



361A Old Finch Ave.  
Toronto, ON M1B 5K7  
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Telephone: 416-392-5900  
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**Chair**  
Councillor Raymond Cho

**Chief Executive Officer**  
John Tracogna

**Chief Operating Officer**  
Robin D. Hale

2016-04-25

**REQUEST FOR QUOTATION  
VARIABLE FREQUENCY DRIVE INSTALLATION  
RFQ 13 (2016-05)**

The Toronto Zoo invites you to submit a quotation to provide labour, tools, materials and equipment to complete the installation of Variable Frequency Drives on various fan motors in our pavilions. Pricing should include, but not limited to mobilization, profit, overhead, materials, equipment, disposal off site, site cleaning site security, permits, samples, notifications, as built-drawings and warranties.

The work shall commence once a Purchase Order has been issued. All work must be completed in the timeframe indicated in the RFQ (**Friday, 2016-07-29**)

The Quotation package includes Instructions, Terms & Conditions, Specifications, and Forms. Quoted prices shall remain in effect for a period of ninety (90) days from the Quotation due date.

Site Meeting: A site meeting will be held on **Thursday, 2016-05-05 at 13:00 hours (1:00 p.m.)** meeting at the Toronto Zoo, Administrative-Support Centre, 361A Old Finch Avenue, Toronto, Ontario. Please note site visit will involve the examination of equipment at six (6) locations within the Zoo.

Due Date: Your quotation must be completed, and received by the Supervisor, Purchasing & Supply, Toronto Zoo, Administrative-Support Centre, 361A Old Finch Ave., Toronto, Ontario, M1B 5K7 by:

**Wednesday, 2016-05-18, 1200 hours (noon, local time)**

The Board of Management of the Toronto Zoo reserves the right to reject any or all quotes or to accept any quote, should it deem such an action to be in its interests.

If you have any queries regarding this request for quote, please contact Peter Vasilopoulos, Supervisor of Purchasing & Supply, (416) 392-5916. If you have any technical queries regarding this request for quote, please contact Bill Romberg, Utilities Supervisor, (416) 392-5995.

Yours truly,

Paul K. Whittam  
Manager, Financial Services



## INSTRUCTIONS

- 1.1 Ensure that you have received all **twenty-seven (27)** pages.
- 1.2 A site meeting will be held on **Thursday, 2016-05-05 at 13:00 hours (1:00 p.m.)** at the Toronto Zoo, Main Gate - Public Entrance, 2000 Meadowvale Rd. Scarborough, Ontario. 2hrs
- 1.3 Complete all forms in section 4.0 and return by due date and time received on or before **Wednesday, 2016-05-18, 1200 hours (noon, local time)** or your quotation will not be considered. Include signed copies of any addenda with your submission package. Use the attached submission label, when you submit your response and deliver to the Toronto Zoo
- 1.4 If the Toronto Zoo determines that an amendment is required to this RFQ, the Toronto Zoo representative will issue by email or post a written addendum on the Toronto Zoo Website that will form part of this RFQ. No amendment of any kind to the RFQ is effective unless it is provided by email or posted in a formal written addendum on the Toronto Zoo website. Upon submitting a Proposal, Proponents will be deemed to have received notice of all addenda and acknowledged on the submission form.
- 1.5 Quotations must not be submitted by facsimile, email or any other electronic format.
- 1.6 Show itemized cost of HST if applicable.
- 1.7 All Prices submitted shall be quoted in Canadian currency
- 1.8 Toronto Zoo reserves the right to award in whole or in part on the basis of the bids received, Lump Sum Price or Breakdown Price.
- 1.9 Quotation prices shall remain in effect for a period of ninety (90) days from the Quotation due date.
- 1.10 Include product information, shop drawings, samples, and pictures, as necessary.
- 1.11 Provide references of at least three (3) clients for whom your company has performed similar work. References must include photos of three (3) different installations, client company name, contact name, address and e-mail address.
- 1.12 If applicable, suggested alternative products are acceptable, however all such products must be quoted separately and should not replace the Toronto Zoo requested product, work or service.
- 1.13 It is the responsibility of the Bidder to understand all aspects of the RFQ and to obtain clarification if necessary before submitting their quotation.
- 1.14 All bidders must attend the location for a site visit and carefully examine the physical layout and associated job requirements in order to bid this project.
- 1.15 For any questions concerning the contract terms and conditions of this RFQ, please contact:  
Peter Vasilopoulos, Supervisor, Purchasing & Supply, Tel: 416-392-5916, Fax: 416-392-6711,  
E-mail: [pvasilopoulos@torontozoo.ca](mailto:pvasilopoulos@torontozoo.ca)

For any technical queries concerning the specifications of this RFQ, please contact:  
Bill Romberg, Utilities Supervisor, (416) 392-5995, Fax 416-392-5934,  
E-mail: [wromberg@torontozoo.ca](mailto:wromberg@torontozoo.ca)

## **2.0 TERMS AND CONDITIONS**

- 2.1 Definitions:** Wherever used in the Request for Quotation the word “Board” means the Board of Management of the Toronto Zoo and the word “Vendor” means the person or persons or Corporation to whom the purchase order is issued.
- 2.2 Vendor Assurance:** Unless otherwise stated, the goods, material, articles, equipment, work or services, specified or called for in or under this Quotation, shall be delivered or completely performed, as the case may be, by the Vendor as soon as possible and in any event within the period set out herein as the guaranteed period of delivery or completion.
- 2.3 Country of Origin:** Wherever possible, the goods, services, materials, articles or equipment, specified or called for in or under this Quotation, shall be of Canadian origin and manufacture.
- 2.4 Delivery:** The prices stated in this Quotation cover the services, material, articles or equipment referred to herein, being delivered F.O.B. destination, freight, express, duty and all other charges prepaid, unless otherwise indicated herein. A detailed delivery ticket or piece tally, showing the exact quantity of goods, material, articles or equipment shall accompany each delivery. A receiver’s receipt shall not bind the Board to accept the goods, material, articles or equipment covered thereby, or the particulars of the delivery ticket or piece tally therefore. The Vendor shall not be entitled to any interest upon any bill due to delay in its approval by the CEO of the Toronto Zoo or his designate.
- 2.5 Invoicing:** Unless otherwise indicated herein, the prices stated are payable in Canadian Funds at the head office of the Board. Any Harmonized Services Tax applicable shall be shown as a separate item. The Vendor’s GST registration number must be indicated on the invoice.

The Vendor shall clearly show any special charges such as packaging and freight, where applicable, as separate items on the invoice.

Payments to non-resident Vendors may be subject to withholding taxes under the Income Tax Act (Canada). Unless a non-resident Vendor provides the Board with a letter from Revenue Canada, Taxation waiving the withholding requirements, the Board will withhold the taxes it determines are required under the Income Tax Act (Canada).

- 2.6 Notice of Delivery:** The Vendor shall notify the Purchasing Agent of the Board at the address given for the mailing of invoices, in writing as soon as possible of the details of the shipment of the goods, materials, articles or equipment.
- 2.7 Right to Cancel:** The Board shall have the right to cancel at any time this Quotation or any contract or any part of any contract resulting from this Quotation in respect of the goods, material, articles, equipment, work or services set out in this Quotation or any such contract or part of such contract, not delivered or performed at the time of such cancellation, and the Board will not be responsible to make any payments in respect of any such goods, materials, articles, equipment, work or services and shall not incur any liability whatsoever in respect thereto.

In the event that the Vendor fails or neglects by any act or omission to comply with any of the conditions set out herein, this Quotation or any contract resulting from this Quotation may be unconditionally cancelled by the Board without notice to the Vendor.

- 2.8 Official Agreement:** No verbal arrangement or agreement, relating to the goods, material, articles, equipment, work or services, specified or called for under this Quotation, will be considered binding, and every notice advice or other communication pertaining thereto, must be in writing and signed by a duly authorized person.
- 2.9 Worker's Rights:** The Vendor shall comply with the conditions of the Board relating to Worker's Rights, a copy of which is available on application to the Manager, Fair Wage and Labour Trades Office, City of Toronto, 18<sup>th</sup> Floor, West Tower, City Hall, Toronto, Ontario, M5H 2N2 or by phone at 416-392-7300.
- 2.10 Indemnity:** The Vendor shall at all times well and truly save, defend, keep harmless and fully indemnify the Board, the City of Toronto, Toronto Region and Conservation Authority and their servants, employees, officers or agents, hereinafter called the "Indemnities", from and against all actions, suits, claims, demands, losses, costs, charges, damages, and expenses, brought or made against or incurred by the Indemnities, its or their servants, officers, employees, agents or invitees in any way relating, directly or indirectly, to goods, material, articles or equipment supplied or to be supplied, or to the supplying of goods or services, pursuant to this Quotation, or any other claim, action, suit, demand, loss, cost, charge, damage or expense relating to copyright, trademark or patent with regard directly or indirectly with any such goods, services, material, articles or equipment or the supply or performance thereof.
- 2.11 Insurance:** The Contractor shall, at his/her own expense obtain and, until the work is fully complete maintain, broad-scope insurance coverages, hereof, satisfactory to the Chief Executive Officer as to form and substance, with the indicated policy form of the Canadian Construction Documents Committee (CCDC), its equivalent or better subject to such modifications therein to cover unusual aspects of the work, working conditions or other circumstances as may be specified elsewhere in the Contract.
- 2.11.1 The Contractor shall effect, maintain and keep in force, at its sole cost and expense and satisfactory to the Chief Executive Officer as to form and substance the insurance described below:
- 2.11.2 All risks property insurance on property of every description and kind owned by the contractor or for which the Contractor is responsible while on the premises of the Board in an amount not less than full replacement value. The policy shall be endorsed to provide a waiver of subrogation against the Board for any loss or damage to insured property, however caused.
- 2.11.3 Commercial general liability insurance, including owners' and contractors' protective, products, completed operations, personal injury, employer's liability, contractual liability, occurrence basis property damage, liability arising from the sale of serving of alcoholic beverages and provisions for cross liability and severability of interests with a limit of not less than Two Million Dollars (\$2,000,000.00) per occurrence. The policy shall be endorsed to name the Board as an additional insured with respect to the operations of the Contractor under this agreement.
- 2.11.4 Standard automobile liability insurance for all owned vehicles with limits of not less than Two Million Dollars (\$2,000,000.00) per occurrence.
- 2.11.4.1 All policies of insurance required to be taken out by the Contractor shall be placed with insurers licensed to conduct business in the Province of Ontario and shall be subject to the approval of the Chief Executive Officer, acting reasonably.

2.11.4.2 The Contractor shall deliver to the Board evidence of the insurance required prior to the commencement of the agreement, in form and detail satisfactory to the Chief Executive Officer acting reasonably.

2.11.4.3 The provisions of this section 2.11 shall no way limit the requirements and obligations imposed on the Contractor elsewhere in the Contract, nor relieve the Contractor from compliance therewith and fulfillment thereof.

2.11.4.4 The parties agree that insurance policies may be subject to deductible amounts, which deductible amounts shall be borne by the Contractor.

2.11.4.5 The provisions of this article shall in no way limit the requirements and obligations imposed on the Contractor elsewhere in the Contract, nor relieve the Contractor from compliance therewith and fulfillment thereof.

**2.12 Liability for Acts of Vendor Employees, Contractors or Agents:** The Vendor acknowledges responsibility and accepts liability for the acts of any of its employees, contractors and agents while on Toronto Zoo property. The Toronto Zoo reserves the right to request background checks for any individual providing the services requested on behalf of the Vendor.

**2.13 Accessibility for Ontarians with Disabilities Act (AODA) Requirements:**

"Pursuant to Section 6 of Ontario Regulation 429/07 ("Regulation"), Accessibility Standards for Customer Service made under the *Accessibility for Ontarians with Disabilities Act, 2005*, the contractor, i.e. successful bidder/proponent, shall ensure that all of its employees, agents, volunteers, or others for whom it is at law responsible, receive training about the provision of the goods and services contemplated herein to persons with disabilities. Such training shall be provided in accordance with Section 6 of the Regulation and shall include, without limitation, a review of the purposes of the Act and the requirements of the Regulation, regarding all matters set out in Section 6 of the Regulation. This training will take approximately **twenty minutes** and is available on-line at <http://www.mcsc.gov.on.ca/mcsc/serve-ability/splash.html>

The contractor, i.e. **successful bidder/ proponent** where requested by the Toronto Zoo shall provide written proof that all employees, agents, volunteers, or others for whom it is at law responsible have been trained as required under the act as well as any documentation regarding training policies, practices and procedures."

**2.14 Guaranty of Quotation:** All goods, material, articles, equipment, work or services, specified or called for in or under this Quotation, shall be supplied or performed at the price or process and on the basis set forth or referred to in and in accordance with the Offer and this Quotation. The basis on which this Quotation is given shall include any specifications, plans, price schedules, samples, addenda or other details pertaining thereto, or provided in connection therewith.

**2.15 Right of Notice:** Any notice that the Board may be required or desire to give to the Vendor shall for all purposes to be deemed to have been sufficiently and properly given and afforded by registered mail addressed to the Vendor at the address shown for the Vendor on this form and shall therefore be presumed to have been received by the Vendor on the third day following such registration.

- 2.16 Formal Contract:** The Vendor may be required and shall, if requested by the solicitor for the Board so to do, to execute and enter into a formal contract that is satisfactory to the solicitor for the Board, in order to document the contract resulting from this Quotation and to embody indemnity and related provisions that in the opinion of such solicitor are required to protect the Board.
- 2.17 Charity Status:** The Toronto Zoo is a registered charitable organization (registration #BN 119216398RR0001) and accordingly may be eligible for preferred pricing which should be reflected in the Quotation as submitted.
- 2.18 Performance Evaluation:** The Contractor's performance will be evaluated by the Chief Executive Officer and/or Chief Executive Officer's Representative during the Contract and at the end of the Contract. In the event that the Contractor's performance is considered unsatisfactory by the Chief Executive Officer and/or Chief Executive Officer's Representative, the Contractor and/or its affiliates may become ineligible from bidding on future contracts issued by the Board.

### **3.0 PROJECT REQUIREMENTS & SCOPE OF WORK**

Supply all labour, materials, equipment and all services necessary for the execution and completion, to the Toronto Zoo's satisfaction, the installation of approved VFD's including appropriately sized wiring, associated components, materials, equipment including but not limited to mobilization, profit, overhead, materials, equipment, disposal off site, site cleaning site security, permits, samples, notifications, as built-drawings and warranties and services necessary for the complete installation. This includes approved, successful operational tests and all other requirements written, implied or expected to complete the entire project and leave "ready for immediate use and operation".

The contractor is responsible for all pricing and all other arrangements with all subcontractors as required (The Toronto Zoo requires the company information of every contractor to be submitted with the quotation) including rigging, cranes, excavators, boring equipment, line tracing, locates and general construction on site and working within the confines of regular business operating hours and site rules to complete the project as per design specifications and to the satisfaction of TSSA, Toronto Zoo and all other codes and regulations.

The contractor will also warrant their work for a period of not less than one (1) year.

1. The contractor will be required to provide and responsible for the following
  - a. all applicable licensing, certifications and insurance required in this field of industry
  - b. WSIB Clearance Certificate prior to commencing the work
  - c. All underground service locates and will follow the Guidelines for Excavation as required by TSSA and the Electrical Safety Authority.
  - d. Provide shop drawings for review and approvals
  - e. Three copies of close out documents, including as-built & shop drawings and warranty
2. Supply all labour, materials, equipment and services necessary to complete the installation of VFD's connecting to existing motors and supply feed panels at all buildings as per attached specifications.
3. Work site to be cleaned on a daily basis. Project waste to be disposed off site.
4. Do not scale drawings. All dimensions are to be verified on site.
5. Any discrepancies must be brought to the attention of the Toronto Zoo.



6. Contractor must adhere to Toronto Zoo Policies and Occupational Health & Safety Act at all times when on Zoo property.
7. Contractor is to check in and out at Security when entering or exiting Zoo property.
8. Adjacent areas must be protected during site work, service connections, delivery and placement. The Contractor is to make good any/all damages upon completion of work.

The work shall commence immediately upon receipt of a Purchase Order and once the incentive applications have been approved.

The Contractor is responsible for all pricing and all other arrangements with their subcontractors as required. Work is to commence as soon as the award is made and be completed, installed and fully operational by **Friday, 2016-07-29**

### **3.2 CONTRACTOR RESPONSIBILITIES**

1. Regular meetings/communication with the Toronto Zoo Project Team to review project status and to discuss issues that may arise during the project including shut down schedules
2. Provide samples, mock ups, etc. as required.
3. Provide product information, MSDS sheets to the Project Team prior to start of the work where applicable.
4. Protect adjacent areas not included in the project. Any damage caused will be the responsibility of the contractor to rectify at no additional cost to the Zoo.
5. Protect adjacent holdings/exhibits to prevent heat or dust towards the holdings/exhibits.
6. Clean-up the work area daily and making good any damage caused as a result of the work.
7. Secure the work site and provide construction signs and barriers to prevent injury to Zoo personnel and the public who will require access to the space during the work.
8. Upon award of contract, Contractor is to finish all work, including clean up and demobilization by the completion date specified.
9. Submit all shop drawings for review and approval prior to start of fabrication. Review of shop drawings shall not mean that the Toronto Zoo approves detail design inherent in shop drawings, responsibility for which shall remain with the Contractor submitting same, and such review shall not relieve the Contractor of his responsibility for errors or omissions in shop drawings or of his responsibility for meeting all requirements of the subcontract documents.
10. Submit close out documents as requested. Include warranties and "As built" drawings.

### **3.3 SAFETY SPECIFICATIONS**

1. It is the responsibility of the Contractor to protect the site as required during construction.



2. Ensure that awareness of public safety is considered and protect visitors in the vicinity during the construction period.
3. All necessary personal protective equipment must be worn at all times and MSDS sheets must be available on site as required.
4. The contractor is to abide by applicable Toronto Zoo Health & Safety Policies, the Ontario Health and Safety Acts, the Ontario Building Code and all other applicable codes including the Fire Codes.
5. It is the responsibility of the Contractor to ensure that the work site is properly protected at all times. All work sites must be marked and barriered adequately with construction signs posted to secure and isolate the work site from the public or other personnel that have access to the area.

### **3.4 OTHER INFORMATION**

The successful bidder must demonstrate the ability to complete the work to standards acceptable to the Zoo and prove past performance in the completion of similar types of work for other clients by providing relevant examples of work and references. The successful bidder must also demonstrate and guarantee that they can produce the work in the allotted time.

**4.0 SUBMISSION FORMS:**

I/We, hereby, submit the Quotation and will comply with all terms, conditions, specifications and drawings (when provided) as set out within the Board’s Quotation.

I/We, hereby, have received, allowed for and included as part of our submission all issued Addendum numbered \_\_\_\_\_.

This form must be completed, properly signed and received on or before the date and time specified or your Quotation will not be considered. Quotation prices shall remain in effect for a period of ninety (90) days from the Quotation due date.

The Board of Management of the Toronto Zoo reserves the right to reject any or all Quotations or to accept any Quotation, should it deem such action to be in its interests.

By signing and submitting this FORM, you are agreeing to the release of your quotation information, as deemed necessary by the Board, in order to conduct business associated with this quotation or project.

<b>COMPANY INFORMATION</b>	
Company Name:	
Name of authorized Signing Officer	Title:
Signature:	Date:
Contact Name:	Title:
Address:	
Telephone #:	Fax #:
Email:	Web Site:
HST #:	

**RFQ 13 (2016-05) VARIABLE FREQUENCY DRIVE INSTALLATION**

**4.1 QUOTATION PRICING - LUMP SUM PRICE**

	DESCRIPTION	Price complete excluding HST
	Supply all labour, materials, equipment and services necessary for the installation of approved ABB Variable Frequency Drives, BACNET capable, including appropriately sized wiring, associated components necessary for the complete installation including approved, successful operational tests and all other requirements written, implied or expected to complete the entire project and leave safe and in a state of “ready for immediate use and operation” in accordance to the specifications within the RFQ at the following locations.	
	<b>AFRICA PAVILION</b>	\$
	<b>INDO MALAYA PAVILION</b>	
	<b>AUSTRALASIA PAVILION</b>	
	<b>AMERICAS PAVILION</b>	
	<b>MEMBERSHIP BUILDING</b>	
	<b>ADMINISTRATIVE SUPPORT CENTRE</b>	
		<b>HST</b>
		<b>Total</b>

**4.2 UNIT PRICING**

	All prices are to include the supply and installation of all labour, material, charges, payroll, burden and profit. DESCRIPTION:	Price complete including HST
		\$

**4.3 SEPARATE PRICING:**

All prices are to include the supply and installation of all labour, material, charges, payroll, burden and profit. The Additional Pricing is the increase in bulk quotation price if item is included in the overall scope of work.	
Description	Price complete excluding HST
<b>TO SUPPLY AND INSTALL A BYPASS ON THE DRIVE</b>	\$

**RFQ 13 (2016-05) VARIABLE FREQUENCY DRIVE INSTALLATION**

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**4.4 BREAKDOWN PRICING**

Provide breakdown pricing for the following items that are included in the Lump Sum Price

<b>COMMITMENT TO DELIVER</b>	<b>YES / NO</b>
Please confirm that you are able to complete the work by <b>Friday 2016-07-29.</b>	

<b>WARRANTY</b>	<b>Specify</b>
Please confirm warranty upon completion of the project.	

<b>DISCOUNT</b>	<b>Discount</b>	<b>Days</b>
Discount allowed for prompt payment and period within which invoice must be paid to qualify.	%	

**SUBMISSION LABEL**

This address label should be printed and affixed to the front of your sealed tender, quotation and proposal envelope/package submission. Toronto Zoo will not be held responsible for envelopes and packages that are not properly labelled or submitted to an address other than the one listed on this label.

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**Vendor Name**

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**RFQ 13 (2016-05) – VARIABLE FREQUENCY DRIVE INSTALLATIONS**  
**Closing: Wednesday, 2016-05-18, 12:00 (Noon) local time**

**TO BE RETURNED TO**

**TORONTO ZOO  
C/O SUPERVISOR, PURCHASING & SUPPLY  
ADMINISTRATIVE SUPPORT CENTRE  
361A OLD FINCH AVE.  
TORONTO, ONTARIO  
M1B 5K7**

**NOTICE OF NO BID**

**INSTRUCTIONS:**

It is important to the Toronto Zoo to receive a reply from all invited bidders. If you are unable, or do not wish to submit a bid, please complete the following portions of this form. State your reason for not bidding by checking the applicable box (es) or by explaining briefly in the space provided. It is not necessary to return any other Request for Proposal/Quotation/Tender documents or forms. Please just return this completed form by fax or by mail prior to the official closing date. **Purchasing and Supply Fax Number: (416) 392-6711.**

<b>A Proposal/Quotation/Tender is not submitted for the following reason(s):</b>		
<input type="checkbox"/>	Project/quantity too large.	<input type="checkbox"/> Project/quantity too small.
<input type="checkbox"/>	We do not offer services or commodities to these requirements	<input type="checkbox"/> Cannot meet delivery or completion requirement
<input type="checkbox"/>	We do not offer this service or commodity.	<input type="checkbox"/> Agreements with other company do not permit us to sell directly.
<input type="checkbox"/>	Cannot handle due to present commitments.	<input type="checkbox"/> Licensing restrictions
<input type="checkbox"/>	Unable to bid competitively.	<input type="checkbox"/> We do not wish to bid on this service or commodity in the future.
<input type="checkbox"/>	Insufficient information to prepare quote/proposal/tender	<input type="checkbox"/> Specifications are not sufficiently defined
<input type="checkbox"/>	We are unable to meet bonding or insurance requirements.	

Other reasons or additional comments (please explain):

Company Name:	
Address	
Contact Person:	
Signature of Company Representative:	
Date:	
Phone Number:	
Email address	
Fax Number:	

## SPECIFICATIONS - Variable Frequency Drives for HVAC Applications

**PART 1-GENERAL****1.01 DESCRIPTION**

- A. This specification is to cover a complete Variable Frequency motor Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use with a standard NEMA Design B induction motor.
- B. The drive manufacturer shall supply the drive and all necessary options as herein specified. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of twenty years. VFD's that are manufactured by a third party and "brand labeled" shall not be acceptable. All VFDs installed on this project shall be from the same manufacturer.

**1.02 QUALITY ASSURANCE**

- A. Referenced Standards:
  - 1. Institute of Electrical and Electronic Engineers (IEEE)
    - a) Standard 519-1992, IEEE Guide for Harmonic Content and Control.
  - 2. Underwriters laboratories
    - a) UL508C
  - 3. National Electrical Manufacturer's Association (NEMA)
    - a) ICS 7.0, AC Adjustable Speed Drives
  - 4. IEC 16800 Parts 1 and 2
  - 5. National Electric Code (NEC)
    - a) NEC 430.120, Adjustable-Speed Drive Systems
  - 6. International Building Code (IBC)
    - a) IBC 2006 Seismic – referencing ASC 7-05 and ICC AC-156
- B. Qualifications:
  - 1. VFDs and options shall be UL listed as a complete assembly. VFD's that require the customer to supply external fuses for the VFD to be UL listed are not acceptable. VFDs with red label UL stickers, requiring additional branch circuit protection are not acceptable. The base VFD shall be UL listed for 100 KAIC without the need for input fuses.
  - 2. CE Mark – The VFD shall conform to the European Union ElectroMagnetic Compatibility directive, a requirement for CE marking. The VFD shall meet product standard EN 61800-3 for the First Environment restricted level.
  - 3. The entire VFD enclosure, including the bypass shall be seismically certified and labeled as such in accordance with the 2006 International Building Code (IBC):
    - a) VFD manufacturer shall provide Seismic Certification and Installation requirements at time of submittal.
    - b) Seismic importance factor of 1.5 rating is required, and shall be based upon actual shake test data as defined by ICC AC-156.
    - c) Seismic ratings based upon calculations alone are not acceptable. Certification of Seismic rating must be based on testing done in all three axis of motion.
  - 4. Acceptable Manufactures
    - a) ABB ACH Series.



- b) Alternate manufacturer's requests must be submitted in writing to the Engineer for approval at least  working days prior to bid. Approval does not relieve the supplier of specification requirements.
5. The VFD manufacturer shall have available a comprehensive, HVAC Drive Computer Based Training (CBT) product. The CBT product shall include detailed, interactive sections covering VFD unpacking, proper mechanical and electrical installation, and programming. The CBT product shall allow the user to provide just-in-time training to new personnel or refresher training for maintenance and repair personnel on the user's site. The CBT product shall be repeatable, precise and shall include record keeping capability. The CBT product shall record answers to simulations and tests by student ID number. The CBT product must be professionally produced and have interactive sections, student tests, and include video clips of proper wiring and installation.

### 1.03 SUBMITTALS

- A. Submittals shall include the following information:
  1. Outline dimensions, conduit entry locations and weight.
  2. Customer connection and power wiring diagrams.
  3. Complete technical product description include a complete list of options provided. **Any portions of this specification not meet must be clearly indicated or the supplier and contractor shall be liable to provide all additional components required to meet this specification.**
  4. Compliance to IEEE 519 – harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD).
    - a) The VFD manufacturer shall provide calculations; specific to this installation, showing total harmonic voltage distortion is less than 5%. Input filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE standard 519. All VFD's shall include a minimum of 5% impedance reactors, **no exceptions.**

## PART 2 – PRODUCTS

### 2.01 VARIABLE FREQUENCY DRIVES

- A. The VFD package as specified herein shall be enclosed in a UL Listed Type enclosure, exceeding NEMA enclosure design criteria (enclosures with only NEMA ratings are not acceptable), completely assembled and tested by the manufacturer in an ISO9001 facility. The VFD tolerated voltage window shall allow the VFD to operate from a line of +30% nominal, and -35% nominal voltage as a minimum.
  1. Environmental operating conditions: VFDs shall be capable of continuous operation at 0 to 50<sup>0</sup> C (32 to 122<sup>0</sup> F) ambient temperature as per VFD manufacturers documented/submittal data or VFD must be oversized to meet these temperature requirements. Not acceptable are VFD's that can only operate at 40° C intermittently (average during a 24 hour period) and therefore must be oversized. Altitude 0 to 3300 feet above sea level, less than 95% humidity, non-condensing. All circuit boards shall have conformal coating.
  2. Enclosure shall be rated UL Type 1 and shall be UL listed as a plenum rated VFD. VFD's without these ratings are not acceptable. NEMA only type 1 enclosures are not acceptable (must be UL Type 1).
- B. All VFDs shall have the following standard features:

1. All VFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.
2. The keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate “bumpless transfer” of speed reference when switching between “Hand” and “Auto” modes. There shall be fault reset and “Help” buttons on the keypad. The Help button shall include “on-line” assistance for programming and troubleshooting.
3. There shall be a built-in time clock in the VFD keypad. The clock shall have a battery back up with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the VFD shall automatically revert to hours of operation since initial power up. Capacitor back-up is not acceptable. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output Form-C relays. The VFD shall have a digital input that allows an override to the time clock (when in the off mode) for a programmable time frame. There shall be four (4) separate, independent timer functions that have both weekday and weekend settings.
4. The VFD’s shall utilize pre-programmed application macro’s specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time. The VFD shall have two user macros to allow the end-user to create and save custom settings.
5. The VFD shall have cooling fans that are designed for easy replacement. The fans shall be designed for replacement without requiring removing the VFD from the wall or removal of circuit boards. The VFD cooling fans shall operate only when required. To extend the fan and bearing operating life, the VFD shall cycle the cooling fans on and off as required.
6. The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to set point without tripping or component damage (flying start).
7. The VFD shall have the ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable.
8. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430.250 for 4-pole motors.
9. The VFD shall have internal 5% impedance reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. VFD’s with only one DC reactor shall add an AC line reactor.
10. The input current rating of the VFD shall be no more than 3% greater than the output current rating. VFD’s with higher input current ratings require the upstream wiring, protection devices, and source transformers to be oversized per NEC 430.120. Input and output current ratings must be shown on the VFD nameplate.
11. The VFD shall include a coordinated AC transient surge protection system consisting of 4-120 joule rated MOV’s (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.
12. The VFD shall provide a programmable loss-of-load (broken belt / broken coupling) Form-C relay output. The drive shall be programmable to signal the loss-of-load condition via a keypad warning, Form-C relay output, and / or over the serial communications bus. The loss-of-load condition sensing algorithm shall include a programmable time delay that will allow for motor acceleration from zero speed without signaling a false loss-of-load condition.
13. The VFD shall have user programmable underload and overload curve functions to allow user defined indications of broken belt or mechanical failure / jam condition causing motor overload
14. The VFD shall include multiple “two zone” PID algorithms that allow the VFD to maintain PID control from two separate feedback signals (4-20mA, 0-10V, and / or serial

communications). The two zone control PID algorithm will control motor speed based on a minimum, maximum, or average of the two feedback signals. All of the VFD PID controllers shall include the ability for “two zone” control.

15. If the input reference (4-20mA or 2-10V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, Form-C relay output and / or over the serial communication bus.
16. The VFD shall have programmable “Sleep” and “Wake up” functions to allow the drive to be started and stopped from the level of a process feedback signal.

C. All VFDs to have the following adjustments:

1. Three (3) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed. The lockout range must be fully adjustable, from 0 to full speed.
2. Two (2) PID Set point controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the VFD, using the microprocessor in the VFD for the closed-loop control. The VFD shall have 250 ma of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The PID set point shall be adjustable from the VFD keypad, analog inputs, or over the communications bus. There shall be two independent parameter sets for the PID controller and the capability to switch between the parameter sets via a digital input, serial communications or from the keypad. The independent parameter sets are typically used for night setback, switching between summer and winter set points, etc.
3. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain the set point of an independent process (ie. valves, dampers, etc.). All set points, process variables, etc. to be accessible from the serial communication network.
4. Two (2) programmable analog inputs shall accept current or voltage signals.
5. Two (2) programmable analog outputs (0-20ma or 4-20 ma). The outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, Active Feedback, and other data.
6. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices. All digital inputs shall be programmable to initiate upon an application or removal of 24VDC or 24VAC.
7. Three (3) programmable, digital Form-C relay outputs. The relay outputs shall include programmable on and off delay times and adjustable hysteresis. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating of 2 amps RMS. Outputs shall be true Form-C type contacts; open collector outputs are not acceptable.
8. Run permissive circuit - There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, input contact closure, time-clock control, or serial communications), the VFD shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a VFD digital input and allows VFD motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop and the damper shall be commanded to close. The keypad shall display “start enable 1 (or 2) missing”. The safety input status shall also be transmitted over the serial communications bus.
9. The VFD control shall include a programmable time delay for VFD start and a keypad indication that this time delay is active. A Form C relay output provides a contact closure to signal the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates. The time delay shall be field programmable from 0 – 120 seconds. Start delay shall be active regardless of the start command source (keypad command, input

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- contact closure, time-clock control, or serial communications), and when switching from drive to bypass.
10. Seven (7) programmable preset speeds.
  11. Two independently adjustable accel and decel ramps with 1 – 1800 seconds adjustable time ramps.
  12. The VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and reduce audible motor noise. The VFD shall have selectable software for optimization of motor noise, energy consumption, and motor speed control.
  13. The VFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual VFD temperature that allows higher carrier frequency settings without derating the VFD.
  14. The VFD shall include password protection against parameter changes.
- D. The Keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable). All VFD faults shall be displayed in English words. The keypad shall include a minimum of 14 assistants including:
1. Start-up assistant
  2. Parameter assistants
    - a. PID assistant
    - b. Reference assistant
    - c. I/O assistant
    - d. Serial communications assistant
    - e. Option module assistant
    - f. Panel display assistant
    - g. Low noise set-up assistant
  3. Maintenance assistant
  4. Troubleshooting assistant
  5. Drive optimizer assistants
- E. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):
- Output Frequency
  - Motor Speed (RPM, %, or Engineering units)
  - Motor Current
  - Motor Torque
  - Motor Power (kW)
  - DC Bus Voltage
  - Output Voltage
- F. The VFD shall include a fireman’s override input. Upon receipt of a contact closure from the fire / smoke control station, the VFD shall operate in one of two modes: 1) Operate at a programmed predetermined fixed speed ranging from -500Hz (reverse) to 500Hz (forward). 2) Operate in a specific fireman’s override PID algorithm that automatically adjusts motor speed based on override set point and feedback. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands), except customer defined safety run interlocks, and force the motor to run in one of the two modes above. “Override Mode” shall be displayed on the keypad. Upon removal of the override signal, the VFD shall resume normal operation, without the need to cycle the normal digital input run command.
- G. Serial Communications
1. The VFD shall have an EIA-485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2, Siemens Building Technologies FLN, and BACnet. [Optional protocols for LonWorks, Profibus, EtherNet, BACnet IP, and DeviceNet shall be available.]

Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be “certified” by the governing authority (i.e. BTL Listing for BACnet). Use of non-certified protocols is not allowed.

2. The BACnet connection shall be an EIA-485, MS/TP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:
    - a. Data Sharing – Read Property – B.
    - b. Data Sharing – Write Property – B.
    - c. Device Management – Dynamic Device Binding (Who-Is; I-Am).
    - d. Device Management – Dynamic Object Binding (Who-Has; I-Have).
    - e. Device Management – Communication Control – B.
  3. If additional hardware is required to obtain the BACnet interface, the VFD manufacturer shall supply one BACnet gateway per drive. Multiple VFDs sharing one gateway shall not be acceptable.
  4. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible.
  5. Serial communication in bypass shall include, but not be limited to; bypass run-stop control, the ability to force the unit to bypass, and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the DDC to monitor feedback such as, current (in amps), kilowatt hours (resettable), operating hours (resettable), and bypass logic board temperature. The DDC shall also be capable of monitoring the bypass relay output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible.
  6. The VFD / bypass shall allow the DDC to control the drive and bypass digital and analog outputs via the serial interface. This control shall be independent of any VFD function. The analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive and bypass’ digital (Form-C relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive and bypass’ digital inputs shall be capable of being monitored by the DDC system. This allows for remote monitoring of which (of up to 4) safeties are open.
  7. The VFD shall include an independent PID loop for customer use. The independent PID loop may be used for cooling tower bypass value control, chilled water value / hot water valve control, etc. Both the VFD PID control loop and the independent PID control loop shall continue functioning even if the serial communications connection is lost. As default, the VFD shall keep the last good set point command and last good DO & AO commands in memory in the event the serial communications connection is lost and continue controlling the process.
- H. EMI / RFI filters. All VFD’s shall include EMI/RFI filters. The onboard filters shall allow the VFD assembly to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted level with up to 100 feet of motor cable. No Exceptions. Certified test reports shall be provided with the submittals confirming compliance to EN 61800-3, First Environment.



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- I. All VFD's through 75HP at 480 V shall be protected from input and output power mis-wiring. The VFD shall sense this condition and display an alarm on the keypad. The VFD shall not sustain damage from this power mis-wiring condition.
  
- J. **OPTIONAL FEATURES** – Optional features to be furnished and mounted by the drive manufacturer. All optional features shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label. [Choose one of the options listed below].
  1. [A complete factory wired and tested bypass system consisting of an output contactor and bypass contactor per section 2.01K below.]
  2. [Door interlocked, padlockable circuit breaker that will disconnect all input power from the drive and all internally mounted options. Circuit breaker option shall be available with or without systems requiring bypass.]
  3. [Door interlocked, padlockable disconnect switch that will disconnect all input power from the drive and all internally mounted options. Disconnect option shall be available with or without systems requiring bypass.]
  4. [Fieldbus adapters - Optional protocols such as LonWorks, DeviceNet, Ethernet IP (ControlNet over Ethernet & ModBus TCP), BACnet IP, and Profibus shall be available with the addition of an option card.]

**K. BYPASS CONTROLLER**

1. A complete factory wired and tested bypass system consisting of a door interlocked, padlockable circuit breaker, output contactor, bypass contactor, and fast acting VFD input fuses are required. UL Listed motor overload protection shall be provided in both drive and bypass modes.
2. The bypass enclosure door and VFD enclosure must be mechanically interlocked such that the disconnecting device must be in the "Off" position before either enclosure may be accessed.
3. The VFD and bypass package shall have a UL listed short circuit current rating (SCCR) of 100,000 amps and this rating shall be indicated on the UL data label.
4. The drive and bypass package shall be seismic certified and labeled to the IBC:
  - a. Seismic importance factor of 1.5 rating is required, and shall be based upon actual shake table test data as defined by ICC AC-156.
5. Drive Isolation Fuses - To ensure maximum possible bypass operation, fast acting fuses, exclusive to the VFD, shall be provided to allow the VFD to disconnect from the line prior to clearing upstream branch circuit protection. This maintains bypass operation capability in the event of a VFD failure. Bypass designs which have no such fuses, or that incorporate fuses common to both the VFD and the bypass, will not be accepted.
6. The system (VFD and Bypass) tolerated voltage window shall allow the system to operate from a line of +30%, -35% nominal voltage range. The system shall incorporate circuitry that will allow the drive or bypass contactor to remain "sealed in" over this voltage tolerance at a minimum.
7. The bypass shall maintain positive contactor control through the voltage tolerance window of nominal voltage +30%, -35%. This feature is designed to avoid contactor coil failure during brown out / low line conditions and allow for input single phase operation when in the VFD mode. Designs that will not allow input single phase operation in the VFD mode are not acceptable.
8. Motor protection from single phase power conditions - the bypass system must be able to detect a single phase input power condition while running in bypass, disengage the motor in a controlled fashion, and give a single phase input power indication. Bypass systems not incorporating single phase protection in bypass mode are not acceptable.
9. The bypass system shall NOT depend on the VFD for bypass operation. The bypass system shall be designed for stand alone operation and shall be completely functional in both Hand and Automatic modes even if the VFD has been removed from the system for repair / replacement. Serial communications shall remain functional even with the VFD removed.

10. Serial communications – the bypass shall be capable of being monitored and / or controlled via serial communications. On-board communications protocols shall include ModBus; Johnson Controls N2; Siemens Building Technologies FLN (P1); and BACnet.
11. Serial communication capabilities shall include, but not be limited to; bypass run-stop control; the ability to force the unit to bypass; and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the DDC to monitor feedback such as, current (in amps), kilowatt hours (resettable), operating hours (resettable), and bypass logic board temperature. The DDC shall also be capable of monitoring the bypass relay output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus and / or via a Form-C relay output – keypad “Hand” or “Auto” selected, bypass selected, and broken belt indication. The DDC system shall also be able to monitor if the motor is running in the VFD mode or bypass mode over serial communications. A minimum of 50 field serial communications points shall be capable of being monitored in the bypass mode.
12. The bypass serial communications shall allow control of the bypass’ digital outputs via the serial interface. This control shall be independent of any bypass function or operating state. The bypass’ digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the bypass’ digital inputs shall be capable of being monitored by the DDC system.
13. There shall be an adjustable motor current sensing circuit for the bypass and VFD modes to provide proof of flow (broken belt) indication. The condition shall be indicated on the keypad display, transmitted over the building automation protocol and / or via a Form-C relay output contact closure. The broken belt indication shall be programmable to be a system (drive and bypass) indication. The broken belt condition sensing algorithm shall be programmable to cause only a warning or a fault and / or system shutdown.
14. The digital inputs for the system shall accept 24VAC or 24VDC. The bypass shall incorporate an internally sourced power supply and not require an external control power source. The bypass power board shall supply 250 ma of 24 VDC for use by others to power external devices.
15. There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad command, time-clock control, digital input, or serial communications) the bypass shall provide a dry contact closure that will signal the damper to open (motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a bypass system input and allows motor operation. Up to four separate safety interlock inputs shall be provided. When any safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close. This feature will also operate in Fireman’s override / smoke control mode.
16. The bypass control shall monitor the status of the VFD and bypass contactors and indicate when there is a welded contactor contact or open contactor coil. This failed contactor condition shall be indicated on the bypass LCD display, programmed to fire a Form-C relay output, and / or over the serial communications protocol.
17. The bypass control shall include a programmable time delay for bypass start and keypad indication that this time delay is in process. A Form C relay output provides a contact closure to signal the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates at full speed in the bypass mode. The time delay shall be field programmable from 0 – 120 seconds.
18. There shall be a keypad adjustment to select manual or automatic transfer bypass. The user shall be able to select via keypad programming which drive faults will result in an automatic transfer to the bypass mode and which faults require a manual transfer to bypass. The user may select whether the system shall automatically transfer from drive to bypass mode on the following drive fault conditions:
  - a. Over current



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- b. Over voltage
  - c. Under voltage
  - d. Loss of analog input
19. The following operators shall be provided:
- a. Bypass Hand-Off-Auto
  - b. Drive mode selector
  - c. Bypass mode selector
  - d. Bypass fault reset
20. The bypass shall include a two line, 20 character LCD display. The display shall allow the user to access and view:
- a. Energy savings – in US dollars
  - b. Bypass motor amps
  - c. Bypass input voltage– average and individual phase voltage
  - d. Bypass power (kW)
  - e. Bypass faults and fault logs
  - f. Bypass warnings
  - g. Bypass operating time (resettable)
  - h. Bypass energy (kilowatt hours – resettable)
  - i. I/O status
  - j. Parameter settings / programming
  - k. Printed circuit board temperature
21. The following indicating lights (LED type) or keypad display indications shall be provided. A test mode or push to test feature shall be provided.
- a. Power-on (Ready)
  - b. Run enable
  - c. Drive mode selected
  - d. Bypass mode selected
  - e. Drive running
  - f. Bypass running
  - g. Drive fault
  - h. Bypass fault
  - i. Bypass H-O-A mode
  - j. Automatic transfer to bypass selected
  - k. Safety open
  - l. Damper opening
  - m. Damper end-switch made
22. The Bypass controller shall have six programmable digital inputs, and five programmable Form-C relay outputs. This I/O allows for a total System (VFD and Bypass) I/O count of 24 points as standard. The bypass I/O shall be available to the BAS / DDC system even with the VFD removed.
23. The on-board Form-C relay outputs in the bypass shall be programmable for any of the following indications.
- a. System started
  - b. System running
  - c. Bypass override enabled
  - d. Drive fault
  - e. Bypass fault
  - f. Bypass H-O-A position
  - g. Motor proof-of-flow (broken belt)
  - h. Overload
  - i. Bypass selected
  - j. Bypass run
  - k. System started (damper opening)
  - l. Bypass alarm
  - m. Over temperature
24. The bypass shall provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in VFD or Bypass mode. The remote start/stop contact

- shall operate in VFD and bypass modes. The terminal strip shall allow for independent connection of up to four (4) unique safety inputs.
25. The bypass shall include a supervisory control mode. In this bypass mode, the bypass shall monitor the value of the VFD's analog input (feedback). This feedback value is used to control the bypass contactor on and off state. The supervisory mode shall allow the user to maintain hysteresis control over applications such as cooling towers and booster pumps even with the VFD out of service.
  26. The user shall be able to select the text to be displayed on the keypad when an external safety opens. Example text display indications include "FireStat", "FreezStat", "Over pressure" and "Low suction". The user shall also be able to determine which of the four (4) safety contacts is open over the serial communications connection.
  27. Smoke Control Override Mode (Override 1) – The bypass shall include a dedicated digital input that will transfer the motor from VFD mode to Bypass mode upon receipt of a dry contact closure from the Fire / Smoke Control System. The Smoke Control Override Mode action is not programmable and will always function as described in the bypass User's Manual documentation. In this mode, the system will ignore low priority safeties and acknowledge high priority safeties as required by UL 864/UUKL. All keypad control, serial communications control, and normal customer start / stop control inputs will be disregarded. This Smoke Control Mode shall be designed to meet the intent of UL864/UUKL.
  28. Fireman's Override Mode (Override 2) – the bypass shall include a second, programmable override input which will allow the user to configure the unit to acknowledge some digital inputs, all digital inputs, ignore digital inputs or any combination of the above. This programmability allows the user to program the bypass unit to react in whatever manner the local Authority Having Jurisdiction (AHJ) requires. The Override 2 action may be programmed for "Run-to-Destruction". The user may also force the unit into Override 2 via the serial communications link.
  29. Class 10, 20, or 30 (programmable) electronic motor overload protection shall be included.

### **PART 3 – EXECUTION**

#### **3.01 INSTALLATION**

- A. Installation shall be the responsibility of the mechanical contractor. The contractor shall install the drive in accordance with the recommendations of the VFD manufacturer as outlined in the VFD installation manual.
- B. Power wiring shall be completed by the electrical contractor, to NEC code 430.122 wiring requirements based on the VFD input current. Caution: VFDs supplied without internal reactors have substantially higher input current ratings, which may require larger input power wiring and branch circuit protection. The contractor shall complete all wiring in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

#### **3.02 START-UP**

- A. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer.

#### **3.03 PRODUCT SUPPORT**

- A. Factory trained application engineering and service personnel that are thoroughly familiar with the VFD products offered shall be locally available at both the specifying and installation locations. A toll free 24/365 technical support line shall be available.
- B. A computer based training CD or 8-hour professionally generated video (VCR format) shall be provided to the owner at the time of project closeout. The training shall include installation, programming and operation of the VFD, bypass and serial communication.

## 3.04 WARRANTY

- A. The VFD Product Warranty shall be 24 months from the date of certified start-up, not to exceed 30 months from the date of shipment. The warranty shall include all parts, labor, travel time and expenses. A toll free 24/365 technical support line shall be available.

**End of Section**

**APPENDIX A– LIST OF SUB-CONTRACTOR**

The Bidder proposes to sublet the following portions of the Work to the persons firms or corporations indicated. The Bidder (Contractor) is responsible for all pricing with all subcontractors.

The Bidder submits that in proposing the under mentioned subcontractors, the Bidder has consulted each and have ascertained to our completed satisfaction that those names are fully acquainted with the extent and nature of the work and that they will execute their work with the requirements of the contract documents.

<b>Work or services to be provided</b>	<b>Name and address of sub-contractor or person</b>	<b>Telephone</b>

<b>Name of Bidder:</b>	
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**APPENDIX B- BUILDING IDENTIFICATION & EQUIPMENT - REQUIREMENTS**

<b>Building Identification</b>	<b>Equipment - Requirements</b>	<b>Capacity</b>
<b>Africa Pavilion</b>	4- fan motors Run permissive damper interlock All safeties to be left operational Starter to be modified as required	50 HP, 208-230 / 3 PH  1770 RPM
<b>Indo Malaya Pavilion</b>	3- fan motors Run permissive damper interlock All safeties to be left operational Starter to be modified as required	30 HP, 208-230 / 3PH  1770 RPM
<b>Austral Asia Pavilion</b>	1-fan motor Run permissive damper interlock All safeties to be left operational Starter to be modified as required	15 HP, 208-230 /3 PH  1755 RPM
<b>Americas Pavilion</b>	1-fan motor Run permissive damper interlock All safeties to be left operational Starter to be modified as required	15 HP, 208-230 / 3 PH  1765 RPM
<b>Administrative Support Centre</b>	2-fan motors Run permissive damper interlock All safeties to be left operational Starter to be modified as required	10 HP, 575 / 3 PH  1725 RPM
<b>Membership</b>	1-fan motors Run permissive damper interlock All safeties to be left operational Starter to be modified as required	10 HP, 575 / 3 PH  1760 RPM