. 27-Oct. 1</td>
<td>$1440</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td>PSS/U</td>
<td>Apr. 8-9</td>
<td>$950</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td>Introduction to PSS/E Dynamic Simulation</td>
<td>Sept. 20-24</td>
<td>$1440</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td><strong>TRANSMISSION/DISTRIBUTION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distribution Lightning Protection</td>
<td>Mar. 1-3</td>
<td>$1370</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td>Fundamentals of Protective Relaying</td>
<td>Mar. 8-11</td>
<td>$1380</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td></td>
<td>Nov. 8-11</td>
<td>$1380</td>
<td>Atlanta, GA</td>
</tr>
<tr>
<td>Transmission Line Uprating</td>
<td>Apr. 19-23</td>
<td>$1440</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td>Electric and Magnetic Fields of Power Lines</td>
<td>May 25-27</td>
<td>$1270</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td></td>
<td>Sept. 1-3</td>
<td>$1270</td>
<td>San Francisco, CA</td>
</tr>
<tr>
<td>Real-Time Thermal Monitoring and Rating of Transmission Circuits</td>
<td>Jun. 7-9</td>
<td>$1270</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td>Advanced Transmission Line Design</td>
<td>Oct. 4-8</td>
<td>$1440</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td>Low Voltage Secondary Networks</td>
<td>Oct. 13-14</td>
<td>$950</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td>Power Distribution Systems</td>
<td>Nov. 1-5</td>
<td>$1440</td>
<td>Boston, MA</td>
</tr>
<tr>
<td>Power Quality</td>
<td>Nov. 16-18</td>
<td>$1270</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td><strong>UNDERGROUND CABLE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underground Cable Systems</td>
<td>Mar. 15-19</td>
<td>$1440</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td>Cable and Accessory Failure Analysis-Joint Course with Georgia Power</td>
<td>May 18-20</td>
<td>$1380</td>
<td>Atlanta, GA</td>
</tr>
<tr>
<td>Underground T&amp;D Cable Systems-Joint Course with Georgia Power</td>
<td>Oct. 4-8</td>
<td>$1540</td>
<td>Atlanta, GA</td>
</tr>
<tr>
<td><strong>PLANNING/SCHEDULING/OPERATIONS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power System Scheduling and Operation</td>
<td>Mar. 29-Apr. 2</td>
<td>$1440</td>
<td>San Francisco, CA</td>
</tr>
<tr>
<td></td>
<td>Oct. 25-29</td>
<td>$1440</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td>Transmission Access and Power Wheeling</td>
<td>Apr. 5-7</td>
<td>$1270</td>
<td>San Francisco, CA</td>
</tr>
<tr>
<td></td>
<td>Jun. 2-4</td>
<td>$1270</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td></td>
<td>Nov. 8-10</td>
<td>$1270</td>
<td>Tampa, FL</td>
</tr>
<tr>
<td>Power System Planning Techniques</td>
<td>May 3-7</td>
<td>$1440</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
<tr>
<td></td>
<td>Sept. 27-Oct. 1</td>
<td>$1440</td>
<td>San Francisco, CA</td>
</tr>
<tr>
<td></td>
<td>Nov. 15-19</td>
<td>$1440</td>
<td>PTI Offices-Schenectady, NY</td>
</tr>
</tbody>
</table>

(continued)
1993 SHORT COURSE SCHEDULE (continued)

Reliability Analysis Techniques for Resource Planning
Utility Economics and Finance
Load-Weather Modelling for Load Forecasting
Least Cost Planning
Advanced Applications for Power System Operation

May 17-21
Sept. 13-17
Oct. 13-15
Oct. 18-20
Dec. 13-15
$1440
$1440
$1270
$1270
$1270

PTI Offices-Schenectady, NY
PTI Offices-Schenectady, NY
Raleigh, NC
PTI Offices-Schenectady, NY
PTI Offices-Schenectady, NY

POWER PRODUCTION

Power Plant Performance
Generation Expansion with Independent Power Producers
Combined Cycle Technology
Steam Generation Control
Power Plant Testing

Mar. 1-5
Apr. 26-28
Oct. 4-6
Nov. 1-4
Dec. 14-16
$1540
$1270
$1270
$1480
$1270

PTI Offices-Schenectady, NY
PTI Offices-Schenectady, NY
PTI Offices-Schenectady, NY
PTI Offices-Schenectady, NY
PTI Offices-Schenectady, NY

INDUSTRIAL

Industrial Power System Engineering

Oct. 18-22
$1440

PTI Offices-Schenectady, NY

For further information on courses or registration contact:
Patricia M. Myers, Power Technologies, Inc.
1482 Erie Boulevard, P.O. Box 1058
Schenectady, NY 12301-1058
Telephone (518) 395-5186 • Fax (518) 346-2777

RECENT PUBLICATIONS

Author(s) and (Affiliation)
H.K. Clark (PTI), R.K. Gupta, C. Loutan, and D.R. Sutphin (PG&E)
J.V. Mitsche, Editor (PTI)
J.J. Burke, Editor (PTI)
J.J. Burke (PTI)
H.M. Merrill (PTI), E.O. Crousillat (World Bank), P. Dorfner, (Hungarian Electricity Board), and P. Alvarado (Costa Rican Electricity Utility)
J.J. Burke, Chrmn, (PTI), WG on Neutral Grounding of Distribution Systems
J.J. Burke (PTI)
T.A. Short (PTI)
J.J. Burke (PTI)

Publication Title
Experience with Dynamic System Monitors to Enhance Stability Analysis
Standard Handbook for Electrical Engineers, Chapter 16, Computer Analysis of Power Systems
Standard Handbook for Electrical Engineers, Chapter 18, Power Distribution
Philosophies of Overcurrent Protection
Conflicting Objectives and Risk in Power System Planning
IEEE Guide for the Application of Neutral Grounding in Electrical Utility Systems, Part IV - Distribution
Voltage Stability: Criteria, Planning Tools, Load Modeling
Harmonics & IEEE 519
The Effect of TOV on Gapped and Gapless MOV's

Date & Occasion of Presentation
July 12-16, 1992 - Presented at the IEEE/PES 1992 Summer Meeting, Seattle, WA
August 12, 1992 - publication of the IEEE Power Engineering Society, IEEE Surge Protective Devices Committee
September 14-15, 1992 - Presented at the EPRIN/NERC Forum on Operational and Planning Aspects of Voltage Stability, Breckenridge, CO
September 17, 1992 - Presented to the Electric Council of New England
September 21-25, 1992 - Presented to SPD Committee Meeting, Kansas City, MO

For further information on any of these publications, please contact:
Jeanne M. Aviles, Power Technologies, Inc.
1482 Erie Boulevard, P.O. Box 1058
Schenectady, NY 12301-1058
Telephone (518) 395-5047 • Fax (518) 346-2777