Power Quality/EMI Case Studies

Case No. 1

Hello Mike, how about if I give you a brief overview of a building I just completed that is typical of what I have been finding.

The building is a 106,290 sq. feet, five story plus mechanical penthouse, office building. The 120/208 volt, three-phase service is supplied by a 150 kVA, 480 transformer that feeds a 600-amp main distribution panel. The lighting and mechanical equipment is fed from a 277/480 volt, three-phase riser. An additional 112.5 kVA transformer was installed in the mechanical penthouse to provide normal and emergency 120/208 volt, three-phase power to several cubicles on the third floor and a computer room on the fifth floor

This building was experiencing various problems such as overheating and tripping of two 100 amp sub-panel breakers in the main distribution panel; the main transformer was too hot to touch and was operating at a low power factor.

After several electrical contractors tried to fix the tripping breakers, an Electrical Engineer (that was familiar with the property) was called in and he did a power quality survey. His report (the size of a phone book) showed all the Fluke 41 readings and stated that the building was rich in harmonics and recommended major upgrades in the electrical system to the tune of $200,000.

As that kind of money would need to be budgeted, the owner of the property (who was looking for a quick solution for the tripping breakers) called in the Power Quality Manager of the local electric utility. This person removed all panel covers and did a similar survey with a Fluke 41. His recommendations were much the same except his report, (and bill), were bigger.

Both engineers said the temperature of the transformer was normal and not a problem.

When I inspected the building, I did a 15-minute walk-through with a triaxial Gaussmeter and had readings up to 30 mG in a variety of office and common areas. The actual readings were not as important as the fact that it simply established that there was a problem. During a walk-through, I try to keep the Gaussmeter at least one meter away from anything. My experience has indicated that any reading of one mG or more with one meter of distance is a sign of a problem.

Next, I went to the 480 volt, three-phase Motor Control Center (MCC) in the mechanical penthouse and checked the equipment grounding conductor for current. Each half of the parallel feed (two raceways) to the MCC had three conductors and one equipment grounding conductor. One grounding conductor was carrying twelve amperes and the other eight amperes. These conduit risers were also warm to the touch and had high mG readings as did other piping, handrails, etc. The grounding electrode conductor from the transformer to the water pipe read 1 ampere.

An inspection of the grounding and bonding revealed that neither transformer was grounded to building steel, the neutral to ground bond was missing in the main distribution panel and the system main was only grounded to the main water pipe. There was no bonding between the service equipment (600 main) to the building steel, and there was no bonding between the water pipe to building steel.

An inspection of the eight 120/208 volt, three-phase, 100 ampere sub-panels and the six 277/480 volt, three-phase, 100 amp lighting panels revealed that 25 circuits had an excess of .5 amps net current. The highest reading was 14 amps. (In commercial work, I generally disregard any reading below .5 amps because it can be difficult to find the problem).

The total of the 120/208-volt net currents came to 90 amps and there were 20 amps from the 277/480-volt lighting side. In other words, there were 90 amps of transformer neutral balancing current that did not have a direct path back to the transformer. A total of 110 amperes was flowing through the building steel.

I found 18 circuits had neutral to ground shorts in receptacles at connectors or wires cut on the ears of add-on boxes. A large copier had a neutral to ground shorted surge suppressor, five lighting fixtures had ballast wires caught under ballasts or ballast covers. The emergency feed transformer in the mechanical penthouse fed a panel next to it, which fed several emergency circuits in cubicles on the third floor. These cubicles also had normal power fed from the third floor panel. All the neutrals were tied together in the cubicles causing net current.

While working with one electrician to clear the net currents, another installed the needed and supplemental grounding and bonding and grounding rods. Initially, before the net currents were cleared, the ampere on the grounding electrode conductor for the main transformer (to building steel) was 30 amps!

The new (and proper) grounding connection for the transformer allowed the transformer to recover some needed neutral current and the transformer cooled down some, but did not cool fully until all the net currents were cleared. The current on the main transformer grounding electrode conductor (after the fixes) is now about 2 amperes.

Clearing the net currents and correcting the bonding and grounding has eliminated the problems at this property and improved the power factor on the transformer for a lot less than 200,000 dollars! The reduction of net current helps in extending the life of lamps and ballasts, and the reduction of fires.

> **Mike Holt's Comment:** If you would like to see a great video on how net current causes fires, contact my office and ask for the open neutral fire video. The normal cost is $50, but if you tell them you're a newsletter member, I will make this video available for only $25 (includes the cost of shipping).

There is much to this subject (EMI/Net Current) and it has been quite an education tracking down net currents and observing the path ground current takes. Though I am fairly new to the EMF world I am constantly amazed at how well the detection process works.

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Case 1 – Update

Mike I have received many e-mails concerning the EMI/Net Current case so I would like to clarify the significance of the 120 amps on the structural steel of the building.

A transformer with a neutral works best when all the energy sent out to the circuits returned directly back to the neutral of the transformer through the grounded (neutral) conductors. In fact, a transformer cannot put out more power than it can get back. EMF detection includes finding wiring problems that prevents all the power from returning to the transformer. If all of your operating power is not returning to the transformer, then the fault current needed to trip a circuit breaker (from a line-to-ground fault) will return not either.

The EMF readings that we picked up by the Gaussmeter during the walkthrough were from circuits that had neutral to ground shorts and the neutral current was flowing onto the grounding system. This return neutral current was no longer returning to the neutral of the transformer, but was running through the structural steel of the building.

To clarify, one circuit for instance, was on the fifth floor on the East Side of the building. The transformer supplying its power is on the West Side of the first floor. So what do we get?

1. Five floors of an energized column giving off EMF's all the way down.
2. Circuit that give off EMF's its entire run from the circuit breaker, because it is missing the needed balancing neutral current (net current).
3. We get a main riser that is giving off EMF's all the way back to the transformer because it is missing balancing current.
4. We get a transformer that is heating up because it is missing balancing neutral current.

Now multiply this 25 times, (the number of net currents found), and you have a seriously deprived transformer with multiple circuits having limited ability to provide enough current to trip a breaker during a short, and EMF's all over. However, this is typical of what is out there. These power quality problems effect sensitive equipment, and cause lamps and ballasts to fail sooner.

Sometimes whenever EMF’s are created, a high impedance neutral return path is created and the equipment grounding conductors now have current flowing on them [violates 250-6 Objection current]. Additionally, our 0-volt ground reference for the transformer now is energized and our transformer output voltage-to-ground could be higher.

To compound the problem, EMF's given off by a monitor will increase in proportion to the net current of a circuit that has net current.

I have only touched on the subject, but to me, work in EMF detection has really advanced. It is no longer just about living under power lines. EMF detection is a powerful way to discover hidden electrical problems that you would never otherwise find.

Ed Chavern   www.angelfire.com/pa3/emf

Case No. 2

Being a small electrical contractor specializing in power problems in large office buildings I have invested a large amount of money in electrical data recorders to find harmonic problems--- after ten years of this type of work---I have discovered that the majority of the Power Quality problems are "poor installation practices" and many times "engineering practices".

When we are called in on a PQ problem we meet with the contractor and his Forman, the engineer and the customer and/or the building manager. Before we setup any equipment we ask about the installation. Too many times common neutrals are used and these circuits are referred to as "dedicated circuits". Or a separate neutral is run but it is connected to another neutral by mistake. I've had engineers tell me "just install it the way I have it on the plans" and then two years later we are changing the installation to provide separate neutrals to computer related equipment.

What I'm trying to say is --all the test equipment can't correct poor installation practices. The second biggest problem in the power quality area is the end user, Example: The paralegal with one of those little desk heaters---rated at 14 amps!!! And the plug strip, you know we got the good ones with the surge suppressor so we can run seven or eight work stations off one circuit and when you tell them it's poor practice they say it's been that way for years!

One firm EDS on I-75 has a classroom with 21 stand alone computers on one circuit with a load of fifteen amperes! Told them about it over a year ago, and it has never been changed.

I was called to another job where the power would cause the computers on one circuit to actually re-boot. My first step was to identify the circuit back at the source and start taking some readings. But we couldn't get a reading! I changed the batteries on the circuit tracers---tested them on other circuits to prove they were operating. Four hours later and I still could not find the circuit! Somehow the installing electrician had the neutral of this circuit tied to a different transformer source two floors below.

Just some of my thoughts on Power Quality.
Charlie Trowbridge, trow1943@bellsouth.net

Response to Case No. 2

This is the problem may people find when they hire an engineering firm to do Power Quality Analysis. Most engineers have not been electricians and miss out on where a majority of the problems originate. IE: Poor installation and improper grounding and bonding. Also Engineering firms, rarely identify problems with conduit routing, unless they use an electrician who has been trained in Power Quality analysis. Most "engineering" firms, (no offense to engineers), cringe at the thoughts of an electrician/technician being able to assist them in the cloak and dagger world of power quality analysis. But I think we all need to work together to solve these problems.

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Mike Holt's Comment:
Because Power Quality and Electromagnetic Interference analysis is a relativity new area, many of us do not know the basics, the symptoms, and or the solutions to these problems. As a matter of fact, many times we don't know where to turn to when there is a problem. In an effort to help you, help others, I would like to post on my website companies that offer analysis and solution to PQ and EMI problems.

If you do this type of work let me know. Give me a brief history of your company, where you do business (Florida, Northeast US, Western State, North America, North and South America, etc). Submit one comprehensive case study of a job you have done (one or two pages), with three references of jobs you have completed with a brief summary about that job.

I will post your company name on my site (lots of exposure) so that others who need your service and expertise will know how to get in contact with you.

Business Name:
Contact Name:
Title:
Brief history of company:
Business Location: City, State
Geographical Area:
Reference No. 1: Include contact name, address, city, state and brief description of problems and solutions.
Reference No. 2: Include contact name, address, city, state and brief description of problems and solutions.
Reference No. 3: Include contact name, address, city, state and brief description of problems and solutions.
Case Study: Include contact name, address, city, state and detail description of problems and solutions. This needs to be about 1-2 pages. Don't worry about grammar, typos or spelling.
Other information, you would like others to know about.

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