Accessing Power Quality Information and Monitoring Results Using the World Wide Web or a Private Corporate Web

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Abstract

Utilities all over the world are implementing power quality programs. These programs include system-wide monitoring projects as well as the evaluation of individual end-use power quality concerns and equipment. These evaluations and studies have resulted in a wealth of knowledge and data for utility power quality engineers collected by both EPRI and the individual utilities. The challenge has been to quickly and easily distribute this information to other utility employees, especially those employees who have to solve customer problems. Sending hard copies is inefficient and not cost effective. In addition, keeping track of this data and information becomes a major burden as the number of case studies performed grows.

The PQ Database addresses this problem by providing a searchable repository for storing power quality related documents. It provides a media that is flexible enough to support this diverse data set. This program was developed and released by EPRI on CD-ROM and runs under the Microsoft Windows operating systems. However, this software package is a workstation version. The software is designed to be installed and run on each employee's computer.

With the explosion of the Internet and graphical web browsers, obtaining information is easier than ever before. Power quality information is no exception to this. Many utilities are

implementing what is called an Intranet. This term is used to describe a company-wide "internal Internet" which is secure from the outside (firewall protected) but which gives employees access to information from various departments through the use of a standard web browser.

Another feature developed for the Internet is monitoring power quality. Power quality monitoring information is now obtainable over the Internet. Rather than installing custom software on every engineer's computer, a utility now has the option of using the Intranet and Internet to supply critical power quality measurements to all engineers and selected customers. The system is fully protected by the use of passwords, and since the user can only view the data, there is no chance of monitor thresholds being reset or data being erased.

This paper describes both systems in detail and gives examples of utilities and large industrial and commercial companies currently using the system. A case study is presented on one utility's approach to using the Intranet and Internet for accessing power quality information.

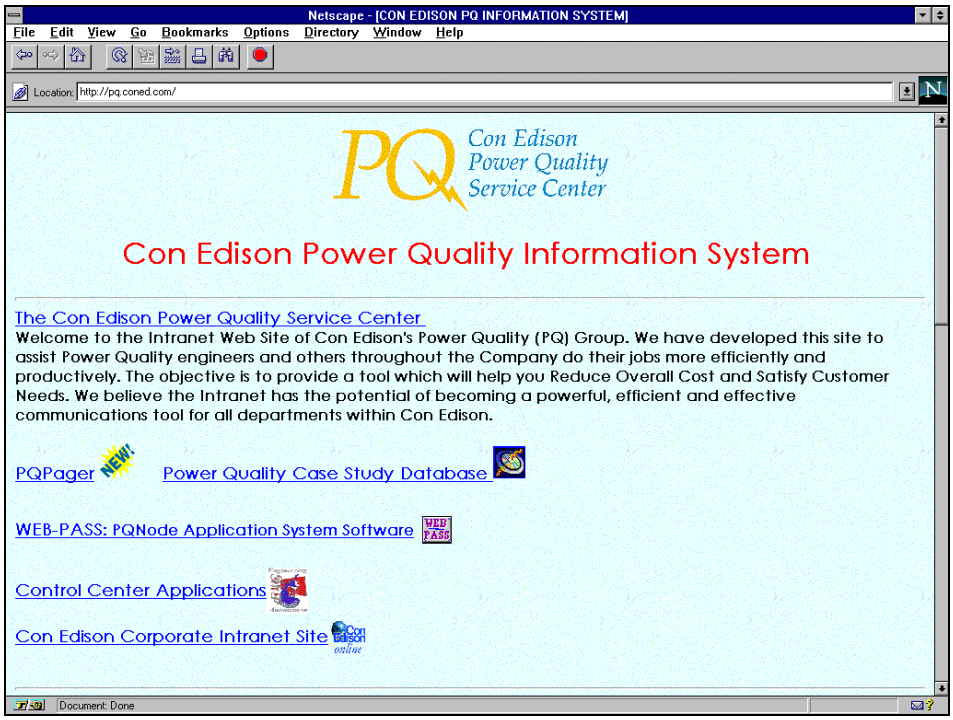

Figure 1: Portion of Con Edison's Power Quality Intranet Home Page.

Introduction

Consolidated Edison Company of New York, Inc. (Con Edison) has been monitoring power quality on their system since the early 1990s. Con Edison has installed power quality monitors on all their distribution networks in Manhattan with plans on expanding this to all of their distribution systems. Along with the power quality monitoring program, Con Edison has employed a power quality service center in their Manhattan service territory.

Although this service center is located in Manhattan, it serves as a resource for the entire company. For this reason, it became necessary to develop and implement a system that would allow engineers from all operating districts and boroughs to query measurement data and case study information.

Power Quality Database (PQ Database™) Web Version

The volume of information and the amount of resources required for a power quality investigation can make completing the task or finding a specific piece of reference information almost impossible. Much of this information that a PQ engineer requires exists in the form of reports and other written materials that are not adequately indexed or cataloged, making it inaccessible to individuals who need to use the information. Unfortunately, the wide range of concerns involved in power quality evaluations makes it very difficult to put information together in a form that is convenient for power quality engineers to use as a reference.

The PQ Database addresses this problem by providing a searchable repository for storing power quality related documents. It provides a media that is flexible enough to support this diverse data set. This program was developed and released by EPRI on CD-ROM and runs under the Microsoft Windows operating systems. However, this software package was essentially a workstation version implying that the software had to be installed and run on every employee's computer, not to mention the fact that a CD-ROM drive or a large hard drive was needed to store the information locally on each computer. This could become burdensome to utilities which might have to dedicate multiple computers to the database. A more flexible and less hardware intensive system was required.

The PQ Database workstation version was developed under the Microsoft Access database program which is "open database connectivity" (ODBC) compliant. EPRI and Con Edison jointly funded a project to convert the Windows based workstation PQ Database program to a server based program which could be accessed over an Inter/Intranet using a standard web browser. The project resulted in the development of a back-end server routine which accessed the ODBC compliant database enabling the utility to keep one master database and avoiding maintenance, hardware, and training costs associated with installing the workstation version on every employee's computer.

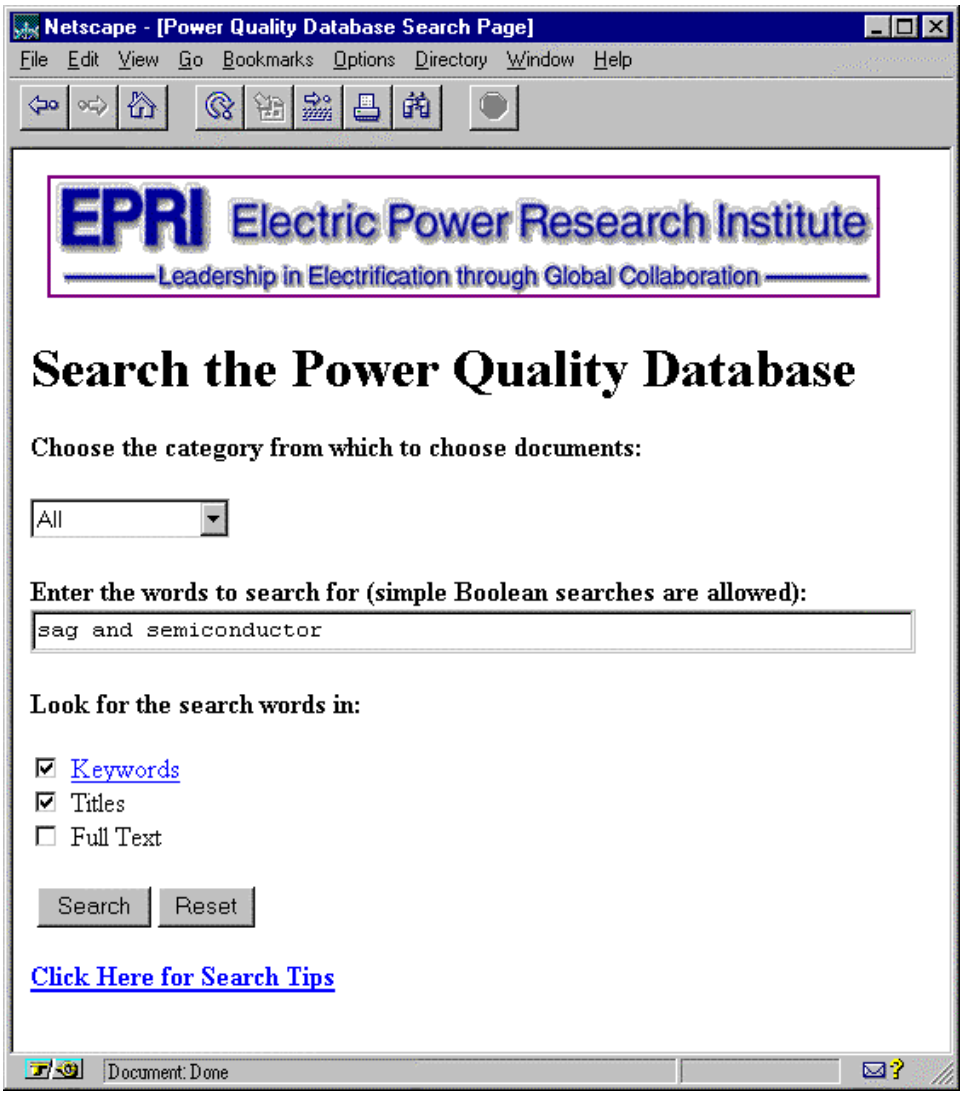

Figure 2: Search window from web version of the PQ Database.

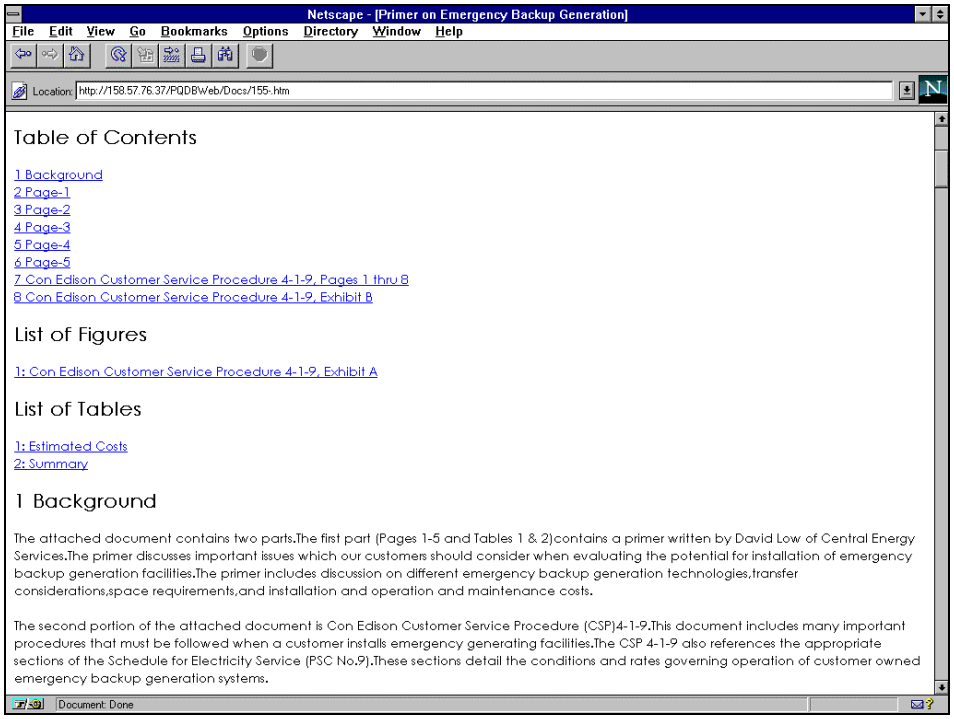

Figure 3: Contents of a Document on Con Edison's Intranet PQ Database. The documents are in a structured format with hypertext links to additional contents.

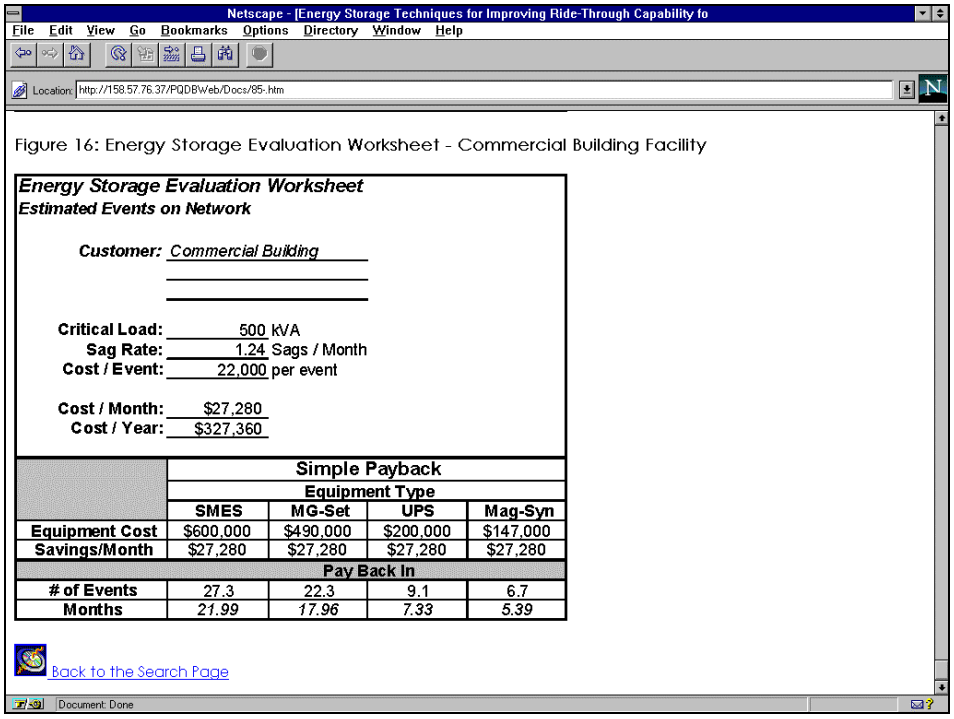

Figure 4: The PQ Database contains economic analysis information within many of the case studies.

PQWeb™

With the plethora of power quality data available at most utilities, there was a need to allow engineers in other customer service areas to view the information. This was accomplished with the PQ Database™. However, several visionaries in the utility industry had the need to respond to both customer and company inquiries into power quality measurements. In the past, one central location in the utility was used to monitor power quality data from around the utility operating area. This information was then stored on a PC and analyzed by power quality engineers. If a customer or utility engineer needed this information, a request was submitted to the power quality group in the utility. The request was then processed and a report was generated and delivered to the party requesting the information. It was Con Edison's and EPRI's goal to make this information more readily available to key customers and Con Edison engineers in other Customer Service Areas (CSA).

As a result of this need, PQWeb™ was developed. PQWeb™ is an Intra- and Internet application. It is based on EPRI's PQView™ software developed to analyze power quality data and is being integrated into the Measurement Module of EPRI's PQ Diagnostic System. PQWeb™ allows users to view data over the web from a power quality measurements database that has been characterized by PQView. While the data gathering and characterization is conducted at a central location, the information is available from any PC with a WEB browser. Security levels and passwords are implemented to avoid unwanted persons from viewing what could be highly confidential data.

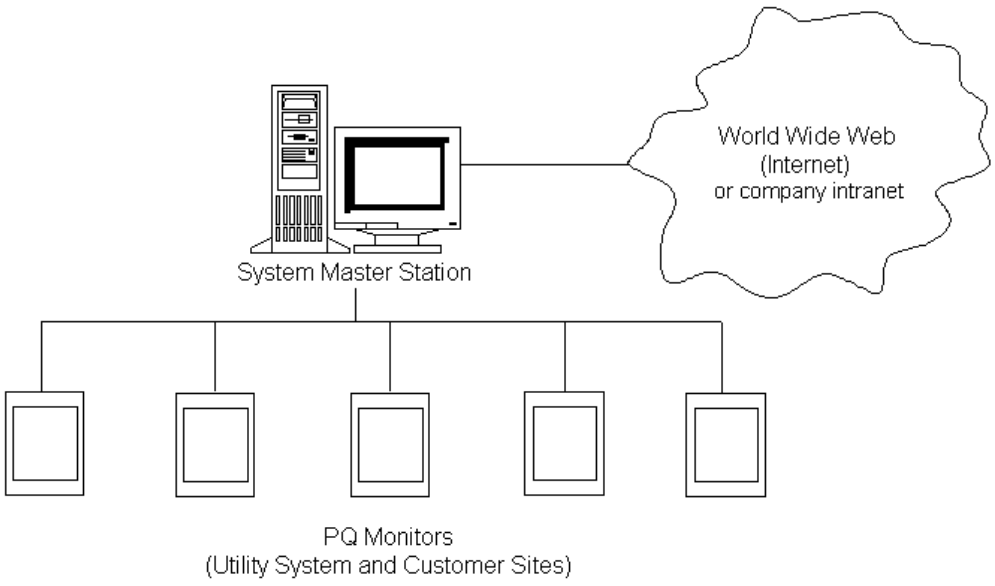

Figure 5: Utility master station and power quality monitors on utility system and customer sites.

How it Works

PQWeb™ uses a World Wide Web (WWW) or Intranet server to deliver power quality information and data to engineers, customers, and representatives who need quick access to power quality data. In order to access the data, the user only needs to know the address (URL) of the power quality master station, have a WWW client program such as Netscape™ or Microsoft Internet Explorer™, and have the required passwords to enter the system. The application processes requests from the user and sends an HTML file back to the user through a Web browser. The main screen for PQWeb™ is illustrated in Figure 6.

The user may view an RMS report which may contain an event list, histogram table, CBEMA curve, and/or 3D Histogram. A time range filter is applied to the request, and the report is sent back to the user. Figure 6 illustrates the screen used to submit a query to the back-end server.

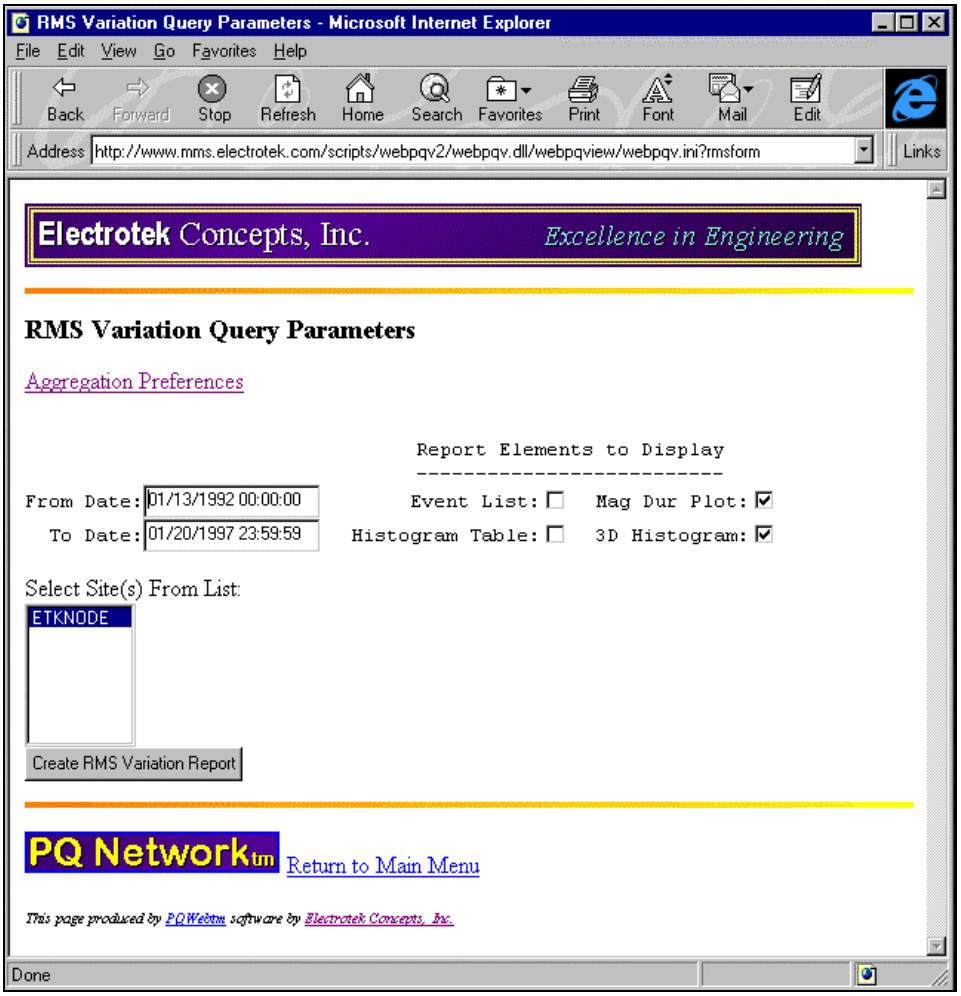

Figure 6: Query select form from PQWeb.

The date and time ranges are entered, the monitoring site(s) is selected, and the power quality information wanted is selected. The request is sent to the back-end server, and the results are displayed as shown in Figures 7 through 9.

What Can be Viewed

The PQWeb software allows viewing of all data that has been previously downloaded from the monitoring instruments using the monitors proprietary software and stored on the network server.

For example, if an engineer is looking for events that occurred during the previous week, a password is entered, sites of interest are selected, and the date and time of interest are entered. An Event List is returned, and the user may view each event in more detail. The events are viewed individually by phase as shown in Figure 10.

The disturbance detail allows the user to view all aspects of an event. Cycle-by-cycle RMS summaries and waveform captures can be used for troubleshooting. Voltages and or currents can be displayed. Data such as this is now immediately available to such groups as control room operators, system protection engineers, customer service representatives, and any other employee connected to the Con Edison network. Access is available across a range of operating systems, including OS2 and UNIX.

Event List

Type	Event Description	Mag (Per Unit)	Duration
RMS Variation	ETKNODE - Phase A Voltage Inst. Nominal 10/29/93 09:04:21 PM	0.89	2 Cyc
RMS Variation	ETKNODE - Phase C Voltage Inst. Sag 10/29/93 08:55:08 PM	0.88	3 Cyc
RMS Variation	ETKNODE - Phase C Voltage Inst. Nominal 10/29/93 02:50:56 PM	0.86	3 Cyc
RMS Variation	ETKNODE - Phase B Voltage Inst. Nominal 10/25/93 01:30:39 PM	0.77	5 Cyc
RMS Variation	ETKNODE - Phase C Voltage Inst. Sag 10/25/93 12:49:59 AM	0.86	3 Cyc
RMS Variation	ETKNODE - Phase B Voltage Inst. Nominal 10/12/93 01:42:18 PM	0.88	4 Cyc
RMS Variation	ETKNODE - Phase A Voltage Inst. Nominal 10/12/93 12:11:16 PM	0.85	5 Cyc
RMS Variation	ETKNODE - Phase C Voltage Inst. Nominal 10/08/93 02:59:55 PM	0.25	3 Cyc
RMS Variation	ETKNODE - Phase B Voltage Outage 10/02/93 10:11:13 PM	0.00	00:36:45
RMS Variation	ETKNODE - Phase C Voltage Inst. Nominal 10/01/93 01:04:37 PM	0.77	2 Cyc

Figure 7: Event list returned via Internet and HTML document to user after submitting request.

The Event List contains information about power quality measurements that match the given criteria submitted to the back-end server. This information includes the following:

- Event type
- Event Description
- Event Magnitude
- Event Duration

From the Event List the user may select to view the detail of the disturbance.

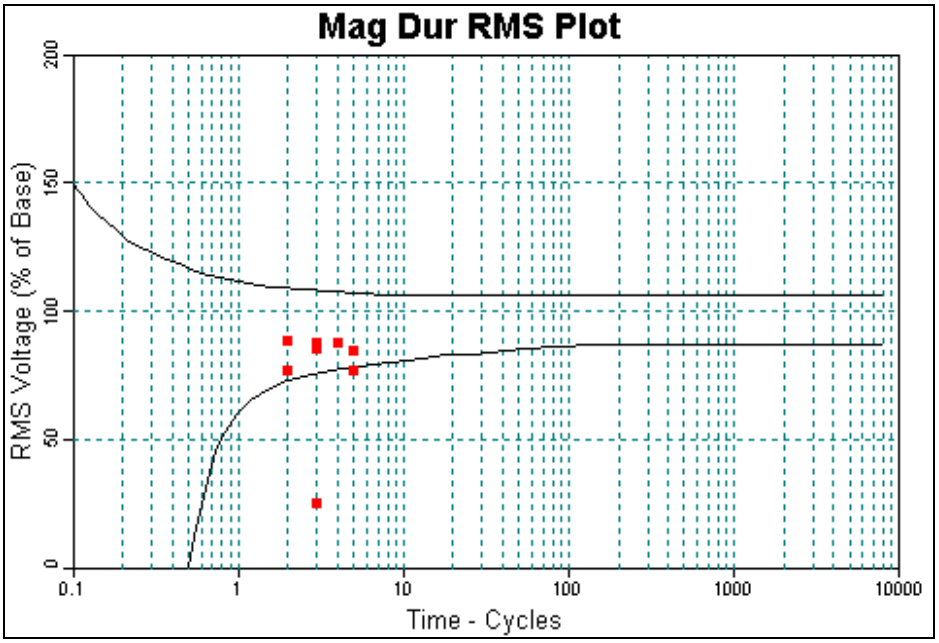

Figure 8: Example magnitude duration plot with CBEMA curve overlay.

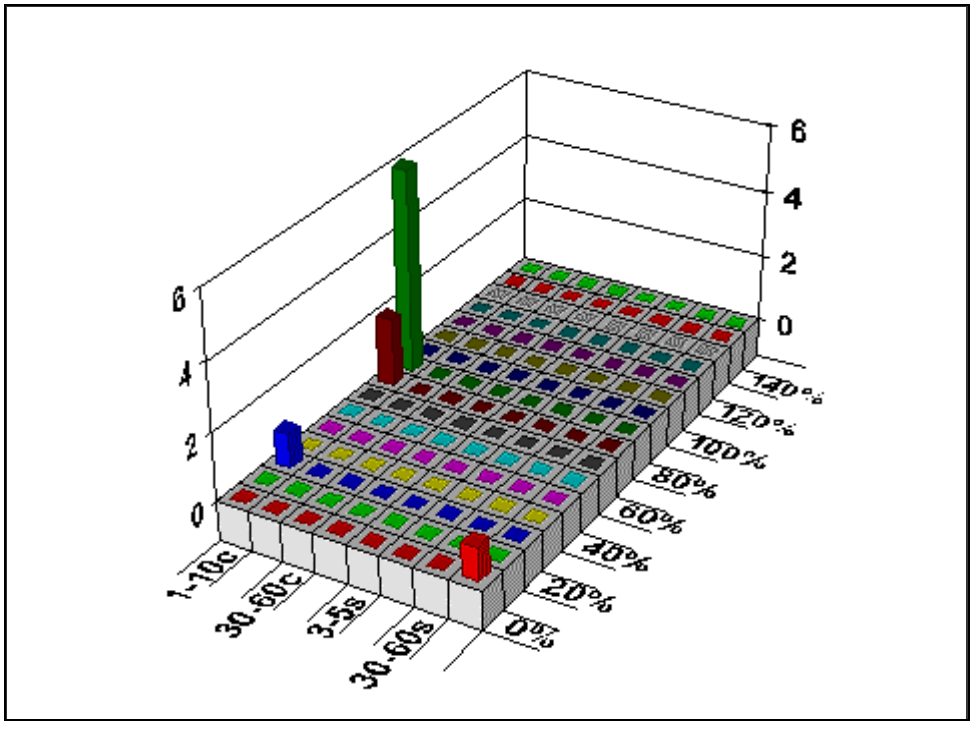

Figure 9: Example 3-D histogram bar chart illustrating RMS variations for given time range.

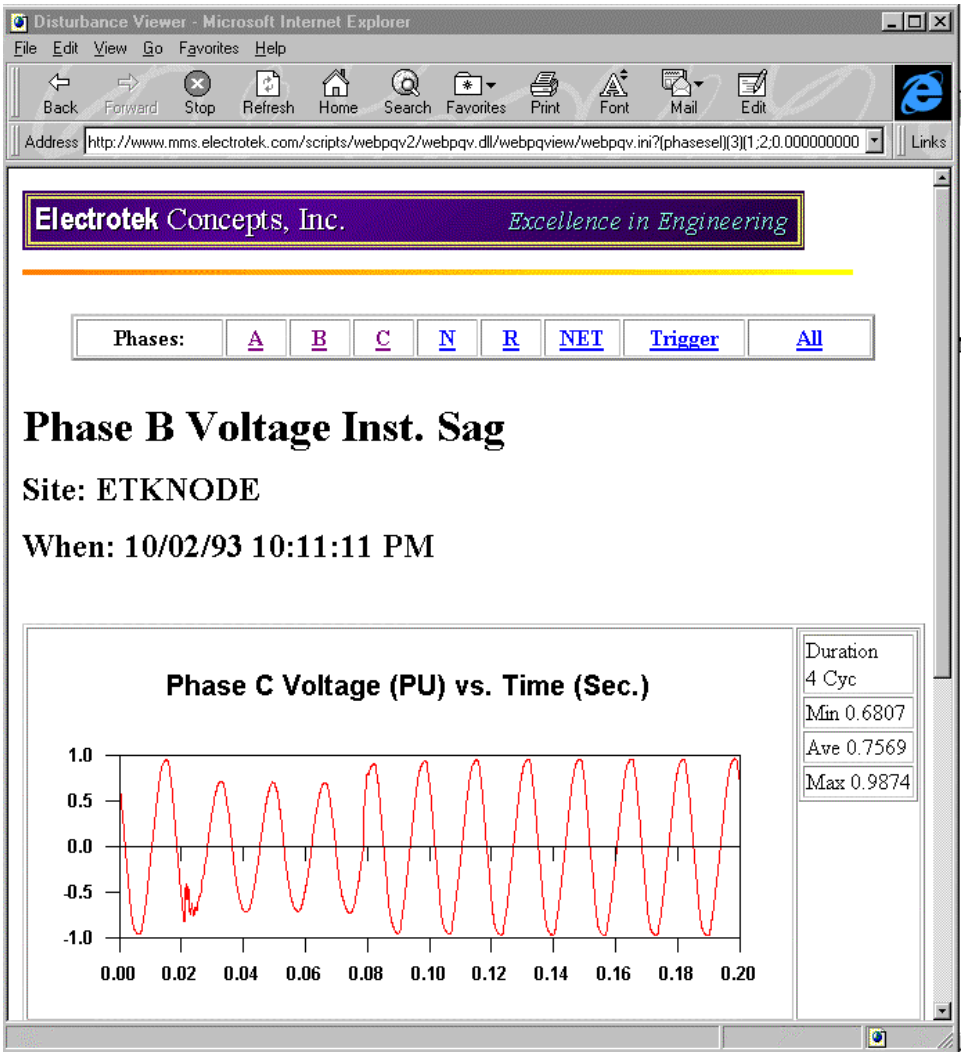

Figure 10: PQWeb™ single event viewer.

WebPASS™

WebPASS™ was developed for the Intra/Internet as a result of the need to look at raw data which has been downloaded from BMI PQNodes. This allows users to view the data from remote locations without having to have network access to the raw data.

WebPASS™ data selection is similar to PQWeb™. WebPASS™ allows the user to plot trends of the RMS voltages and currents. These trends can be selected for one day, one week, one month, one year, or any arbitrary period of time. The trend data displays the minimum, maximum, and average RMS values of all cycles. It is a convenient method to summarize the power quality of a site over a given period of time. This plot is also useful to show voltage regulation and load change patterns

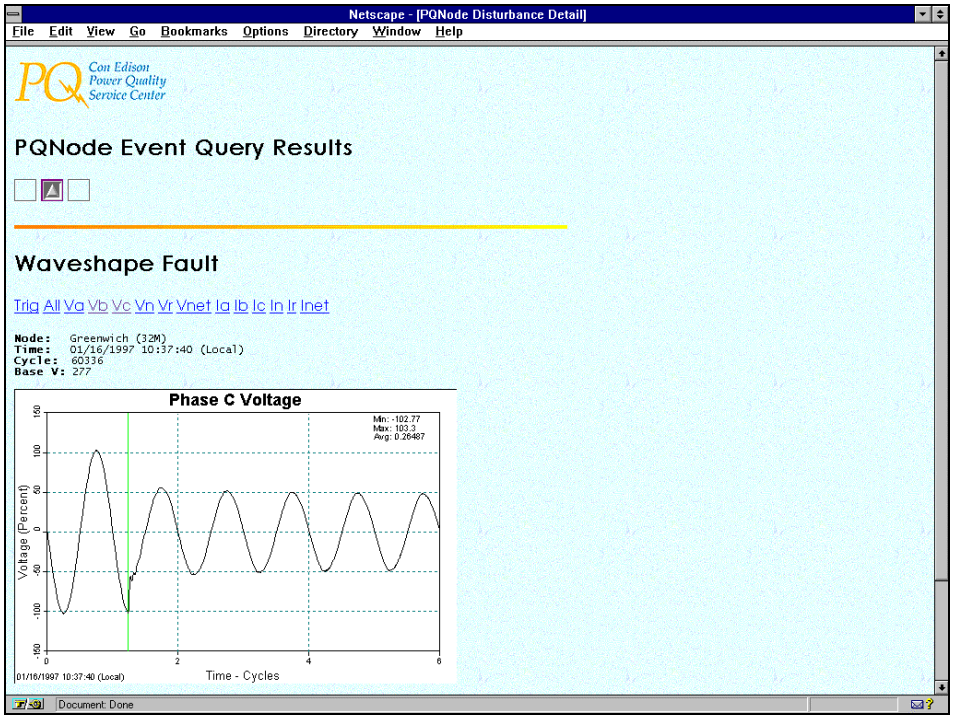

Figure 11: Actual event data from the Con Edison PQ Intranet site.

Steady-state snapshot results can also be displayed in WebPASS™. These events reveal loading conditions prior to an event and allow the user to monitor normal conditions.

All of this allows the users to view power quality data without having to install a large amount of software on their computers. All of the work is done on the WEB server, so the user only needs a standard WEB browser to view the data.

Related Reading

[1] EPRI Innovator IN-107153, December 1996.

[2] Power Quality Database: Users Guide, EPRI Final Report AP-106028, December 1995.

[3] Dabbs, William, et al, “Probing Power Quality Data”, IEEE Computer Applications in Power, Volume 7 Number 2, April 1994.

Acknowledgements

PQWeb is a module of the EPRI PQView software and is part of the EPRI Power Quality Diagnostic System.

Biographies

Christopher J. Melhorn received an ASE from York College of Pennsylvania in 1986 and a BSEET from the Pennsylvania State University in 1989. Upon graduation, he joined Electrotek Concepts, Inc. as an Associate Engineer and now holds the title of Manager, Industrial & Utility Applications. His experience at Electrotek includes working with EPRI and Utilities on case studies involving power quality issues. He was also extensively involved in the EPRI DPQ project site selection phase. Mr. Melhorn has designed and implemented monitoring systems for utilities and end-users throughout the US and abroad, including Con Edison's current power quality monitoring system. Mr. Melhorn is presently involved in developing new software for the power systems engineering environment and working to increase Electrotek's industrial and utility based clientele.

Kelley P. Flatford received her BS in Computer Science from East Tennessee State University in 1993. Ms. Flatford joined Electrotek Concepts, Inc. in 1996 as a software engineer. Her primary areas of expertise include programming in Visual C++/MFC, Visual Basic, and other high level programming languages. Since joining Electrotek, Ms. Flatford has been instrumental in the development of web based applications like PQWeb. This work includes the use of HTML, script languages, and Microsoft InterDev. Ms. Flatford is currently the lead software engineer on EPRI's web based version of the Power Quality Diagnostic Systems (PQDS) Measurement Module.

Peter Hofmann received his BSME from Newark College of Engineering. Mr. Hofmann is the manager of Con Edison's Manhattan Customer Service Power Quality group. During his twelve years at Con Edison, he has had Distribution Engineering and Operations experience in both overhead and underground network systems.