# New Construction/Retrofit

## Standards of Harmonics

While encouraging all forms of cost-effective, electric conservation improvements, National Grid (*the "Company"*) desires to ensure that these measures will not have an adverse impact on the quality-of-power available for its customers, both participants in its programs and non-participants.

In recent years, the Company has become increasingly concerned about potential quality of power issues associated with the rapid proliferation of some electronic energy saving equipment. The large harmonic current content of some solid state devices may, for example, reduce the effective rating of capacitors, overload the neutral conductor of three phase lines, and cause interference on communication circuits. Additionally, harmonics can affect the operation of computers and cause motors to overheat.

Because the effects of the harmonic distortion caused by a particular measure can differ substantially depending on individual site characteristics, the Company has developed a flexible procedure for approving harmonics producing equipment for both New Construction and Retrofit projects.

Examples of solid state devices which must be evaluated in accordance with this procedure are:

- Current limiters or static dimmers for fluorescent systems.
- Compact fluorescent lamps (*with electronic ballasts*).
- Variable frequency drives (*VFD*) systems [*also called adjustable speed drives (ASD) or variable speed drives (VSDs*)], which are not included in the New Construction and Retrofit Variable Speed Drive application.

### Harmonic Test for Eligibility

**NOTE: BEFORE GOING THROUGH THE ENTIRE PROCESS LISTED BELOW, DETERMINE THE QUANTITY CALLED FOR IN LINE 6. DIVIDE THE NUMBER ON LINE 6 BY THE NAMEPLATE KVA OF THE TRANSFORMER THAT WILL BE SUPPLYING POWER TO THE LOAD INDICATED ON LINE 6. IF THE ANSWER IS LESS THAN .05 (THE DEVICE DEMAND IS LESS THAN 5% OF THE NAMEPLATE KVA OF THE TRANSFORMER) STOP HERE. THE PROPOSED MEASURE MEETS OUR STANDARDS FOR HARMONICS; NO FURTHER EVALUATION OF HARMONICS IS NEEDED.**

1. Completely describe the energy saving measure proposed. *When multiple measures are being installed in the same facility a separate Harmonics Test Report worksheet must be completed for each measure* along with a report summarizing all measures. (See #11.)

   _____

   _____

   _____

   Note: When multiple measures are being installed questions 2 and 5 are the same for all measures and need to be completed only once.

2. Enter the short circuit duty at the main switch in amps. This value should be obtained from the Company. In cases where the customer owns the service transformer the nameplate data from the transformer must be supplied to the Company so that the short circuit duty can be calculated ..... _____amps

3. Enter the expected average monthly billing demand for this facility over the next year…..... _____kW

4. Convert the expected average demand (*calculated in line 3*) to amps.....…….… _____amps

5. Calculate the Short Circuit Ratio (*SCR*) by dividing line 2 by line 4.....… _____SCR

6. Enter the total power to be supplied by the transformer that will serve solid state devices such as:
   - computers, printers, copiers
   - uninterruptible power supplies (*UPSs*)
   - fluorescent lighting systems
   - variable frequency drives
   - silicon-controlled rectifiers (*SCRs*)

   Be sure to include both existing and proposed loads. For VFDs, driven motor HP multiplied by 0.85 is a fair estimate of power in kW. *(For example, if two 40 HP VFDs are being added as additional load on a transformer already supplying power to a 60 HP VFD, the total solid state demand on that transformer would be approximately 119 kW)* ..…….....… _____kW

7. The devices to be installed must be tested for harmonic current distortion. In most cases these tests have already been done by the equipment manufacturer and that data can be obtained. In those cases where harmonics data cannot be readily obtained from the manufacturer the devices should be tested by a testing laboratory. All tests should be made at normal operating voltages with the devices configured according to the proposed installation with supply impedance approximately equivalent to the supply impedance at the point where the devices will be installed.

   Using the *Harmonic Current Test Report* on the next page, the harmonics data section of the worksheet should be filled out as follows:

   (A) Harmonic Current: The test report will give harmonic information either in amps or percent of fundamental. If the values on the report are given in percent, skip this column and go to column C. Otherwise enter the value of current from the report for each harmonic.

   (B) 60Hz Current: Enter the 60Hz (*fundamental*) Current ($I_F$) from the test report (*skip this column if the test report gives Current in percent of fundamental*).

   (C) Harmonic Current Ratio: If the harmonic test report gave values for harmonics in percent, enter those numbers here (*as decimals, that is 10% =.10*). Otherwise, divide column A by column B and enter result.

   (D) Demand Ratio (*Device Load/Total Load*): Complete the associated calculation. This value will be the same for each harmonic order within each respective measure.

   (E) Overall Percent Current Distortion: This is the percent contribution of this measure to the Total Current Distortion (*TCD*) of the entire facility. Multiply column C by column D and multiply by 100.

   (F) Overall Distortion Squared: Enter the square of column E.

8. Sum column F and record.

9. Take the square root of the total calculated in 8 and enter this value as Total Current Distortion (*TCD*) for the measure.

10. Compare the value of the Total Current Distortion with the limitation in Table A using the Short Circuit Ratio (*SCR*) from line 5. If the calculated TCD for this measure exceeds the limit in the table, remedial action (*installation of filters, reactors, isolation transformers, etc.*) must be taken if the measure is to qualify. Next compare column E with individual harmonic limits given in Table A. The values in column E must also be less than the appropriate limits in Table A if the measure is to qualify. If only one measure is being installed stop here.

**Table A**

| **Maximum Allowable Current Distortion** | | | |
|---|---|---|---|
| **Short Circuit Ratio (Line 5)** | **(TCD Limit) Total Harmonic Current Distortion** | **(Column E Limits) Harmonic Order** **n < 11** | **11 < n < 17** |
| SCR ≤ 20 | 5.0% | 4.0% | 2.0% |
| 20 < SCR ≤ 50 | 8.0% | 7.0% | 3.5% |
| 50 < SCR ≤ 100 | 12.0% | 10.0% | 4.5% |
| 100 < SCR ≤ 1000 | 15.0% | 12.0% | 5.5% |
| 1000 < SCR | 20.0% | 15.0% | 7.0% |

11. If more than one device measure is being installed, for example both a 50 hp and a 40 hp drive, *a separate Harmonics Current Test Report must be completed for each device.* Then a summary test report must be completed for the total of all devices. Only columns E and F of this summary report, along with the total column F and the square root of that total, need be complete. Column E is simply the sum of column E of all the individual worksheets.

12. The values on the "summary report" must then be compared to the limits in Table A. Note that it is possible that a particular measure if installed alone may not qualify under these programs, but if installed in combination with other measures may be acceptable. This might be the case if a measure with particularly high harmonic content is being installed but other measures being installed at the same time have a low harmonic content.

## Harmonic Current Test Report *(complete a separate sheet for each drive)*

| Harmonic Order *(n)* | Harmonic Current (Amps) *(A)* | 60 Hz Current (Amps) *(B)* | Harmonic Current Ratio *(A + B = C)* | Demand Ratio (Device Load/ Total Load)* *(D)* | % Distortion This Measure *(CxDx100 = E)* | % Distortion Squared *($E^2$ = F)* |
|---|---|---|---|---|---|---|
| 3 | | | | | | |
| 5 | | | | | | |
| 7 | | | | | | |
| 9 | | | | | | |
| 11 | | | | | | |
| 13 | | | | | | |
| 15 | | | | | | |
| 17 | | | | | | |
| | | | | | Total | |
| | | | | | Square Root of Total = | |

**TOTAL CURRENT DISTORTION**

***** To calculate the Demand Ratio (*D*):

(a) Load (*equipment connected without device*): _____ kW

(b) New Load (*equipment with device*): _____ kW

(c) Facility Demand (*a+b*): _____ kW

(d) Demand Ratio (*b/c*): _____

## Harmonic Voltage Test Report

The voltage distortion limits for voltages measured at the Customer's main switch are as follows:

Any Individual Harmonic Voltage: Maximum 3.0% of fundamental voltage

Total Harmonic Voltage Distortion: Maximum 5.0% of fundamental voltage

Where Total Harmonic Voltage Distortion $V_{THD} = 100 \times$

$$\frac{\sqrt{\sum_{h=2}^{17} V_h^2}}{V_1}$$

h = harmonic order from 2 to 17

$V_1$ = fundamental line to neutral voltage (*RMS*)

## Important:

Statements or data indicating that neither of these voltage distortion limits are being exceeded **must** be included in this application.

***An Important Note on Variable Frequency:***

VFDs can be sensitive to overvoltages that occur when power factor correcting capacitor banks on the utility power system are switched on. To qualify for an incentive payment under our program, each VFD must include a series reactor (*inductor, choke*) in its AC input connections. Your VFD supplier should assist in the sizing of the reactor. Our minimum requirement is that a 3% impedance reactor, based on the horsepower rating of the VFD, be installed.

As a general rule, a 3% reactor is sufficient to avoid misoperation of VFDs during utility capacitor switching and will also help reduce the magnitude of harmonic currents generated by the drive. In some instances your supplier may find it necessary to install 5% reactors and, rarely, additional filtering devices to meet our current and voltage harmonic distortion requirements.

If your power factor is less that 0.8 (*80%*), we recommend that you consider power factor correction concurrent with the installation of drives, because the presence of power factor correction equipment can influence proper reactor sizing, and because the presence of VFDs can influence the design of power factor correction equipment. In situations where the load due to VFDs is a substantial part of the facility load, we recommend that filters, rather than capacitors be used for power factor correction.

**Notes:**