AHRI Standard 1211 (SI)

2017 Standard for

Performance Rating of Variable Frequency Drives

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Note:

This standard supersedes ANSI/AHRI Standard 1211 (SI)-2011 with Addenda 1 and 2

For I-P ratings, see AHRI Standard 1210 (I-P)-2017

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PERFORMANCE RATING OF VARIABLE FREQUENCY DRIVES

Section 1. Purpose

1.1 *Purpose.* The purpose of this standard is to establish for Variable Frequency Drives (VFDs): definitions; classifications; general test requirements; rating requirements; minimum data requirements for Published Ratings; marking and nameplate data; and conformance conditions.

1.1.1 *Intent.* This standard is intended for the guidance of the industry, including manufacturers, engineers, installers, contractors and users.

1.1.2 *Review and Amendment.* This standard is subject to review and amendment as technology advances.

Section 2. Scope

2.1 *Scope.* This standard applies, within the heating, ventilating, air-conditioning and refrigeration (HVACR) context, to 60 Hz VFDs used in the control of asynchronous induction motors. The range includes all those found within a building including: low voltage (≤ 600 V) and drives that are stand alone, not mechanically integrated into motors.

2.2 *Exclusions.* This standard does not apply to VFDs applied to motors other than those listed above.

Section 3. Definitions

All terms in this document shall follow the standard industry definitions in the ASHRAE Terminology website (https://www.ashrae.org/resources--publications/free-resources/ashrae-terminology), unless otherwise defined in this section.

3.1 *Carrier Switching Frequency*. The frequency at which the power output devices of a VFD are switched on and off.

3.2 *Constant Torque (CT).* Applications where the torque requirement of the driven load remains constant or nearly so over the normal speed range of use. Positive-displacement pumps and reciprocating compressors are examples of constant-torque loads.

3.3 *Drive System Efficiency*. Ratio of the output power from the motor to the input power of the VFD including motor and VFD losses.

3.4 *Equipment Under Test (EUT).* Test sample.

3.5 *Fundamental Current.* Root mean square (RMS) current of the first harmonic (Power Line Frequency).

3.6 Impedance. The measure of the opposition that a circuit presents to current.

3.6.1 Source Impedance. The short-circuit power at the point of common coupling (PCC), divided by the rated apparent power of the drive and as defined in IEC Standard 61000-3-12, Section 3.14 Subsection C.

3.7 *Motor Insulation Stress*. The voltage stress placed on a motor's insulation due to high Peak Voltages and short-rise times that occur when the motor is driven by a VFD.

3.8 *Motor Thermal Equilibrium*. When the observed temperature rise of the motor winding does not vary more than 1K over a period of 30 minutes, or when the observed motor frame or core temperature rise does not vary more than 1K over a period of 60 minutes.

3.9 *Peak Voltage*. The maximum instantaneous voltage measured at a motor's terminals when operated from a VFD.

3.10 *Percent Speed*. The ratio of the measured speed to motor nameplate speed, %.

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3.11 *Percent Torque.* The ratio of the measured torque to the motor torque, %.

3.12 *Power Line Frequency.* The alternating current (AC) frequency of the power supplied to the VFD.

3.13 *Power Line Harmonics.* Components of the power line voltage and current at the input of the VFD that are integer multiples of the fundamental sinusoidal frequency of the power source (example 50 Hz).

3.14 *Published Rating.* A rating of the assigned values of those performance characteristics, under stated Rating Conditions, by which a unit may be chosen to fit its application. These values apply to all units of like nominal size and type (identification) produced by the same manufacturer. As used herein, the term Published Rating includes the rating of all performance characteristics shown on the unit or published in specifications, advertising or other literature controlled by the manufacturer, at stated Rating Conditions.

3.14.1 *Application Rating.* A rating based on tests performed at application Rating Conditions (other than Standard Rating Conditions).

3.14.2 *Standard Rating.* A rating based on tests performed at Standard Rating Conditions.

3.15 *Rating Conditions.* Any set of operating conditions under which a single level of performance results and which causes only that level of performance to occur (e.g. line voltage, ambient temperature).

3.15.1 *Standard Rating Conditions.* Rating Conditions used as the basis of comparison for performance characteristics.

3.16 *"Shall" or "Should."* "Shall" or "should" shall be interpreted as follows:

3.16.1 *Shall.* Where "shall" or "shall not" is used for a provision, that provision is mandatory if compliance with the standard is claimed.

3.16.2 *Should.* "Should" is used to indicate provisions which are not mandatory but are desirable as good practice.

3.17 *Supply Voltage (V_s).* The line to line input voltage to the equipment at time of testing.

3.18 *System Loss ($Loss_{sys}$).* The combination of electrical and mechanical losses represented by the difference between input power to the drive and output power from the motor.

3.19 *Total Harmonic Current Distortion (THD_i).* A measure of power line current distortion that sums the contributions of the individual harmonics.

3.20 *Variable Frequency Drive (VFD).* A power electronic device that regulates the speed of an alternating current (AC) motor by adjusting the frequency and the voltage of the electrical power supplied to the motor.

3.21 *Variable Torque (VT).* Applications where the torque requirement of the driven load is reduced as speed is reduced. Centrifugal fans and pumps are examples of variable-torque (VT) loads.

3.22 *Voltage Rise Time.* The time required for the voltage to increase, measured at the motor terminals when operated from a VFD, from 10% to 90% of the VFD steady state DC bus voltage.

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