

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Provide a harmonics study for the electrical distribution system. The intent of this study is to verify that the specified and supplied equipment will operate properly when correctly installed in the system and will not adversely impact the operation of other equipment, whether existing or new.
- B. The harmonics study shall include all portions of the electrical distribution system, from the normal and alternate sources of power down to each load shown on the one-line diagram. The harmonics study shall consider operation during normal conditions, alternate operational configurations, emergency power conditions and any other operations which could result in harmonic distortion exceeding proscribed standards.

1.2 QUALIFICATIONS

- A. The contractor shall have the harmonics study prepared by qualified engineers of an independent consultant. The consultant shall be a Registered Professional Electrical Engineer (licensed in the state where the project is completed) who has at least ten (10) years of experience and specializes in performing power system studies.
- B. The harmonics study shall be performed using the SKM PowerTools for Windows computer software package.
- C. Pre-approved: PowerStudies, Inc. – Maple Valley, WA

1.3 SUBMITTALS

- A. The contractor shall submit the harmonics study within 30 days after the electrical equipment submittals have been received for review by the engineer. The electrical submittals will be reviewed but not approved until the harmonics study has been received and reviewed.
- B. Submit three (3) copies of the harmonics study.

PART 2 – EXECUTION

- A. The harmonics study shall be in written form and shall include analysis of the harmonic voltages and currents which are likely to be produced on the power distribution system by operation of plant equipment.
- B. The study shall include the “worst case” situation that is likely to be produced. The worst case is defined as that combination of equipment which is deemed most likely to create the highest level of total harmonic voltage distortion and total current demand distortion at a given point.
- C. The study shall include all plant equipment likely to influence the results of the study. This shall include but is not limited to: all feeder circuits attached to the same substation transformer, all conventional loads on those feeder, conventional loads, all non-linear loads, all reactors, all capacitors and all filters.

- D. Non-linear loads shall be modeled with the spectrum produced at full load.

PART 3 – ANALYSIS

- A. Analyze the harmonic calculations and discuss the results at the following locations:
 - 1. The primary side of each unit substation (normal power)
 - 2. The bus of each switchboard (normal and alternate power)
 - 3. Each alternate power source (including generators)
 - 4. The point of common coupling

The point of common coupling shall be taken at the utility metering point (primary side if not primary metered). In the case of multiple primary metering points, the point of common coupling shall correspond to that defined in ANSI/IEEE std 519 (latest version).

- B. Include recommendations for mitigating the total harmonic voltage distortion or total current demand distortion on the system if the combination of loads exceeds or violates the limits of the electric utility or ANSI/IEEE 519 (latest revision).
- C. Include recommendations for mitigating the impact of the harmonic distortion on plant equipment or processes if the levels are such that equipment or processes may be impaired. (***) draft standard)
- D. If diversity factors are used, include discussion on affected units, the loading assumed on each load and the multiplying factor used for each load.
- E. Include discussion of verification measurements and how they compare with calculated results. Account for any discrepancies, adjust model and recalculate values, if necessary.

PART 4 – VERIFICATION

The consulting firm performing the harmonic study shall perform the following:

- A. Measure the harmonic voltages at the following locations:
 - 1. The primary side of each unit substation (normal power)
 - 2. The bus of each switchboard (normal and alternate power)
 - 3. Each alternate power source (including generators)
 - 4. The point of common coupling
- B. Measure the harmonic current at the following locations:
 - 1. The feeder from the secondary of the unit substation to the associated switchboard (normal power)
 - 2. The feeders to all other switchboards (normal and alternate power)
 - 3. The feeder from the alternate power source to the associated switchboard (alternate power)
- C. All measurements shall be taken for how many (X) days while the plant is operating from its normal source of power and how many (X) hours while

operating from the alternate source of power. If operation from the normal source of power includes more than one operating configuration, measurements shall be taken when plant is operating under the configuration that is calculated to produce the highest distortion.

PART 5 – REPORT

The results of the harmonics study shall be summarized in a final report. The report shall include the following attributes:

- A. Introduction and executive summary sections which include assumptions and recommendations. Reiterate assumptions stated elsewhere in the report.
- B. Copy of the project one-line drawing(s).
- C. Printouts from SKM PowerTools for Windows software package of calculated harmonic currents and voltages. Include input data. Provide separate section for each scenario studied.
- D. Printouts from SKM PowerTools for Windows software package of calculated voltage waveforms at all significant buses and current waveforms on all significant circuits. Provide separate section for each scenario studied.
- E. Copies of manufacturer data on harmonic spectrum produced by each non-linear load in the system.
- F. All sections shall be clearly tabulated and shall include an index page for easy reference.