ABU DHABI SEWERAGE SERVICES COMPANY (ADSSC)

GENERAL SPECIFICATION FOR ELECTRICAL WORKS

DIVISION 16 ELECTRICAL

SECTION 16130 VARIABLE FREQUENCY DRIVES (VFD)

DOCUMENT CONTROL SHEET

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01	April 2008	First Issue.
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1. GENERAL REQUIREMENTS

a) All items described within this section shall comply with the provisions of Section 15001: General M&E Requirements.

b) Variable Frequency Drives (VFD) shall be of solid-state, static voltage source type, using minimum 32-bit microprocessor or the latest available, digital sine wave approximation Pulse Width Modulation (PWM) type suitable for the applications, controlling mainly pumps with variable torque characteristics.

c) The VFD shall confirm to CE compliance and UL approved to Standard 508C.

d) The VFD and associated control equipment shall be housed within a cubicle forming part of the relevant Factory Built Assembly (FBA) such as a MCC. A standalone control panel, however, may be provided depending on the design and application that requires special ventilation arrangements and due to space constrains within the MCC cubicles. If so, the detailed technical proposal shall be submitted for ADSSC review and approval.

e) The VFD shall be of proven design to provide high pump efficiency, high availability, minimum maintenance, substantial energy reduction, and longer bearing and seal life at reduced speeds.

f) The VFD shall control pump speed by employing advanced torque control techniques and auto tuning that measure and set all constant and critical parameters of the motor automatically.

g) The VFD cubicle shall be considered as a starter with the addition of a VFD with display unit and a keypad, and therefore shall comply with the requirements of Section 16030: Motor Control Centre and Section 16070: Starters.

h) The Contractor shall provide a properly matched pump-motor-cable-drive system for the specific duty operating in conjunction with VFD considering load–torque characteristics, kW rating, efficiency, thermal capacity, power factor improvement, EMI mitigation, etc. This shall include the use of braided and armoured field cable, if required by the VFD manufacturer.

i) Braided cable shall be used with VFDs, in any event, if the cable length exceeds 100m or the cable passes near a source of large electromagnetic interference (such as a large motor or HV cables).

j) If required, the VFD shall incorporate output reactors to negate the effects of cable capacitance and ensure correct operation of the VFD.

k) The pump driving motor speed shall be variable between maximum speed at full load and at any intermediate speed down to a tenth of full load speed by means of a variable frequency from the VFD to provide a constant torque availability at any speed with a starting torque of 1.5 times full load torque at maximum speed. The VFD shall be capable of supplying the motor continuously at any frequency.

l) The VFD shall utilise a full-wave bridge design incorporating diode rectifiers or semi-controlled bridge consisting of diodes-thyristors combination or 6-pulse/12-pulse converters (whichever satisfy regulations pertaining to reduced harmonics distortion) or the latest available technology.

m) A dc link choke-smoothing reactor shall be included to limit fault throughput.

n) Thyristors shall be chosen to have a rating of 2.5 times the normal peak working voltage. A capacitor/resistance network shall suppress voltage peak transients for every thyristor and excessively high rates of change of voltage (dv/dt) shall be limited by a "snubber" network. Voltage spikes, which may be detrimental to any solid-state component or relay, shall be suppressed by suitable networks.

o) Thyristors shall be capable of maintaining continuously 10% in excess of the current imposed by the maximum load conditions, and be protected against current overloads caused by malfunction of components or circuitry within the inverter or external loads. Overcurrent protection and rate of current rise (di/dt) in the thyristors shall be controlled by electronic current limiting devices, which shall cause trip current circuits to operate.

p) Thyristor heat sinks shall be provided with thermostats, which shall effect tripping in the event of excessive temperatures occurring.

q) Printed circuit boards shall confirm to BS 4584 (IEC 60249), or other approved equivalent standard, and connections by multi-way sockets suitably treated to avoid high resistances being formed between the plug and socket.

r) Anti-condensation heaters shall be provided complete with a hygrostat type switch with reasonable setting range (50-100%), which operates when the preset value of %RH exceeds above dew point. The heaters shall have OFF/AUTO control on the cubicle front door and not be in operation when the VFD is functioning.

s) The harmonics reflected in the incoming electricity supply from the VFD shall not exceed the limits set by the ADWEA. The Contractor shall be responsible for liaison with the ADWEA to ensure full compliance with their requirements.

t) Total Harmonic Distortion (THD) shall be limited to lowest level under 5% as per G5/4-1 in order not to create stresses and resultant problems for the plants distribution systems. It may therefore be necessary to provide active type harmonic filter to achieve the required limits as set by ADWEA and/or G5/4-1/IEEE 519.

u) It will be necessary to conduct field test to measure the harmonics with all VFDs regardless of whether filters, reactors, chokes etc. are installed or not. If the drives do not meet the specified performance, the Contractor shall provide an acceptable solution at no extra cost.

v) The VFD shall be selected based on the following criteria:

i. User-friendly – allowing the operator to configure the VFD at site with ease.
ii. Uniform motor running at all speeds.
iii. Power factor close to unity regardless of the speed of the motor.
iv. High overall system efficiency.
v. No increase of noise in the motor.
vi. Prevents nuisance tripping due to failure of supply for a short duration.

2. CONFIGURATION, CONTROL AND PROTECTION

The VFD shall:

a) Have a self-diagnostic feature on power-up to validate memory, analogue reference, communication link and dynamic breaking (if any) and control power, etc.

b) Allow manual and automatic speed control. A dedicated built-in detachable keypad with LCD display shall be provided.

c) Be suitable derated to operate continuously at the ambient climatic conditions specified in Section 15001: General M&E Requirements.

d) Have the provision to hook-up local and remote emergency stop push buttons to ensure effective direct stopping of the drive in case of emergency without causing any damage to the VFD.

e) Be protected against short circuit between output phases and ground, analogue outputs and logic circuit.

f) Have UL listed solid state I^2t protection and a Class 10, or equivalent, overload protection as per BS EN 60947 meeting Type 2 Coordination. Semiconductor fuses providing the required protection may be permitted to use as approved by ADSSC.

g) Have a dedicated microprocessor-based electronic motor protection system, as described under Section 16090: Motor Protection Relay shall be provided for the protection of the motor.

h) A design that includes an SCR heat-shrink construction for heat transfer.

i) Have a programmable fold back function that will sense a controller/motor overload condition and fold back the frequency to avoid a fault condition.

j) Include semiconductor Metal Oxide Varistors (MOVs), or other approved equivalent method, for protection against voltage surges.

k) Have the following features built in: PID; auto start; multiple pump control; reverse run protection and restart after instantaneous power failure.

l) Self-configure to the Mains operating voltage and frequency.

m) Upon power up, first check availability of connected motor and then update its memory by storing the new data, compare the data, auto tune by optimising the operating characteristics and run the motor.

n) Be factory configured and preset requiring minimal site adjustment during commissioning.

o) Have an output frequency controllable between 0–120Hz.

p) Have an ac presettable fault current limiting facility provided to ensure that when a setting is exceeded voltage and frequency are automatically controlled.

q) Facilitate field adjustment of the following parameters as minimum:

   i. Motor acceleration 0-600 seconds.
   ii. Motor deceleration 0-600 seconds.
   iii. Voltage to frequency ratio boost in proportion to load torque.
   iv. Compensation for motor slip from 0-5% with varying load torque.
   v. Minimum frequency set control.
   vi. Maximum frequency set control.
   vii. Presentable current limit facility.

r) Retain and record run and fault status with a minimum 8 last faults conditions.

s) Be provided with inputs and outputs, as a minimum, user configurable for interface with a third-party control system and remote connection, as follows:

   i. 1 No. Analogue Input 4-20mA.
   ii. 1 No. Analogue Output 4-20mA.

iii. 1 No. Analogue Input 0-10V dc.
iv. 1 No. Analogue Output 0-10V dc.
v. 3 No. Discrete Input.
vi. 2 No. Discrete Output.

t) Be provided with communication interface and facility to integrate the operation of the system. The communication protocols e.g. Profibus, Modbus, etc. shall be compatible with other system equipments such as PLC, RTU, etc.

u) Be provided with a detachable LCD display unit with 3-metre cable length suitable for mounting on the cubicle door. The VFD shall allow the program stored in one drive to copy in another drive by using the display unit and supplied software. The interconnecting cable and associated accessories, together with a user manual, must accompany the VFD.

v) The Contractor shall furnish details of the specific installation and cable length to the VFD manufacturer and obtain, in writing, the recommended size, type and specification of power and control cables used between the VFD and the motor.

w) Be provided with additional control and accessories, if any deemed necessary to meet the operating logic, as described in the particular requirement.

x) Include protective feature(s) not listed in the specification but recommended by the manufacturer in order to avoid damage to VFD/Motor.

y) Be capable of being equipped with a multicore power cable that is armoured, braided, cross-bonded and XLPE insulated.

3. OPERATING CHARACTERSTICS

The VFD shall:

a) Convert 415V 3-Phase 50Hz power to an adjustable voltage and frequency for controlling the speed of the pump. The output voltage shall vary proportionally with the output frequency to maintain a constant volts/hertz value up to a nominal frequency. Above nominal frequency, the output voltage shall remain constant.

b) Closely approximate actual sine wave current throughout the speed range of the drive.

c) Have a frequency resolution of 0.01Hz.

d) Not be sensitive to line notching from other VFD(s) operating nearby.

e) Be capable of passing through a momentary power outage of 3 cycles without causing the drive to trip.

f) Have an adjustable IR compensation (voltage boost) control capable of providing 100% starting torque from the motor. The control shall be adjustable and provide the additional voltage only at the frequency range required starting the motor.

g) Automatically restart after a power loss.

h) Continuously monitor its output current and frequency, and should the drive be operating in current limit or below 10Hz for 10 seconds (stall condition) the VFD will shut down.

i) Allow site configuration of the parameters to match the applications' requirements.

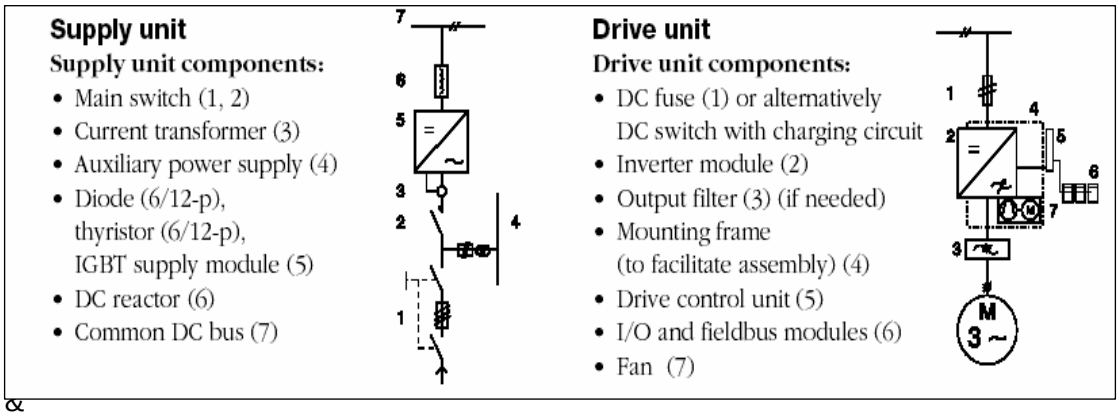
j) Have the capability to avoid up to five critical operating ranges.

k) Be capable of operating at 97% or more efficiency at full load.

l) Operate at a power factor of >96%.

m) Be capable of operating with output open-circuited.

n) Be capable of regenerating power from the motor to the DC bus for controlled deceleration. The maximum deceleration rate shall be determined by the losses in the drive system and be constant and independent of motor speed.



DC Power and Control components of a Typical Drive System

4. SOURCE TESTS

a) The VFD shall be functionally tested with a motor connected to assure proper operation at service and climatic conditions as specified in Section 15001: General M&E Requirements.

b) Certified factory test report listing all tested parameter and protective features together with testing procedure shall be submitted for ADSSC review prior to the ADSSC witness test.

5. FIELD TESTS

a) System validation tests shall be performed as described under Section 15001: General M&E Requirements.

b) The integrated site test on VFD, motor and all other associated devices shall be conducted to verify the input and output current, voltage, frequency, power factor, acceleration and deceleration rate, etc. in accordance with the equipment's operating characteristics.

c) The VFD shall be tested at different operating conditions by adjusting parameters (25, 50, 75 and 100%).

d) The power system shall be tested for harmonics, line notching and for RFI/EMI in cable circuits and in the air.

e) Tests shall be performed during normal plant operation and during operation with the emergency generator, if appropriate.

f) The test results so obtained shall be used to calculate the Total Harmonic Distortion (%THD) and compare the same with IEEE 519, G5/4 and ADWEA regulation.

g) The manufacturer's engineer shall conduct all tests on site.

h) Upon completion of site test, a duly signed report listing all tests and checks together with all supporting documents and drawings, where applicable, shall be submitted by the Contractor to ADSSC for review prior to inviting ADSSC to witness the tests.

END OF SECTION