NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE GENERAL SPECIFICATIONS
Texas

PUMPING PLANT – VARIABLE FREQUENCY DRIVES

CODE 533D

1. SCOPE

This general specification covers the installation of a pump control system designed to operate one pump using a Variable Frequency Drive (VFD). The control system shall be designed utilizing proven technology in control design for a combination of variable flow and pressure ranges to provide flexible operating conditions of the pumping system for optimum efficiency and maximum energy savings. This specification is for three phase motors only; single phase motors are not approved for use with this specification. The control system shall be operator and maintenance friendly to ensure ease of system set up and to limit down time.

The pump control system shall include:

Variable Frequency Drive

VFD protection package

Line reactor (filter)

Load reactor (filter) as required

Lightning arrestors

Enclosure

Main disconnect

Circuit breaker

Alarm and Communication interface

Pressure transducer (see details under section 4.2)

Water flow meter (see details under section 4.3)

2. PUBLIC AND PRIVATE UTILITIES

Utilities are defined to be overhead and underground power or communication lines, and pipelines. The contractor should conduct their own search and discovery for utilities in order to lessen or avoid potential damages. The owner/operator shall complete TX-ENG-80A, Utilities Inventory, during planning and return it to the NRCS representative. The owner/operator shall also ensure that TX-ENG-80B, Cooperator Confirmation of the One-Call Utility Safety System is completed and returned to the NRCS representative prior to layout or any ground disturbance.

3. PRE-SUBMITTALS

Prior to installation of the VFD, the installing contractor (or designated representative) shall provide USDA-NRCS with the following pumping system documentation:

Motor manufacturer, model, rated HP and approximate age of electric motor

Current Pumping Plant (motor/pump unit) efficiency based on a current (less than 6 months old) pump test that includes measured water flow rate, total dynamic head which includes a measured pumping depth, measured electric current, etc.

The desired operating ranges for the pump:

Maximum and minimum pressure (psi)

Maximum and minimum flow (gpm)

Make, Model and HP of proposed VFD

Verification that the power supplier has been notified about the planned installation of a VFD on their power supply and verification of the need to install, or not install harmonics mitigation hardware or line filter or line/load reactor in conjunction with the VFD. If required, the harmonics mitigation hardware or line filter (line or load reactor) will meet the VFD's manufacturers specifications/requirements and IEEE-519 criteria.

Verification that the existing overall pumping plant (motor/pump assembly) is operating at 45% or greater efficiency based on the current pumping plant test.

See Attachment A to this specification for the Pre-Installation Submittals form.

4. EQUIPMENT

Electrical equipment, installation, materials and workmanship shall comply with all applicable codes, safety and fire law regulations at the location of the work and shall conform to applicable codes and standards of the organizations listed below.

1. National Electric Code (NEC).
2. National Electrical Manufacturers Association (NEMA).
3. American National Standards Institute (ANSI).
4. Underwriters Laboratories (UL 508).
5. International Electrotechnical Commission (IEC).
6. Institute of Electrical and Electronics Engineers (IEEE-519).

All equipment and materials shall be new and shall bear the manufacturer's name and trade name.

4.1 Variable Frequency Drive

The VFD controller shall be sized to the pump motor rating and shall be a pulse width modulated (PWM) type. The VFD controller shall be compatible with all equipment utilized at the pump station.

The VFD controller shall allow for both:

i. Automatic control utilizing a pressure transducer for constant pressure or flow meter for constant flowrate.

ii. Manual control by the pump operator for either slowing down or speeding up the pumping system to provide flexible operating conditions of the pumping system.

The VFD shall have the following pump and system protection:

- Low Pressure
- High Pressure
- Low Water Input (low suction pressure/low level)
- Pump Over-Cycling
- Feedback Loss Alarm

The VFD shall protect the motor and the drive against the following conditions/faults:

- Output Phase Loss
- Ground Fault
- Motor overload
- Over Voltage
- Under Voltage
- Phase Imbalance
- Short Circuit protection

These faults shall provide an orderly shutdown of the VFD, with clear indication of the fault. The history of previous faults shall be stored in memory for review. An automatic restart option shall provide a minimum 30 second time delay. This function permits automatic restarting after the drive controller detects a fault, provided that the other operating functions are correct, a run command is present, and the fault has disappeared. This shall be a function that is field selectable.

The VFD efficiency rating shall be of 95% or better across the full operating speed range.

The VFD shall be designed and installed to operate within the service and environmental condition present at the pumping location.

For installations where 3-phase power is not available, single-phase power shall be supplied to the VFD and the VFD shall convert the power to 3-phase. Extreme care shall be taken to properly size the VFD in phase conversion applications and shall only be done in accordance with the manufacturer's specifications. In all cases, a 3-phase motor shall be used.

The VFD shall be equipped with an interface keypad with START/STOP buttons and a display for the visualization of process and alarm status. The VFD setup shall be simple and shall not require the use of a laptop computer. The VFD shall be configured and tested prior to installation to minimize field programming and start up time.

The VFD shall have a standard 12-month warranty against defects in workmanship and materials under normal use operation and service from the date of startup.

4.2 Pressure Transducer

A pressure transducer shall be installed with all VFD's to provide the operator with accurate system operating pressure. The pressure transducer can be mounted above ground in the pump discharge pipe upstream of any control or gate valve, or attached near the pump. The pressure transducer shall also allow for the VFD to provide system pressure control. The pressure transducer shall be industrial grade, and have a static accuracy of 1% of full scale or better. No calibration of the transducer shall be required in the field. The transducer shall be mounted in such a manner as to minimize the possibility of air accumulation around the transducer.

4.3 Flow Meter

A water flow meter is required as a component for all VFD installations to provide the operator with an accurate flowrate. The flow meter shall be adapted for agricultural applications and have a static accuracy of 3% of full scale or better. The flow meter shall be installed per manufacturer's specifications. In those systems where flowrate is used as the controlling input, an electronic flow meter can be used to provide input to the VFD.

4.4 Lightning/Surge Arrestor

The lightning/surge arrestor shall meet the VFD manufactures specifications/requirements. The lightning/surge arrestor shall be provided at the incoming power terminals to the control panel.

4.5 IEEE-519 Harmonics Mitigation Hardware

If required by the local power provider, a full IEEE-519 harmonics analysis of the VFD installation must be performed. Utilizing this analysis the VFD panel manufacturer shall determine the harmonics mitigation hardware necessary to fully comply with IEEE-519.

This shall include the use of a line reactor, harmonics kit, phase-shift transformer, or other appropriate hardware approved for this application. Upon request, the VFD panel manufacturer shall make available their IEEE-519 analysis worksheet.

The appropriate harmonics mitigation hardware shall be fully integrated into the VFD control panel package such that it is deliverable to the job site in a single package and shall not require any additional on-site wiring. Additional heat loads and amp losses resulting from harmonics mitigation hardware shall be determined and appropriate steps shall be taken to ensure that the VFD control panel design accommodates these issues.

5. INSTALLATION

Depending on the design of the VFD unit, the VFD and all required components shall be connected according to manufacturer recommendations. VFDs cannot tolerate dust or dampness; therefore, they shall be installed in enclosures that meet the appropriate NEMA

standard. The mounting cabinet shall be a single free standing, powder-coated steel enclosure of a wall thickness of not less than 0.075 in. The cabinet shall be sized accordingly to allow easy access to components and provide adequate ventilation for VFDs

Direct exposure of the VFD unit to un-filtered, outside air is not acceptable. The enclosure shall include louvers, filter fans, and/or air conditioning as required from VFD heat loss calculations and average ambient temperatures. All louvers, filter fans, and air conditioning units shall conform to appropriate NEMA and UL standards and must be mounted directly to the VFD control panel. Ventilation, cooling, and heating shall be provided as required by manufacturer's recommendations to ensure that the VFD operates within its rated ambient temperature rating and to prevent condensation inside the enclosure.

Additional measures such as painting the enclosure white, installing a sun shield/shade and adding insulation to the inside of the enclosure shall also be considered as to prevent the temperature inside the enclosure from exceeding the acceptable VFD temperature limits.

6. SAFETY

Control panel construction methods shall take into account provisions to ensure operator safety from electrocution. UL508A safety standards shall be observed.

7. POST-INSTALLATION SUBMITTALS

After the VFD is installed, another pump test will be conducted that includes measured water flow rate, total dynamic head which includes a measured pumping depth, measured electric current, etc. to determine potential energy savings from the VFD installation. The installed system must pump at a flow rate and pressure that demonstrates compliance with the system requirements with adjustments applied as needed at the time of the test.

The VFD Installer shall guarantee in writing the VFD installation, and all required components for a period of at least one (1) year against materials and workmanship defects.

The Installer shall furnish user manuals, operation and maintenance manuals, spare parts lists, service bulletins/manuals to the landowner.

See Attachment B to this specification for the Post-Installation Submittals form.

8. ACCEPTANCE AND MEASUREMENT

An onsite check of the completed VFD installation with the pump operating will be performed by an NRCS representative. The acceptability of the VFD installation shall be determined by this on-site inspection and required submittals. Measurement of each VFD installation will be on a completed job basis.

9. ADDITIONAL SITE SPECIFIC CONSTRUCTION and/or MATERIAL DETAILS:

1. Attachment A -- Pre-Installation Submittals form.
2. Attachment B -- Post-Installation Submittals form.
3. TX-ENG-80B
4.

This general specification, the Pre and Post-Installation Submittals, the requirement to notify my power supplier, and the requirement for completion of a TX-ENG-80A and TX-ENG-80B have been reviewed with me and I agree to complete my Variable Frequency Drive (VFD) and installation according to these general specifications.

_____ _____

Owner/ Operator **Date**

_____ _____

VFD Dealer/Installer/Contractor **Date**

USDA United States Department of Agriculture

VFD_TX_2015_R0.xlsm, 4/15/15
Statewide Use

VARIABLE FREQUENCY DRIVE (VFD) PRE-INSTALLATION SUBMITTAL - ATTACHMENT A

Landowner:	County:
Well No. / Name:	
Location or Legal Description:	
Power Supplier:	Meter No.:

Pre-VFD Installation Electric Motor and Pump Information:

Electric Motor Brand:		Motor Model No.:
Motor Hp:	Motor Phase:	Approximate Motor Age (Yrs.):
Pump Type:		Pump Brand:
Pump Model No.:	Pump Curve Available (Yes / No):	If "Yes", attach copy.
Planned Pumping Flowrate:	GPM to	GPM
Planned Pumping Pressure:	PSI to	PSI

Pre-VFD Installation Pumping Plant Efficiency Test Information:

Depth of Well (Ft.):	Depth of Pump (Ft.):	Static Water Level (Ft.):
Measured Water Level During Pump Test (Ft.):		Measured Pump Flowrate (GPM):
Pump Speed (RPM):	Pressure Head on Pump (PSI):	Column Pipe Friction (Ft.):
Total Dynamic Head (Ft.):	Water Hp:	
Measured Amps:	Measured Voltage:	Power Factor:
Assumed Electric Motor Efficiency (%):	Input Hp:	Input kW:
Pump Efficiency (%):	Overall Pumping Plant Efficiency (%):	Cost per kWh ($):
Estimated Pumping Season (Hrs.):	Estimated Seasonal Pumping Cost ($):	

Pumping Plant Test Conducted By (Signature) _____ Date _____

Planned / Proposed VFD Information:

VFD Brand:		VFD Model:
VFD Rated Hp:	VFD Rated Amps:	VFD Efficiency Rating (%):

Contacted local Power Supplier and notified them of planned VFD installation (Yes / No): _____ If "No", state reason:

Does local Power Supplier require Harmonics Line Filter (Yes / No):

Landowner / Representative Signature _____ Date _____

USDA United States Department of Agriculture

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Statewide Use

VARIABLE FREQUENCY DRIVE (VFD) POST-INSTALLATION SUBMITTAL - ATTACHMENT B

Landowner:		County:
Well No. / Name:	Power Supplier Meter No.:	
Location or Legal Description:		

Installed VFD Information:

VFD Brand:		VFD Model No.:	
VFD Serial No.:	VFD Rated Hp:	VFD Rated Amps:	
VFD Efficiency Rating (%):	VFD Operating Range:	Hz. to	Hz.
Harmonics Line Filter Installed (Yes / No):	If "Yes", list Brand and Model below.		
Harmonics Line Filter Brand:	Harmonics Line Filter Model:		

Post-VFD Installation Pumping Plant Efficiency Test Information with VFD Operating:

Static Water Level (Ft.):	Measured Water Level During Pump Test (Ft.):		
Measured Pump Flowrate (GPM):	Pump Speed (RPM):		
Motor Phase:	Pressure Head on Pump (PSI):	Column Pipe Friction (Ft.):	
Total Dynamic Head (Ft.):	Water Hp:	VFD Operating Hz.:	
Measured Amps:	Measured Voltage:	Power Factor:	
Assumed Electric Motor Efficiency (%):	Input Hp:	Input kW:	
Pump Efficiency (%):	Overall Pumping Plant Efficiency (%):	Cost per kWh ($):	
Estimated Pumping Season (Hrs.):	Estimated Seasonal Pumping Cost ($):		
Estimated Cost Savings per Irrigation Season from VFD Installation ($):			

Pumping Plant Test Conducted By (Signature) _____ Date _____

Certification and Guarantee:

I certify the installation, variable frequency drive, and all installed components comply with USDA-NRCS, Texas Conservation Practice General Specification 533D.

I certify the installed Variable Frequency Drive has a _____ year warranty (1-yr. minimum).

I guarantee the VFD installation and all installed components against any defective materials or workmanship for a period of _____ year(s) from the date of completion (1-yr. minimum).

VFD Dealer / Installer / Contractor Signature _____ Company _____ Date _____

I certify that I have contacted my local power supplier and they are aware of the VFD installation on my property and I have complied with all of the local power supplier requirements for my VFD.

Landowner / Representative Signature _____ Date _____