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Variable Frequency Drive (VFD) System Installation Specifications for Agricultural Irrigation Pumping

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Variable Frequency Drive (VFD) controllers require variety of auxiliary equipment and are installed as a system (including installation details) on agricultural pumps to increase pumping plant efficiencies across a variety of pumping conditions. There are tremendous variations in quality, life, and cost of VFD systems – and customers receive limited or no information on details such as efficiency, heat disposal, special motor requirements, and negative impacts to the electrical grid and neighbors.

The VFD specifications are designed to provide VFD owners with a minimum quality level, without adding extras that are not absolutely necessary, and without the customer needing to be an expert on the topic. Specification-compliant VFD systems should be relatively safe, reliable, energy efficient, and have a reasonable cost.

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Section 1 - Applicability

1.A. This document applies to Variable Frequency Drive (VFD) system installations meeting all of the following criteria:

1.A.1. The project owner or authorized representative is applying to participate in the "PG&E Agricultural Pumping VFD Incentive Program", which involves a rebate for a complete VFD system, rather than components

1.A.2. The project involves a VFD system designed to control the speed of a 60 Hz alternating current motor that is rated for:

1.A.2a. 480VAC or less

1.A.2b. 600 HP or less

1.A.3. The VFD-controlled motor will be used specifically for pumping agricultural irrigation water into a pressurized irrigation system.

Section 2 - Definitions

References Used in Specification

AC – Alternating current

AHJ – Authority having jurisdiction, such as the local county building department

CEC – California Electric Code

dv/dt – the rate of voltage change over time

FLA – Full load amps. The current (in amperes) required to deliver the rated horsepower at the rated voltage, speed, and frequency. The value is found on the motor nameplate.

GFCI – Ground Fault Circuit Interruptor

HP – Horsepower

IEC – International Electrotechnical Commission

IEC 61800-5-1:2007 IEC
60721-3-3

IEEE – Institute of Electrical and Electronics Engineers

IEEE 519

NEC – National Electric Code, published by the National Fire Protection Agency (NFPA)

NEMA - National Electric Manufacturers Association

NEMA MG-1 : 2011

NFPA – National Fire Protection Agency

NFPA 70

RPM – Revolutions per minute

SF – Service factor

Terminal – A mechanical device used to make secure wire connections using a screw or other means to put pressure on the connection

THiD – Total harmonic current distortion (also called "TDD")

UL – Underwriters Laboratories

UL 508

VAC – Volts alternating current

VFD – Variable frequency drive, which is a system of electronic components assembled by a manufacturer for sale as the most basic unit used in practice to adjust the rotational speed of alternating current motors.

VFD System – The VFD plus all peripheral equipment typically contained in (or attached to) the enclosure (such as filters, reactors, and cooling), but not including the motor and motor leads. Cable termination filters shall be included in the VFD system

Section 3 - Minimum VFD System Installation, Commissioning and Documentation Requirements

3.A. Installation and Commissioning

3.A.1. VFD and VFD control panel anchoring requirements shall be compliant with the California Building Code.

3.A.2. The VFD system owner shall be given a minimum of 3 hours of training covering basic operations and maintenance activities

3.A.3. A trained VFD installer shall inspect and certify that the installation is compliant with the items listed in the table below

Note. The long-term success of the VFD system is dependent on a quality installation, configuration and good documentation

Installation Checklist

<i>Item Description</i>	<i>Notes</i>
Sensors used for automatic control have been installed per manufacturer's recommendations	Sensors may include flow meters or pressure transmitters or transducers
Conduits, conductors and earth grounds have been installed per manufacturer and/or engineer recommendations	
Motor parameters have been configured within the VFD that match motor nameplate or designer's parameters	Example parameters include name plate: RPM, voltage, full load amperage, frequency, etc.
Sensor calibration within the VFD has been completed and verified	
Motor acceleration and deceleration ramp speeds have been configured	"Optimum" values for these parameters may depend on the system supplied by the water pump rather than electrical or motor constraints. The designer of the irrigation system should be consulted for a recommendation if possible.
VFD display has been programmed to display the following instantaneous values	Motor speed (RPM, %, or engineering units)
	Motor current (Amps)
	Output voltage
	Input voltage
For VFDs used in closed loop control applications, provide both the instantaneous (or averaged) reference measurement and target set point	
The VFD system, including cooling systems, have been function tested in all designed operating modes (manual and automatic as applicable) without faults under normal operating conditions	
Automatic restart after trip functions have been configured and tested	
The carrier frequency has been adjusted as recommended by the system designer	Adjustment of the carrier frequency shall consider all of the following: achieving acceptable audible motor noise, maintaining voltage overshoot and dv/dt ratings of the motor, dv/dt filter requirements, as well as maintaining minimum VFD system and motor efficiencies
Motor input terminal voltages have been measured and the motor voltage and rise time ratings are not exceeded	
All space heaters have been adjusted to maintain temperatures above the maximum dew point temperature, or minimum VFD temperature ratings, based on the space heater purpose, and have been function tested	
Wiring diagrams have been verified to as-built conditions	
A complete documentation package and field training has been provided to the owner per Specification 3.G.2	Documentation includes wiring diagrams, user manual, warranty information, maintenance activities, and step-by-step instructions for adjusting set points
The VFD system is fully shaded, or the enclosure(s) are painted white	
The installation has met all requirements of electric utility and the authority having jurisdiction (AHJ)	
A oil-filled pressure gauge has been installed just downstream of the VFD-controlled pump discharge that provides a NIST-traceable pressure measurement (psi) within +/- 1 psi, with a measurement range no greater than 150% of the maximum pump discharge pressure at zero flow and full speed	

3.B. Documentation to the owner

3.B.1 Provide a standalone documentation package to the customer. All information shall be complete and reflect as-built conditions. Include the following at minimum:

3.B.1.b. An as-built configuration sheet listing the as-built programming parameters configured for the project

3.B.1.b. All documentation provided by the UL-panel shop

Note. A good documentation package is useful for future operation and maintenance

Note. A record of the configuration parameters is critical for record-keeping