

**PART 1 - GENERAL**

- 1.1 All PWM AC Variable Frequency Drives of [ 30 ] hp and above shall be equipped with harmonic mitigation equipment to prevent power system problems resulting from high levels of harmonic distortion.**
- .1 The harmonic mitigation equipment and all of its components shall be manufactured and tested in accordance with the latest applicable standards of UL, CSA and NEMA.
  - .2 Demonstration of compatibility between the harmonic mitigation equipment and the VFD must be available upon request.
  - .3 Harmonic mitigation equipment shall be warranted to be free of defects in materials and workmanship for a period of 12 months from the date of startup or 18 months from the date of shipment.
  - .4 Factory Performance Testing: Manufacturer must be capable of factory testing for harmonic mitigating performance and energy efficiency under actual variable frequency drive loads. A detailed description of the program and a sample test report must be provided at time of quotation.
  - .5 Subject to compliance with all of the contract documents and specifications, the following manufacturers and products are acceptable:
    - .1 MIRUS International Inc. LINEATOR™ Universal Harmonic Filter
    - .2 18 pulse configuration in: Toshiba, Robicon Clean Power Series, Cutler Hammer CP9000, ABB

**PART 2 - PRODUCT****2.1 Key Requirements:**

- .1 The harmonic mitigation equipment shall treat all of the characteristic low frequency harmonics generated by a 3-phase, diode bridge rectifier load (5<sup>th</sup>, 7<sup>th</sup>, 11<sup>th</sup>, 13<sup>th</sup>, etc.).
- .2 The characteristic harmonics shall be suppressed without the need for individual tuning or the requirement to phase shift against other harmonic sources.
- .3 Harmonic mitigation shall be by passive inductor/capacitor network or internal phase shifting transformer. Active electronic components shall not be used.
- .4 Power factor shall be .98 lagging to .95 leading in operating range from full to half load.
- .5 To ensure compatibility with engine generators, the harmonic mitigation equipment must never introduce a capacitive reactive power (KVAR) which is greater than 15% of its kVA rating.
- .6 The harmonic mitigation equipment shall not resonate with system impedances or attract harmonic currents from other harmonic sources.
- .7 The harmonic mitigation equipment in combination with the Variable Frequency Drive shall meet all requirements as outlined in the 1992 edition of IEEE std 519 for individual and total harmonic voltage and current distortion. The Point of Common Coupling (PCC) for all voltage and current harmonic calculations and measurements shall be the input terminals to the harmonic mitigation equipment.
- .8 Total Harmonic Voltage Distortion (THVD) shall meet the requirements of Table 10.2 of IEEE std 519 by not exceeding 5% and by limiting the individual harmonic voltage distortion to less than 3%. These limits shall apply while operating on either utility supply or generator supply when applicable. The harmonic mitigation equipment vendor shall not be responsible for pre-existing voltage distortion caused by other harmonic sources.
- .9 Total Demand Distortion (TDD) of the current at the input terminals of the harmonic mitigation equipment shall not exceed the limits as defined in Table 10.3 of IEEE std 519. For Isc/IL ratio < 20, TDD must be less than 5%. For all other Isc/IL ratios, the TDD must not exceed 8% even when Table 10.3 allows for more relaxed limits. For single-phase applications, the TDD must not exceed 12%.
- .10 The full load efficiency of the harmonic mitigation equipment / VFD combination shall be greater than 96%. The harmonic mitigation equipment itself shall have efficiency no less than 99%.

**2.2 Basic Requirements:**

- .1 All wiring shall be copper.
- .2 Insulation class: 220°C system. Temperature rise: 130°C
- .3 Anti-vibration pads shall be used between the reactor or transformer core and the enclosure.
- .4 Ventilated, sprinkler proof NEMA-3R enclosure.

**2.3 Other Requirements:**

- .1 [OPTION] Submit for approval before shipment certified production test results with serial numbers for harmonic mitigation performance and energy efficiency under actual variable frequency drive loading.

**PART 3 - EXECUTION****3.1 Installation**

- .1 The harmonic mitigation equipment shall be handled, stored and installed in accordance with the manufacturer's recommended installation practices as found in the installation, operation, and maintenance manual. Installation shall comply with all applicable codes.

**3.2 Acceptance**

- .1 [Option] Harmonic compliance shall be verified with onsite field measurements of both the voltage and current harmonic distortion at the input terminals of the harmonic mitigating equipment with and without the equipment operating. A recording type Fluke 41 or equivalent harmonics analyzer displaying individual and total harmonic currents and voltages must be utilized.