REQUEST FOR BID

RFB Posted:	January 5, 2018
Questions Due:	January 12, 2018 2:00 P.M.
Question Posted:	January 18, 2018 2:00 P.M.
Bid Due Date:	January 26, 2018 2:00 P.M.

South Dakota Science and Technology Authority is seeking to purchase a Variable Frequency Drive installed in a self-contained electrical enclosure. This equipment will replace existing equipment that controls the speed of a centrifugal fan used for ventilation of underground facilities at the Sanford Underground Research Facility located in Lead, South Dakota.

Documents included in this Request for Bid include:

A. This Request for Bid
B. Bid Form
C. Purchase Order Terms and Conditions
D. Supporting Attachments:
   - Oro Hondo Fan RFB Supplement - HMC Drawings.pdf
   - Oro Hondo Fan RFB Supplement - Motor Information.pdf
   - Oro Hondo Fan RFB Supplement - One-Line Diagrams.pdf
   - Oro Hondo Fan RFB Supplement - Publication GEK-95638.pdf
   - Oro Hondo Fan RFB Supplement - Transformer Information.pdf
   - Oro Hondo Fan RFB Supplement – Example Bid Form.pdf

Acronyms used in this Request for Bid:

DOE	–	Department of Energy
DUNE	–	Deep Underground Neutrino Experiment
E-House	–	Self-contained electrical enclosure/building
FAN	–	Oro Hondo, American Davidson Ventilation Fan
HMC	–	Homestake Mining Company
LBNF	–	Long Baseline Neutrino Facility
MVS	–	Mine Ventilation Services, Inc.
RFB	–	Request for Bid
SDSTA	–	South Dakota Science and Technology Authority
SURF	–	Sanford Underground Research Facility

VFD – Variable Frequency Drive

WC – Water Column, water gauge, inches H_2O

1.0 Scope

Due to the long lead-time for a VFD, SDSTA has elected to procure a VFD installed and delivered in a pre-assembled E-House package. The E-House must include all necessary equipment to support the operation of the VFD and the E-House environment.

SDSTA has divided the complete VFD replacement project into three parts:

1. Design and Procurement of VFD pre-installed in a self-contained E-House (includes commissioning.)
2. Site preparation:
    a. Demolition of existing VFD and building.
    b. Concrete/foundation work and placement of the E-House.
3. Installation of conduit & cable and electrical connections from the E-House to the power source and FAN motor.

The scope of this RFB only includes PART ONE, the procurement of a VFD and E-House. Parts two (site preparation) and three (electrical connection) will be performed under a separate contract(s).

SDSTA requests that Bids include an itemized bid form listing each component, service, inclusion, exclusion, deviation, and/or option as separate line items with a cost listed for each item. Components are defined as functional units or systems (i.e. VFD, switchgear, E-House, transformer, cooling system, etc.) or any single item that has a value of 10% or more of the total value of the Bid.

The bid form is provided for brief descriptions, quantities, lead times, and costs. The bid form should be supplemented by attachments providing detailed descriptions, diagrams, explanations, and pertinent information relating to the proposed equipment, services, and options.

A bid form is requested so that a fair and equal comparison of all Bids received is possible. It is important that bidders use bid form that SDSTA provides, in the requested format, to enable SDSTA to perform an impartial evaluation and bid selection.

The Bid MUST include a cost breakdown of all major components as separate line items on a bid form. Lead-time is a consideration in the selection and must be listed for each long lead line item.

At a minimum, the bid form must include a separate line item for each of the following:

1. VFD type, model, and ratings.
2. Ancillary equipment required for drive operation.
3. E-House with dimensions, services included (lighting, outlets, and environmental controls), and required services that are NOT included.
4. Recommended critical spare parts.
5. Commissioning, (include time and a breakdown of hourly and per diem rates.)
6. Warranty information.

Additions, deviations, exclusions, and/or substitutions to the specified VFD requirements must be listed as separate line items on the bid form.

Options and suggested or recommended alternatives may be offered but must be listed with costs as individual line items on a separate page of the bid form. Cost adders and reductions should be indicated.

Options and alternatives may include, but are not limited to:

- Cost additions/reductions of vendor stated alternates, substitutions, exceptions, and exclusions
- Options for procurement and/or stocking of critical spare parts inventory
- Remote monitoring and/or support of VFD equipment by manufacturer
- Support contracts and extended warranties

All deviations, exceptions, or exclusions to the RFB submittal requirements must be clearly stated and explained in the Bid. Deviations, exceptions, or exclusions may or may not be accepted during the SDSTA evaluation and selection process.

SDSTA reserves the right to accept or reject any or all Bids. Acceptance of a Bid does not imply acceptance of any proposed options or alternatives. If a Bid has contingencies on other aspects of the VFD replacement project these contingencies must be clearly stated on the bid forms.

This RFB is for VFD design and procurement only. If the bidder is interested in performing the entire VFD replacement project, please notify the SDSTA contract administrator at mbaumann@sanfordlab.org. SDSTA reserves the right to consider offers for complete turn-key VFD replacement and bidders are encouraged to present turn-key solutions.

2.0 Background Information

Primary ventilation for the underground facilities at SURF is provided by an American Davidson direct driven, centrifugal fan powered by a GE 3000 horsepower synchronous motor and a 3000-horsepower rated GE LCI VFD. The FAN, located in Kirk Canyon, draws air from the underground through the Oro Hondo shaft and exhausts to the atmosphere. Installed by HMC in 1986, the FAN was sized to provide 478,000 ACFM at a pressure of 26.5 inches WC and a fan speed of 720 RPM at 60 Hz. The ventilation system is designed to operate continuously 24 hours/day, 365 days/year.

The FAN was shut down in 2002 when HMC closed the mine. In 2009 the mine was reopened by SDSTA as an underground science facility. The FAN motor was cleaned and tested and the FAN was recommissioned in 2010.

An aerial photo of the FAN site is shown in **Figure 1**.

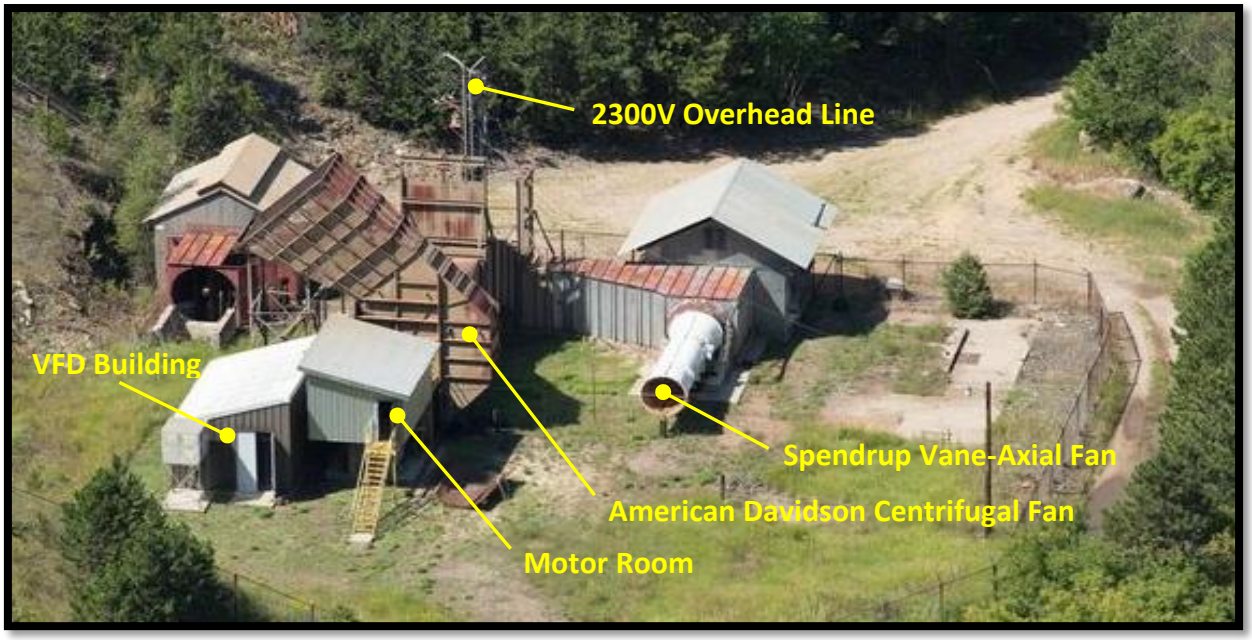


Figure 1 - Oro Hondo FAN Site in Kirk Canyon

SURF must provide a reliable ventilation system for existing and future underground science facilities, particularly to support the upcoming, DOE funded, LBNF/DUNE experiment. Due to the age and condition of the existing GE VFD numerous unexpected fan outages have occurred since the recommissioning in 2010 and parts for the VFD are no longer readily available. Uncertainty in the integrity and supportability of the existing VFD necessitates the replacement with a new, reliable, and serviceable VFD.

3.0 Existing Conditions

3.1 Power Distribution

The FAN site power is supplied on overhead lines from the nearby Oro Hondo Substation, which is owned and operated by SDSTA. The substation is supplied at 69kV by Black Hills Energy.

Two transformers located at the substation are dedicated to the FAN site and step 69kV down to 2300 volts. The 2300-Volt distribution system is an ungrounded delta-delta system. Switchgear on the secondary side of the transformers, located at the substation, are interlocked so that the transformers cannot be operated in parallel.

The length of the 2300-Volt overhead line from the metal clad switchgear at the Oro Hondo Substation to the FAN site is approximately 400 feet.

Figure 2 illustrates the Oro Hondo Substation distribution. A power distribution diagram for the FAN site is shown in **Figure 3.**

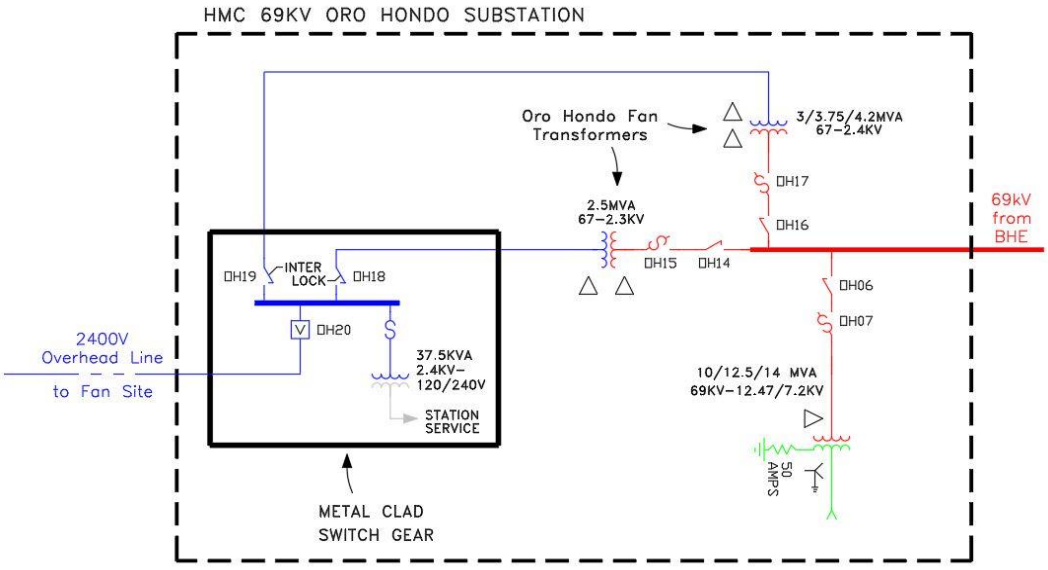


Figure 2 - Oro Hondo Substation Distribution Diagram

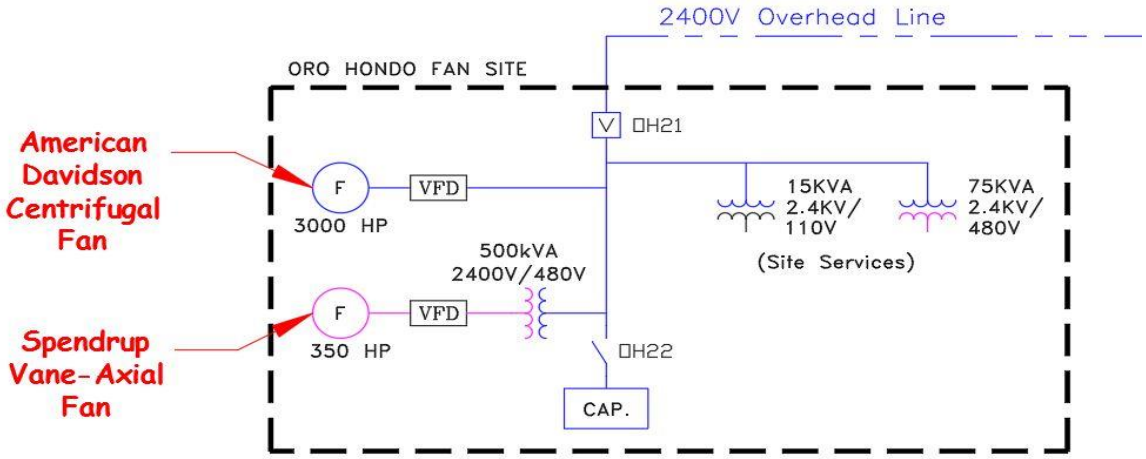


Figure 3 - FAN Site Power Distribution Diagram

Transformer Data:

Main transformer –
GE, Delta-Delta, Rated 3,000 kVA continuous @ 55 °C Rise, self-cooled, oil.
67kV primary (+/- 5%), 2400-Volt secondary,
Impedance = 9.01%, K-factor = 4
BIL: HV = 350kV, LV = 110kV.

Backup transformer –
Westinghouse, Delta-Delta, Rated 2,500 kVA continuous @ 55 °C Rise, self-cooled, oil.
67kV primary (+/- 5%), 2300-Volt secondary.
Impedance = 7.4%
Available short-circuit kVA = 32,000.
BIL: HV = 350kV, LV = 60kV.

Note: The Westinghouse back-up transformer was upgraded to 125% of original self-cooled nameplate rating.

A complete power distribution diagram of the Oro Hondo 2300V system is shown in **Appendix A**. Photographs of transformer nameplates are available in supporting documents attached to the RFB.

3.2 FAN Motor

The FAN motor is the original GE 3000 horsepower synchronous motor with brushless exciter that was installed in 1986. The motor is housed in a weather-proof building and has been maintained regularly since it was originally installed. It was disassembled, cleaned and tested in 2009.

Motor/Exciter Technical Information can be found in **Appendix B**.

Pages from the original GE HMC project document "GEK-95638 *Adjustable Speed Drives Systems* "that contain information and specifications for the existing motor, exciter, and VFD are provided as an attachment to the RFB. Photographs of motor and exciter nameplates are also available in supporting documents attached to the RFB.

3.3 Control Building

The existing FAN VFD is housed in an insulated motor control building of metal frame construction with a mono-pitched roof. The outer dimensions are 16 feet wide by 24 feet long with a ceiling height of 10 feet, rising to approximately 14 feet. The structure is built on a 6-inch concrete slab supported by a 60-inch deep foundation resting on spread footers. Walk-in access is through a 2'-6" x 80" steel door. A double 30" x 10-foot door set provides access for installing/removing equipment. Dimensions are taken from HMC drawing #8962-90 sheet 2, which is provided in an attachment to the RFB. The motor control building houses the following equipment:

1. 2400V, 800 amps continuous, Source-side circuit interrupter
2. GE 3000 HP LCI VFD
3. 75 kVA, 2400V/480V, 3-phase Transformer
4. LCI 480V Control Power Disconnect
5. Control Building Exhaust Fan Disconnect
6. Control Building Heater Disconnect
7. Fan Isolation Damper Hoist Disconnect
8. 15 kVA 480V/240-120V, 1-phase Lighting Transformer
9. 100 Amp, 1-phase, 16-space, Load Center providing power to:
    - LCI VFD Heater
    - Control Building Lights & Outlets
    - Motor House Lights & Outlets
    - Control Power for instrumentation and GE 90/30 PLC system
10. Cisco Ethernet Switch and Fiber Optic Patch Panel

3.4 FAN

The SURF ventilation system operates continuously 24 hours/day, 365 days/year. The Oro Hondo fan is an American Davidson type 1400-SIBAB92, single inlet, backward inclined airfoil blade impeller, centrifugal fan direct coupled to a 3000 HP, 720 RPM motor. Following is fan data taken from American Davidson "For Construction" drawing 2446D24 (HMC drawing #8962-90 sheet 22):

Design Parameters		
Volume	478,000	CFM
Static Pressure	26.5	in. WC
Inlet Density	0.0538	lbs./ft^3
Maximum Inlet Temperature	120	°F
Operating Temperature	93	°F
Fan speed	720	RPM
Absorbed Power	2192	BHP
Diffuser Outlet Velocity	2830	ft./min
Technical Data		
Impeller Diameter	143	inches
Impeller Weight	13,200	lbs.
Impeller WR^2	201,900	lb.–ft^2

Fan testing was performed by Mine Ventilation Services (MVS) in the summer of 2017. Dirt build-up on the fan blades and slight corrosion in seams and corners of the fan housing and ducts was found during visual inspections. Fan vibration with increasing fan speed was also noted. A future RFB will be issued to replace the fan bearings, clean and paint the fan housing, and clean and balance the impeller.

3.5 PLC Control System

SURF currently uses GE 90/30 PLCs for monitor and control of underground dewatering pumps, underground CO monitoring, Waste Water Treatment Plant control, Oro Hondo fan/ventilation system, electrical substation monitoring. The facility has multiple PLC processors inter-connected over a dedicated Ethernet control system network.

3.6 Instrumentation

Instrumentation includes motor winding and bearing RTDs, FAN vibration monitor, FAN inlet duct airflow, CO monitors, humidity sensor, wet bulb/dry bulb temperature.

3.7 Communication Network

SDSTA's IT department manages, maintains, and secures the network infrastructure, servers, and SURF issued computing devices. The physical network infrastructure consists of a fiber-optic backbone plant that extends through-out the surface and underground facilities. The network architecture integrates separate logical networks into an enterprise wide campus. Each logical network is isolated from the others through firewall zones. The telephone system consists of both wired digital and VoIP telephones.

Telephone service, office automation and control system networks are available at the FAN site over fiber-optic cables.

3.8 Climate Data for Lead, SD[1]:

Ambient Temperature: -30 °F to 110 °F

Relative Humidity: 5 to 95% non-condensing[2]

Actual Elevation at Fan: 4,950 feet above sea level

[1] For information only. Data from NOAA for Lead, SD. Not intended to be drive design parameters.

[2] Fan discharge air is moisture laden and will be 70-75 °F consistently. Discharge air will be condensing at times in the area around the fan, drive building, and motor enclosure.

4.0 Replacement Requirements

4.1 FAN Motor

SDSTA had third-party PDMA testing and bearing oil analysis of the motor done in December 2017. The results of these tests indicate that the motor is in good to excellent condition and should operate reliably, especially at the reduced load requirements, for many years. A slight buildup of dirt and oil in the exciter was noted during inspection.

The conclusion of the motor evaluation is that disassembly for a clean and bake, refurbishment, or replacement cannot be justified. SDSTA will have the exciter removed and serviced.

Replacement or refurbishment of the existing motor is not required. The replacement VFD provider is responsible for insuring that the new VFD is compatible with the existing synchronous motor and brushless exciter.

Technical Information for the motor and exciter can be found in **Appendix B**.

Pages from the original GE HMC project document "GEK-95638 *Adjustable Speed Drives Systems* "that contains information and specifications for the existing motor, exciter, and VFD are provided as an attachment to the RFB. Photographs of motor and exciter nameplates are also available in supporting documents attached to the RFB.

4.2 Control Building/E-House

SDSTA intends to purchase a new VFD pre-installed in a complete, self-contained, enclosure that will be delivered and installed as a single unit. Ideally, the E-House will contain the VFD and all lighting, heating, cooling and support equipment required to operate the VFD. SDSTA understands that transformers, cooling units, or other equipment may require installation external to the E-House.

SDSTA will remove/demolish the existing control building and ALL equipment contained within. The location of the existing building will be reused as the location of a new E-House. The extent of the removal of the existing concrete pad and foundations will be determined by the foundation requirements for the new E-House. Existing concrete infrastructure should be reused to support the E-House if practical.

The existing conduit and cable tray that supply 2300V service and motor connections are routed on above ground support structures. These existing conduit rack structures are to be reused for routing conduit and cable to the new E-House. The E-House must be designed to accommodate the penetrations required to interface with the existing conduit positions. Transitions that prevent top entry of conduit and cable into the E-House should be considered.

SDSTA assumes that a single 2300V three-phase service is required to power the E-House, VFD, and all supporting systems. Services required to support the E-House must be incorporated into the E-House design. If this requirement cannot be accommodated and power sources in addition to a 2300V service are required from SDSTA, this must be clearly communicated in the Bid. In this case, a cost for SDSTA to provide these services will be estimated and considered during Bid evaluation and selection.

The equipment listed in section 4.4 is used to support the existing LCI VFD and control building infrastructure. Most of this equipment will be eliminated. However, some equipment will continue to be used and must be removed and relocated from the existing control building. This equipment includes the PLC control system and HMI, airflow monitoring instrumentation, telephone and network equipment.

PLC and instrumentation equipment will be relocated by SDSTA. SDSTA requests that 8 to 10 linear feet of clear wall space, from floor to ceiling, is provided inside the E-House for mounting of SURF instrumentation and controls. A depth of 12 inches from the wall surface and an additional 30 inches (minimum) of clear working space in front of this mounting area are required.

Due to the high humidity environment in the immediate area around the FAN discharge, extra precautions should be taken to seal and coat the E-House to control corrosion and intrusion of moisture. The life expectancy of the SURF experiments and required ventilation is 30 years.

4.3 Power Supply

The existing 69kV to 2300V substation transformers and overhead supply lines to the FAN site will continue to be used. Removal of the control building includes decommissioning of the existing supply side 2300V circuit interrupter. A new circuit interrupter with remote trip, motorized closure, and LOTO provisions must be included in the E-House/VFD design. Short-circuit and arc-flash calculations, lightening and surge protection, and phase-to-ground detection of the ungrounded delta-delta system should be provided.

4.4 FAN VFD

The procurement contract requires that the VFD supplier is responsible for designing and providing a VFD that meets SURF's needs based on the design requirements and fan operating parameters described below.

The SURF footprint is only a small fraction of the 350 miles of underground workings that were maintained and ventilated by HMC. Consequently, the demands on the ventilation FAN are much less than it was designed to provide for HMC mine operations. Originally designed for 478,000 ACFM at a static pressure of 26.5 inches WC, the FAN is currently providing 255,000 ACFM at 8.8 inches WC. The FAN is operating at 410 RPM and the motor is developing ±412 horsepower to satisfy the present airflow demand.

Future airflow requirements for SURF were determined during the preliminary design of the LBNF/DUNE project. Detailed analysis and modeling of the ventilation system were performed resulting in planned improvements that will reduce air velocities and system pressure drop. The final airflow requirements to support SURF and LBNF/DUNE will range from 400,000 to 500,000 ACFM at static pressures between 7 and 14 inches WC. The FAN will operate between 473 and 621 RPM, requiring 612 BHP (min) to 1385 BHP (max), to meet these demands. The design operating point for the FAN is 400,000 ACFM at 9.0 inches WC, requiring approximately 500 RPM and 700 horsepower. **Table 1** summarizes this airflow information:

Table 1- FAN Operating Data

Fan Operating Range Design Values					
Fan Operating Point	**Press. (in. WC)**	**Airflow (ACFM)**	**Fan Speed**	**Brake HP**	**Air Density**
Full Speed	26.48	478,000	720	2194	0.0538
Current	8.84	255,000	410	412	0.062
Future Minimum	7.00	400,000	473	612	0.062
Design	9.00	400,000	496	**703**	0.062
Future Maximum	14.00	500,000	621	1385	0.062

SDSTA has elected to use the existing 3000 HP motor to avoid additional, unnecessary cost. When sizing a VFD for this application the following factors should be considered (refer to speed/power and speed/torque FAN curves in **Appendix C**):

1. Based on ventilation requirements, system modeling, and the FAN curve characteristics, the 3000 HP motor is a factor of four times larger than the design point of the ventilation system. At worst case, if the FAN were operated at full speed (720 RPM, 60 Hz) the maximum horsepower required would be ~2200 HP, suggesting that the existing motor is a factor of 1.5 times larger than would ever be required.

2. Backward-inclined airfoil blade impellers are the most efficient centrifugal fan impeller design. Often referred to as "load limiting" or "non-overloading", the brake horsepower for this type of impeller drops off quickly once the maximum airflow is reached at a given speed. Taking this into account, it is highly unlikely that the FAN will ever exceed ~2200 horsepower with the static pressure drop that will exist in the SURF ventilation system.

3. The breakaway torque required to start the FAN is 1,076 ft. lbs. The 3000 HP motor can develop ~16,000 ft. lbs. of torque at full speed. Since the FAN operates 24/365 and has infrequent starts, acceleration is not a concern and long acceleration times are acceptable. These facts indicate that motor load during starting is minimal and should not be a deciding factor in VFD sizing.

Factoring in these considerations for sizing the VFD, the 3000 HP motor is at least 1.5 times more than is required to run the FAN under worst case conditions. A VFD for this FAN does not require significant overload ratings or compensation for altitude. These parameters are already accounted for by the excess motor capacity in relation to the FAN/VFD requirements. However, precautions can be taken to insure VFD overload conditions do not occur to:

- Motor winding RTDs can be incorporated into VFD motor overload protection.
- VFD current limits can be set to prevent motor currents above the maximum anticipated operating range of the FAN.
- VFD output frequency can be limited so that the FAN speed cannot exceed the maximum speed in the anticipated operating range.

By limiting the VFD output, the motor will never approach its full-load current and over-temperature limits, but the VFD/motor combination will still have adequate capacity to run the FAN within its required operating range.

4.5 VFD Specifications

The replacement VFD must meet or exceed the general specifications, features and capabilities of the existing GE LCI VFD. Details on those specifications and features can be found in the original GE publication "GEK-95368 *Adjustable Speed Drives Systems*", which is provided as an attachment to the RFB. Exceptions to this requirement are:

- The original VFD ratings must be corrected to match the current and future FAN operating conditions and required capacities.
- The most recent electrical codes and standards must be incorporated into the new VFD design and installation. Codes that must be used include:
    A. NFPA 70 – 2017 Edition
    B. NFPA 70E – 2015 Edition
    C. Applicable sections of the 2017 version of 29 CFR Part 1910 & 1926 OSHA Regulations.
- Specific requirements listed in section 5.5.1 either modify, replace, or are in addition to the original VFD specifications.

Requirements

1. The VFD shall have flying-start (starting a spinning load) capability.
2. The VFD shall maintain a voltage regulation of ±2% of maximum rated output voltage.
3. The VFD shall maintain an output frequency stability of ±0.5% for 24 hours.
4. The VFD shall limit total harmonic distortion (THD) to less than 5% voltage and 8% current.
5. The VFD shall monitor, detect and compensate for input phase reversal.
6. The VFD must be capable of withstanding transient voltage spikes.
7. The VFD must have digital and analog I/O provisions for hardwired control. At a minimum, the available I/O signals must include:
    a. Interlock digital input. (i.e. enable or permissive start)
    b. Start and Stop control digital inputs, configurable for 2-wire or 3-wire control.
    c. Local/Remote digital input.
    d. * Acceptable digital input signal levels are 24VDC, 24VAC, and 120VAC.
    e. Drive Fault/Ready digital output.

f. Drive Auxiliary/Running digital output.
g. * Digital outputs must be form-C contacts with minimum contact ratings of 2.0 amps @ 120 VAC/30 VDC.
h. Speed reference (SETPOINT) analog input.
i. Motor CURRENT analog output.
j. Motor SPEED analog output.
k. * Acceptable analog signal levels are 1-5 VDC or 4-20 mA DC into 500 ohms.

8. The VFD shall have revenue quality energy consumption (kilowatt-hours) metering on the supply side of the drive.

9. The VFD must have a local human/machine interface (HMI) located on the front of the VFD.
    a. The HMI must have a graphical color display.
    b. HMI functions must include:
        1. View and change configuration parameters.
        2. Save and restore VFD configuration program data.
        3. Display drive status (stopped, running, at speed, direction/rotation, faulted, etc.)
        4. Display fault codes and fault history.
        5. Display command and alarm logs.
        6. Create and view trends of drive operating data.
        7. VFD faults resetting.
        8. Local/Remote mode selection.
        9. Stop, Start, Jog, Direction control in local mode.
        10. Frequency/speed setpoint control in local mode.
        11. Display VFD input information (input phase-to-phase voltage & current, frequency, power, power factor, instantaneous kVA, kVAR, harmonic distortion.)
        12. Display VFD output information (phase voltage, phase current, DC buss voltage, output frequency, output power, speed command input value, motor overload %trip or equivalent.)

10. The VFD shall have the following communication features:
    a. Local communication port for connecting a laptop computer to perform programming, diagnostics, and backing up drive configuration parameters.
    b. Ethernet communication port(s) for interfacing with SURF facility PLC & HMI control systems.
        1. A minimum of Modbus TCP/IP is required. (SURF does not have an established standard control system communication protocol. GE 90/30 PLCs are currently in use and an Ethernet control network is in place.)
        2. PLC interface functionality must include:
            - Remote starting and stopping of the VFD.
            - VFD output frequency control (remote speed setpoint.)
            - Access to all metered analog data.
            - Access to drive status, alarm, and diagnostic information.
    c. Internet access for vendor drive support. (Internet connectivity will be administered and managed by the SURF IT department.)

5.0 Submission Requirements

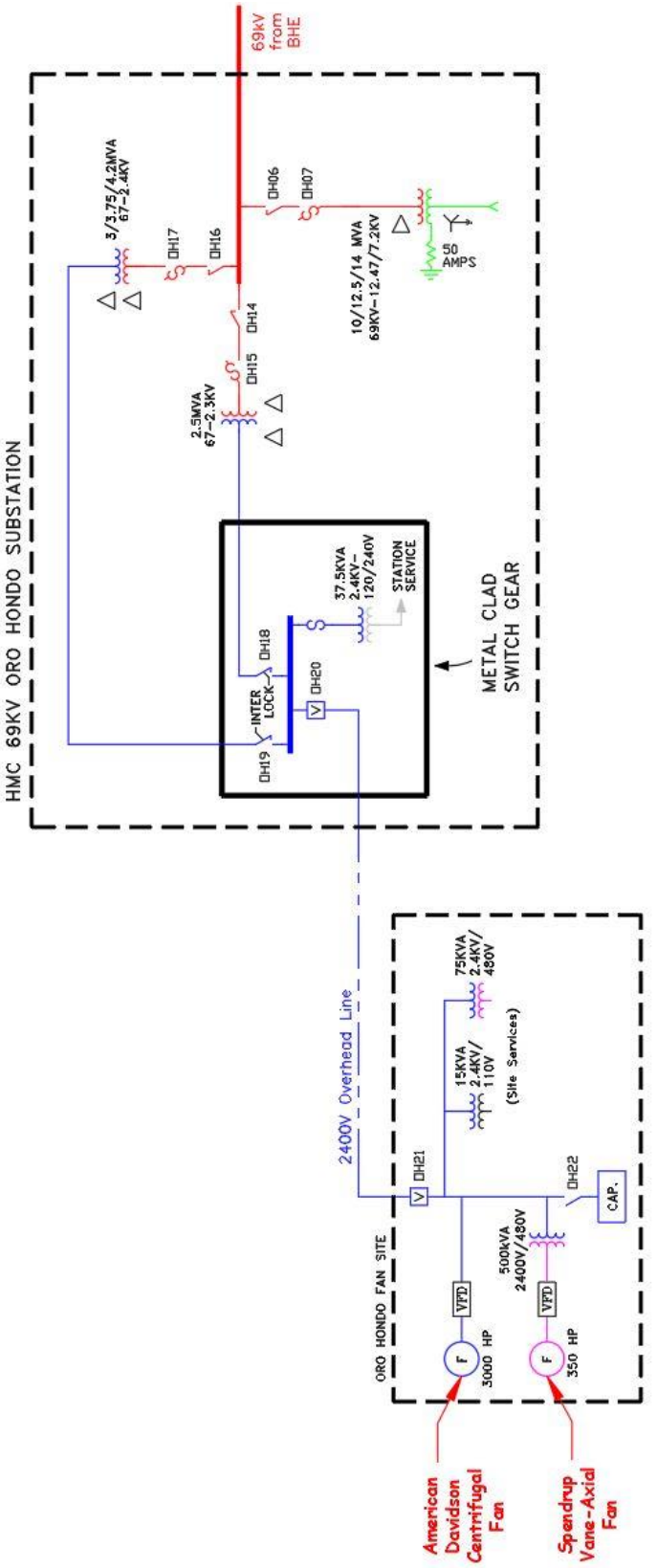
Bidders should submit an electronic copy (pdf format) of the bid no later than 2:00 p.m. on January 26, 2018, to mbaumann@sanfordlab.org. Late submissions will not be accepted.

Questions need to be submitted by January 12, 2018.

Questions/Answers will be emailed to all prospective bids and posted to the sanfordlab.org website no later than January 18, 2018.

The bid period may be extended at the discretion of SDSTA based on the quantity and/or complexity of questions. Any notices of extension of time to respond will be distributed to all prospective bidders by SDSTA.

All communications regarding this procurement between RFB release and award shall be directed by email to mbaumann@sanfordlab.org. Communications with other SDSTA staff regarding this procurement in advance of the award are not allowed.



Oro Hondo Substation 69kV to 2300V distribution | Oro Hondo Fan Site

APPENDIX B – GE Motor/Exciter Technical Information

Motor Data:

GE Synchronous Motor:	Stator Model Number 271R206, Serial Number 270777
Frame:	TS8610 drip-proof
Ratings:	3,000 HP 10 pole / 720 RPM 2,400 Volt, 3-phase, 60 Hz, 616 Amps Full Load Continuous Duty, Service Factor = 1.0 Insulation Class F, Temperature Rise: Stator = 85 °C, Rotor = 80 °C Excitation = 110 Amps @ 125 Volts
Motor Bearings:	Split-Sleeve Babbitt Bearings Sling-ring lubrication, with provisions for future addition of flood flood lubrication. ODE bearing is electrically insulated
Motor RTDs:	Six 10-ohm @ 25 °C (copper) winding RTDs Two 100-ohm @ 0 °C bearing RTDs
Motor Feeders:	Two 500-MCM unshielded conductors per phase
Space Heater:	2400 Watt, 120 Volt, 1-phase

Exciter Data:

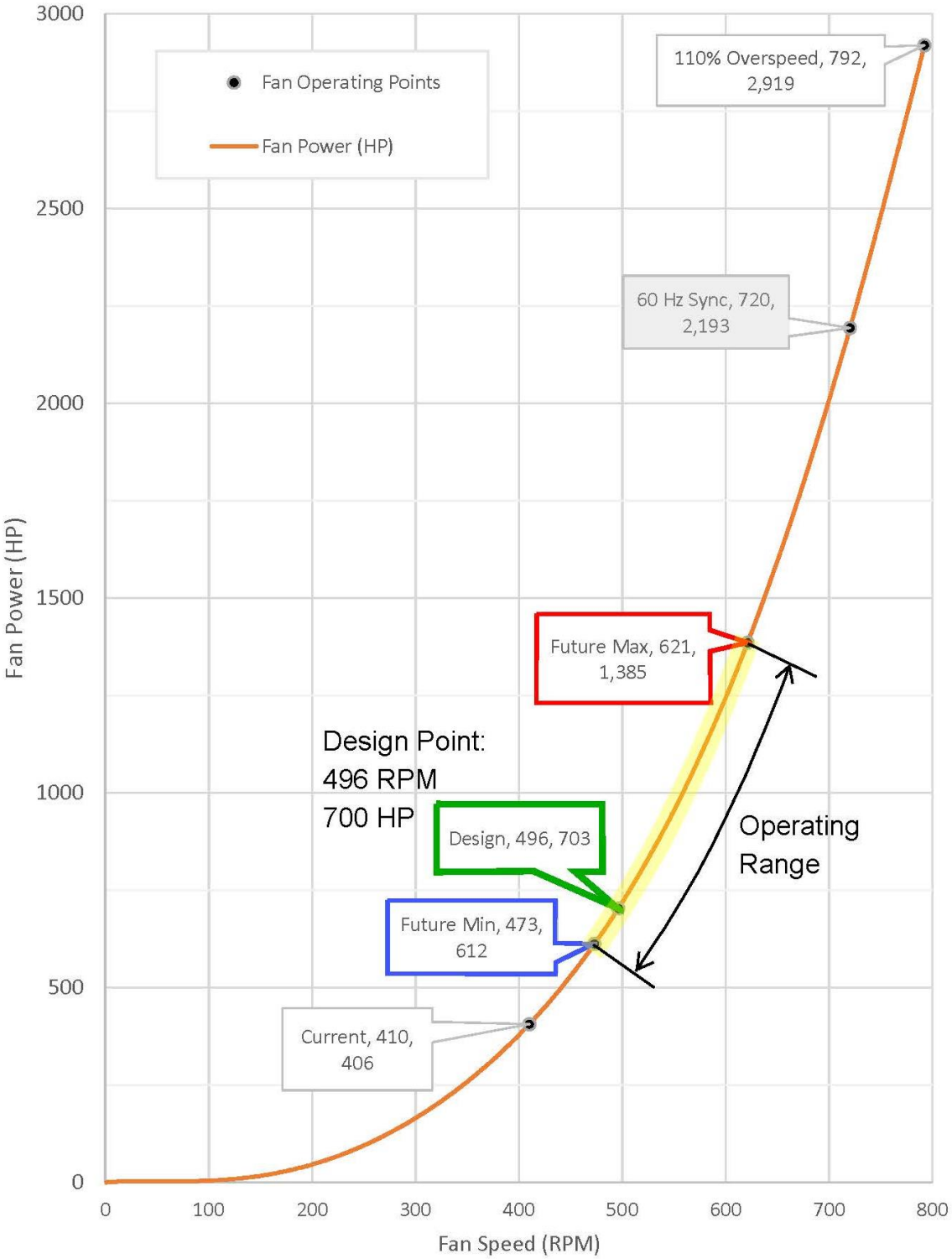
GE Brushless Exciter:	Model Number 271R20
Frame:	Type ARM
Ratings:	6-pole Input = 0 – 460 VAC, 3-phase, 38 Amps @ 218 VAC Maximum Output = 17 kW, (??)ADC @ 125 VDC Insulation: Stator Class F, Rotor Class F Service Factor = 1.0 Temperature Rise: Stator = 80 °C, Rotor = 80 °C
Weights:	Motor Armature = 12,785 Lbs. Exciter Armature = 395 Lbs. Net Wt. = 29,700 Lbs.
Inertia (Wk^2):	Motor Armature = 12,740 Lb-Ft^2 Exciter Armature = 91 Lb-Ft^2

Applicable pages from the original GE project document "GEK-95638 *Adjustable Speed Drives Systems* "are provided in an attachment to the RFB.

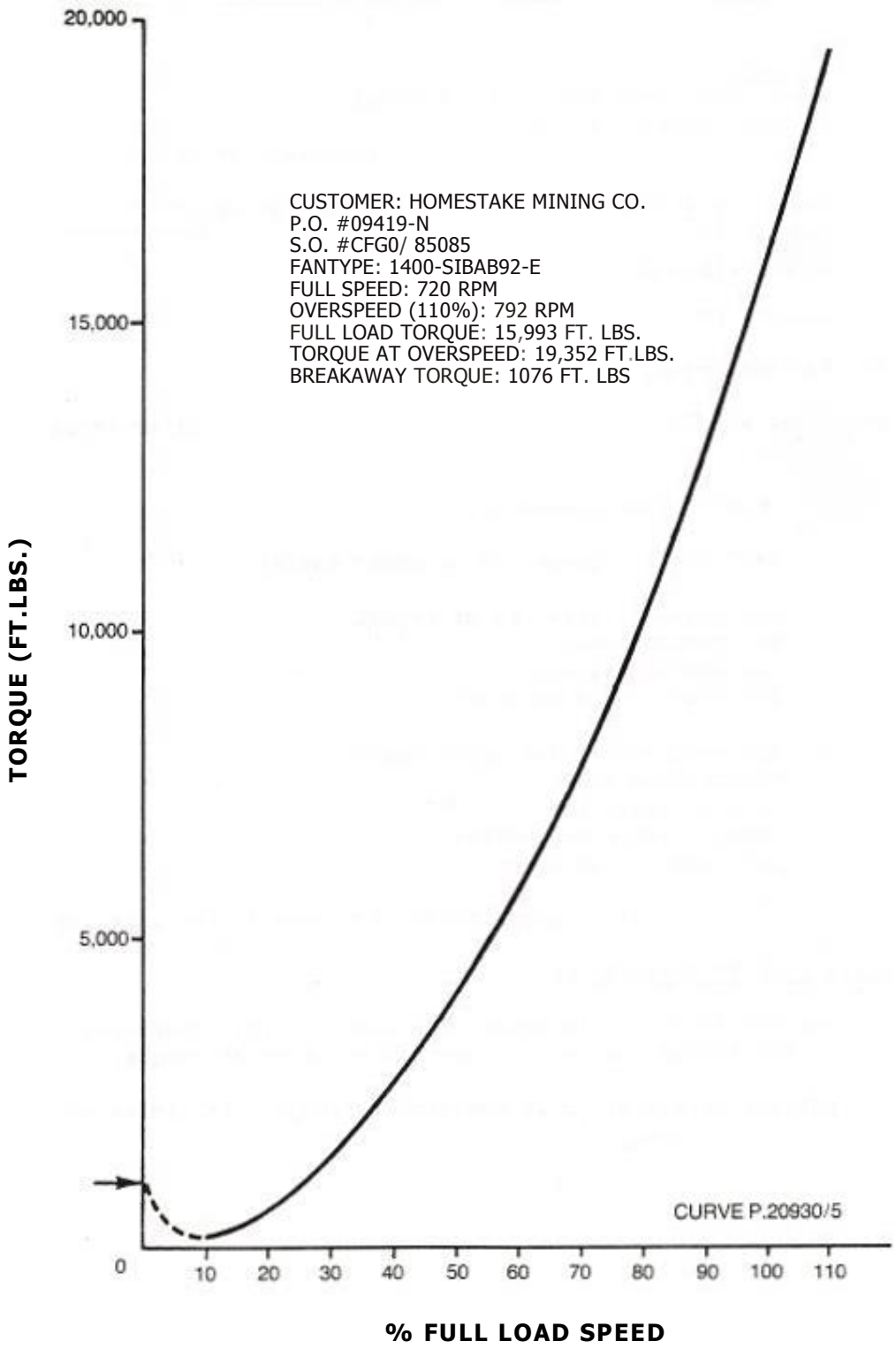
Photographs of the motor and exciter nameplates can be found in attachments to the RFB.

APPENDIX C – FAN Design Curves

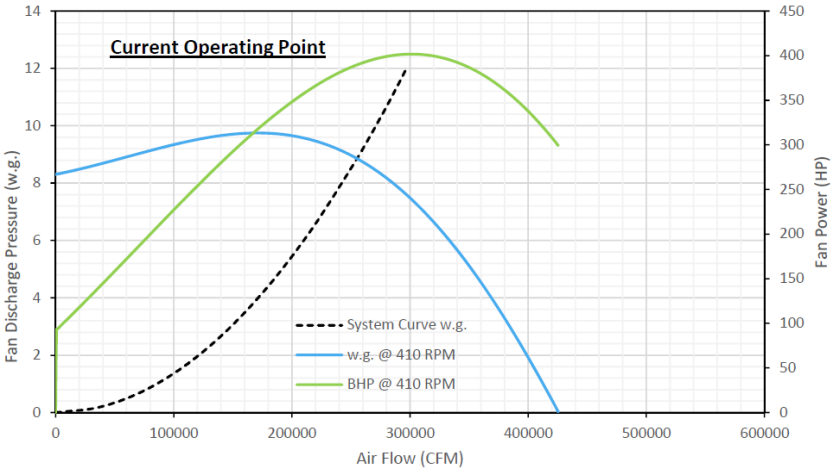
FAN Speed vs Power Curve (future operating range shown)



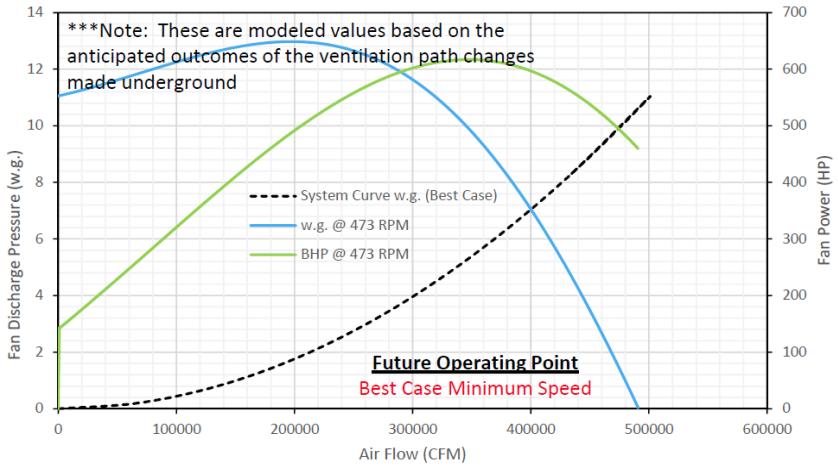
FAN Speed vs Torque Curve.



FAN Curve for Current Operation



FAN Curve for Future Minimum



FAN Curve for Future Maximum