At Load Power Factor Correction

Final Report
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1 – PROJECT OBJECTIVES AND BACKGROUND INFORMATION

1.0 Project Introduction, Objectives, and Overview

Power Factor is the ratio of the power needed to do the work within customer premises to the power delivered by the utility. A power factor of 1.0 is ideal. Equipment located in customer premises emits reactive power that lowers the power factor. There are devices that can be attached to the loads to raise the power factor and reduce the amount of energy lost as heat on the wires in buildings and on the electrical distribution system.

This paper presents the background information, method, and results from an eighteen month long pilot project designed to determine the economic feasibility of "At Load" power factor correction in various scenarios as a method for improving efficiency and reducing losses on the electric utility system. "At Load" power factor correction will be analyzed in multi-family dwellings (apartments), single family residences, commercial buildings and industrial buildings. As power factor correction is not a new concept, the project had four objectives. For all phases of the project, our first objective was to measure the power factor in the different environments. This involved creating data bases to simplify handling of the data being collected. Second, we wanted to gain a better understanding of the reactive loads in the different environments. That understanding includes the age of the appliances or equipment discharging the reactive power and the types of installations involved. Our third objective was to correct the power factor in the most cost effective manner possible. Our final objective was to measure the effect of our installation and determine the cost versus benefit of the installations. Benefit is measured in Kilowatt Hours (KWH) saved.

While the results presented for all of the test environments will be similar, the magnitudes of improvement and the related costs vary from environment to environment. Also, the volume of data being collected and the timeframe of the data collection at the different sites mandated that we divide the project into four phases. This is a summation of the results from all phases of the project. There are individual papers for the Industrial/Commercial analysis, the Vending Machine analysis, and the Multi Family Dwelling analysis phases of the project. The Single Family Residential Data is documented in Part 5.

Many of the references in the paper are to the Transmission and Distribution system in New York, as the work was done there. Nevertheless, the results are valid for nearly all AC distribution systems.

2 – INDUSTRIAL AND COMMERCIAL APPLICATIONS

2.0 Background and Conclusions - Industrial

Accurate data is not available on the number of services in each kilowatt range in the New York metropolitan area, however, Con Ed recently initiated a new tariff that will go into effect over the next three years for services above 500 kilowatts of peak demand. Approximately 7000 meters are affected by this new tariff.

While much of this documentation will reference the New York Metropolitan Area as the work was done here, it is applicable to other areas of the country as well. Conclusions that we have drawn from the work completed to date are the following:

- The power factor is sufficiently low in commercial and industrial buildings that improving it will result in a substantial energy savings throughout the entire utility system, when measured in KWH.

- We can cost effectively improve the power factor for commercial and industrial buildings using the "At Load" technique.

- Standards need to be modified so that new commercial and industrial buildings, and their associated process equipment, are designed with a high power factor as part of the design criteria.

- "At Load" Power Factor Correction in this environment does not greatly increase the amount of harmonics.

- "At Load" Power Factor Correction in this environment will reduce CO_2 emissions by approximately 30 tons annually for each corrected facility of greater than 500-KW, and by approximately 11 tons annually for each corrected facility of greater than 150-KW.

- Power Factor Correction must be load based and must only operate when needed. Excess capacitance connected to the utility system can be as detrimental as excess inductance. Furthermore, in the event of a blackout, the excess capacitance would add extra impedance that would have to be energized, applying extra load to the system during a restart.

- In most applications, “At Load” correction has significant advantages over “Service Entrance” correction with respect to energy savings, cost, return on investment, and reduced levels of equipment damaging harmonics.

2.1 Implementation

Implementation of the “At Load” Power Factor Correction for the industrial locations was relatively simple and involved the following steps:

1. **Acquiring Funding**: This was provided through a NYSERDA grant to offset the cost of equipment that would be installed within the customer premises.

2. **Acquiring Test Sites** : Upon confirming that we had project funding, we proceeded to look for building owners that would be willing to participate in the project.

3. **Initial Measurements** : The first step of the process is a walk through of the facility to look at the equipment located on site. Certain types of equipment are likely sources of reactive power. Those include screw compressors, air conditioning equipment, machinery with fly wheels, and large blowers, among others. The second step is to take measurements at the service entrance of the facility over an extended period of several hours during the building’s prime operating period to determine the reactive load and power factor of the facility. The third step in the process is to take measurements at the interconnection point of obvious sources of the reactive load to determine each machines load characteristics and how much reactive power they are discharging onto the system. Step four involves calculating the size of the devices that need to be attached to each piece of equipment to correct the problem.