Paper Tools

Richard P. Bingham

There are many different types of tools available for troubleshooting, auditing, and evaluating the power quality compatibility and susceptibility of a facility. From handheld DVMs to sophisticated power quality analyzers with mega-hertz sampling rates, each tool has its own strengths and weaknesses for a given application. While there a lots of useful standards and reference materials out there, a good, general purpose tool that covers a wide variety of situations (and is very inexpensive) is the NFPA 70B Electrical Equipment Maintenance publication.

The IEEE Power Engineering Society is responsible for the updating and development of a number of valuable references, such as IEEE 519 and IEEE 1159, along with the entire "color book" series. While these are well-written and useful publications, they are written and reviewed, as the title applies, by primarily power engineers. Often these documents have formulas and technical terms that some electrical contractors are not familiar with, which makes the application of such more challenging.

The NFPA 70B approaches the material from a different perspective. The committee is comprised of members from numerous backgrounds and responsibilities, including the IBEW, NECA, NEMA, NETA, the Dept of State, OSHA, manufacturers of equipment, and others. Angie Stoyas, of the US Army Corp of Engineers, provides vision and effective leadership as the chairperson, and assisted by the knowledgable liason to the NFPA, Joe Sheehan, who also works on the NEC committee. This diverse group of people make sure that the resulting publication is accurate and highly applicable to its readers. Any additions or changes are subject to public proposals and comments, and then must be approved by the entire NFPA organization at its annual meeting.

As the title applies, the purpose of this publication "is to reduce hazards to life and property that can result from failure or malfunction of industrial-type electrical systems and equipment. The first three chapters of these recommendations for an effective Electrical Preventive Maintenance (EPM) program have been prepared with the intent of providing a better understanding of benefits, both direct and intangible, that can be derived from a well-administered EPM program. This practice explains the function, requirements, and economic considerations that can be used to establish such a program."

Today, many companies are outsourcing their electrical equipment maintenance to electrical contractors as a more economical way to maintain their equipment and facilities. For companies that already have established EPM programs based on 70B, the contractor is expected to continue to maintain the program at the same level. And when the contractor is called upon to establish a new program for a facility, it provides an excellent basis for such. Maintenance of motors, lighting, distribution panels, transformers, breakers, fuses and motor control circuits are just some of the topics covered in a step-by-step, concise manner.

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The 1998 revision includes a greatly expanded chapter on power quality. Categories of power quality phenomena covered include harmonics, sags, swells, voltage unbalance and single phasing, transients, over/undervoltage, sustained interruptions, noise, and interharmonics. Each category is broken down into sections on definitions, symptoms and effects, causes, surveying and testing, and recommended solutions. There is also a section on grounding and a list of additional references to consult with if you can't find the answer in the document.

There are graphs of typical power quality phenomena, such as the classic voltage notch and harmonic-laden current waveform of the 6 pole converter, as shown in Figure 1. This waveform is often found in the front end of ASDs and other three phase devices that rectified the AC into DC before converting it into other voltages levels and/or frequencies. This current waveform contains the dominate harmonic pairs (5-7, 11-13, 17-19, 23-35...) that follow the rule: harmonic numbers = integer (1,2,3,..) multiplied by the number of paths of conduction (3 phases * 2 for full wave rectifiers) plus and minus one.

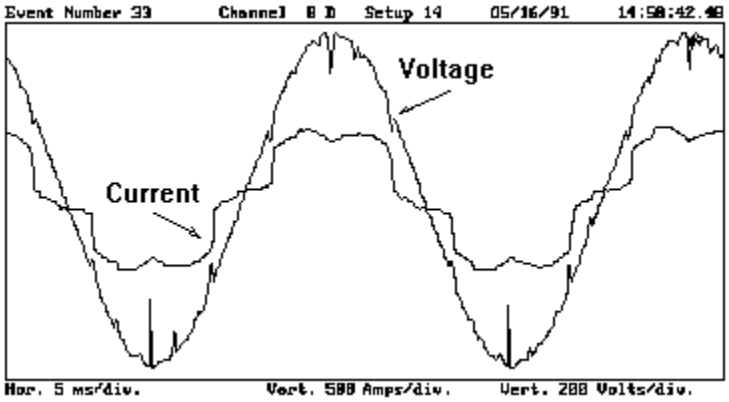

Figure 1

Figure 2 has another classic waveform, the negative transient followed by the ringing voltage which can be 1.2 to 1.8 times the normal peak voltage, which usually occur when the power factor capacitor is switched in. This typically occurs at a certain time in the morning or at certain load levels. The uncharged capacitor "steals electrons" until it is charged up, reducing the voltage waveform in the form of a negative transient. This sudden current draw resonants with the system impedance to cause the ringing waveform after it. Sometimes, the negative transient can be deep enough to cause zero crossing errors. The ringing transients can cause tripping of overvoltage protection circuits.

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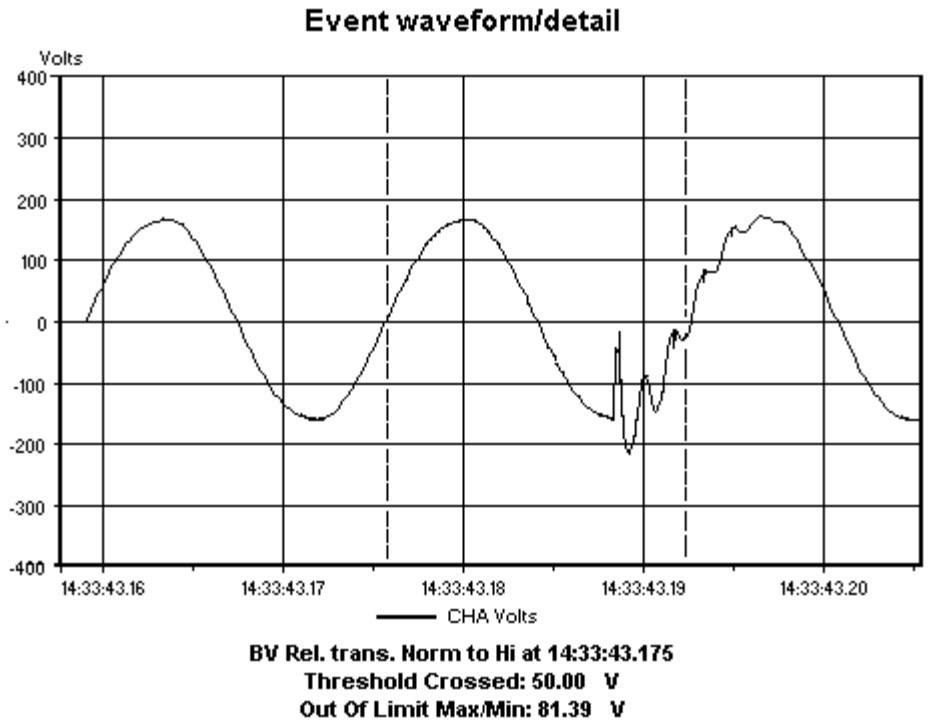

Figure 2.

The NFPA 70B should be a "paper tool" included in every contractor's tool box. Copies can be inexpensively obtained from the National Fire Protection Association, 1 Batterymarch Park, Quincy, MA, over the Internet at www.nfpa.org, or by calling them at 617-770-3000.

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