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Data Request for Harmonic Analysis, Power Capacitor Application, and Harmonic Filter Design Studies

The application of shunt power capacitor banks and harmonic filters often requires a harmonic study to confirm the application will not result in premature equipment failure or power quality problems due to high voltage distortion, high current distortion, and/or system resonance. This document outlines the necessary data to perform this analysis.

Background

Shunt power capacitor banks are most often applied on power systems for power factor correction and/or voltage support. Their application, however, can often degrade your power quality due to system resonance, high voltage distortion, and high current distortion. These power quality issues can disrupt plant operations, degrade electrical equipment, and cause premature failure of your plant electrical equipment, power capacitor bank, and/or harmonic filter bank.

The data requested in this document provides Northeast Power Systems, Inc. (NEPSI) with the necessary information to conduct power system and harmonic analysis of your application. These analysis can identify harmonic problems and aid in planning appropriate steps to correct them before you purchase equipment. Such steps may include the application of harmonic filters in lieu of shunt power capacitor banks or changes to your filter design such as changing your filter's tuning point or the type of filter.

Harmonic filters provide all of the same benefits as power capacitor banks, with added benefits of removing harmonic related concerns. These added benefits come with added equipment costs, and therefore, should only be considered when necessary.

Analysis Method

NEPSI most often uses a digital computer harmonic analysis program (etap® or ESA's EasyPower®) to simulate your system's response to the application of power capacitor banks and harmonic filter banks.

The harmonic analysis program utilizes frequency scan and harmonic current injection techniques to identify critical harmonic currents and calculates expected voltage and current distortion within your electrical network.

IEEE 519-2014, *Recommended Practice and Requirements for Harmonic Control in Electric power Systems* (or other standard if specified) is used as a benchmark to determine the suitability of the application.

The program requires certain information about your system (input data), to perform the analysis. The accuracy of the results are directly related to the accuracy of the input data.

While gathering the data, consideration should be given to future load additions, system expansions, utility source changes, and contingency operation.

Data Requirements

The following two pages provide a complete list of data required to do a thorough harmonic and power factor analysis. Not all data requested is required to determine the suitability of a standard power capacitor bank or the requirement for a harmonic filter, but completely fulfilling the data requests will certainly further protect you from equipment miss-application.

Data Requirements Checklist

Customer Name:	**Project Name:**
☐ System one-line diagram	One-line diagram should include the medium voltage bus at which the power capacitor bank(s) or harmonic filter bank(s) will be applied. It should also include the incoming service transformers, large loads, and switchgear arrangement.
☐ Utility or Source Three-Phase Short Circuit Level	This is typically provided by the electric service provider and is usually provided in one of several forms including; three-phase symmetrical short circuit current (in amps or kA), short circuit MVA, short circuit impedance in ohms or in per unit. Please specify BASE MVA if short circuit level is provided in per unit.
☐ Point of Common Coupling (PCC)	This is the location on the one-line diagram where IEEE 519 compliance is evaluated. It is typically your electric utility metering point. If different please specify location.
☐ Service Transformer(s) Base Power Rating and Leakage Impedance	This information is typically shown on the one-line diagram. If not, it will be shown on your transformer's nameplate. The base rating is typically the "OA" rating or lowest power rating of the transformer. The Leakage Impedance is typically provide in %.
☐ Location and Rating of Proposed Capacitor Bank	Three-phase capacitor rating in kvar or MVAR if known, number of stages, and voltage rating and proposed location.
☐ Utility Bills	Utility bills typically show kW, power factor, and kVA levels. This data is used to validate the harmonic measurement (if provided) and rating of the proposed equipment. If not provided, our analysis can still be completed, but will lack some validation of input data.
☐ Interval Data	Interval data can be obtained from your electric service provider. It typically shows your electric usage on a hourly or 15 minute period. This data is important for systems that have wide load swings. It enables us to evaluate the ability of the automatic controls to track your system load.
☐ Harmonic Measurement Data	Harmonic measurement data is not necessary, but should be provided if available. It is important to note the following when providing this information: 1. Load conditions at time of measurements. Does the measurement period capture your normal full load condition? 2. What if any non-linear loads were not on-line during the measurements. 3. Location of measurements. 4. CT and PT ratios if the measurements are taken on PT and CT secondarys.

Data Requirement Checklist (cont'd)

☐ Non-Linear Load Information	Non-linear loads refers to all loads that produce harmonics (i.e. current drawn by the non-linear load will not be sinusoidal even when it is connected to a sinusoidal voltage). These include VSD's, cycloconverters, induction furnaces, DC rectifiers, LCI drives, etc. It is important that NEPSI has at least a relative magnitude of the existence of these loads, the types of loads, and their ratings. Non-linear load information is not required for resonance analysis as that analysis is dependent only on system impedance data as well as proposed and existing capacitor bank ratings. Most of this information is often shown on the one-line diagram. When the resonance analysis shows a resonant condition of concern, NEPSI recommends a harmonic filter bank or a power capacitor bank that is easily converted to a harmonic filter bank. NEPSI refers these systems as "filter ready" banks. The basis of going with a "filter ready bank" or harmonic filter system is directly related to your plants non-linear load magnitude. Higher levels of non-linear load will likely push our recommendation away from a "filter ready" design toward a harmonic filter design. The harmonic filter design will also be impacted by the magnitude of your non-linear load. Additionally, voltage and current distortion calculations, as well as IEEE 519 compliance evaluation require non-linear load information. Without this information, these calculations cannot be made.
☐ Purpose of Capacitor or Harmonic Filter Bank	For example, power factor correction, voltage support, reduction in load current, etc. If for power factor correction, provide desired power factor level.
☐ Performance Requirements of Capacitor or Harmonic Filter Bank	List all performance Requirements. For example, voltage distortion must remain below 5%, power factor must remain above 98% (lag).
☐ Contingency or Abnormal Plant Operation	Note contingency operation and abnormal plant operating conditions. Conditions might include some or all of the following: 1. Closing a tie breaker and opening a main breaker on a redundant power system. 2. Utility line outage. (i.e. your system being fed from a secondary source). 3. Your system operating from backup generation.