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BuildingName
The Description of the Project
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SPECIFICATION DIVISION 23

NUMBER SECTION DESCRIPTION

END OF CONTENTS TABLE

AUGUST 2105: UPDATE TO IMPROVE CROSS WHEEL LEAKAGE REQUIREMENTS, ADD ROTATION DETECTION DEVICE, IMPROVE BEARING REQUIREMENTS, MODIFY DUAL BELT REQUIREMENT TO ALLOW SPARE BELTS ILO DUAL BELTS, PROVIDE AHRI CERTIFICATION DOCUMENTS, ADD FACTORY TESTING REQUIREMENT, ADVISE DO NOT USE WHEELS IN HAZARDOUS EXHAUST, ADD SOURCE QUALITY CONTROL SECTION, AND MISC. MINOR IMPROVEMENTS, ALL AS A RESULT OF FIELD EXPERIENCE. D. KARLE FOR HVAC MTT.

MAY 2016: REVISED TO ADD INNERGYTECH AND DROP DRI DUE TO DRI NOT BEING ABLE TO COMPLY WITH THE SPECIFICATION. ADDITIONAL MINOR REVISIONS. D. APPEL FOR HVAC MTT. NEVER ISSUED AS MASTER.

DECEMBER 2016: UPDATED TO DROP MOTORS AS A RELATED SECTION TO ALLOW WHEEL MFR.S TO SUPPLY SPECIALTY MOTORS THAT ALLOW SLOW ROTATION OF THE ENERGY WHEEL WHEN DRIVEN BY VFD. ALSO TO POST THE APPEL MAY 2016 CHANGES THAT HAD NEVER BEEN ISSUED AS A MASTER SPEC. D. KARLE FOR HVAC MTT.

DIVISION 23
SECTION 237213 – ROTARY AIR-TO-AIR ENERGY RECOVERY WHEELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Standard General Conditions, Supplemental General Conditions, Division 01 Specification Sections, and other applicable Specification Sections, in particular the Related Sections listed below, apply to this Section.

IN 1 AND 2 BELOW, SELECT PROPER SPEC SECTION NUMBER BY PROJECT. DELETE SUSTAINABLE DESIGN / LEED IF NOT APPLICABLE TO PROJECT.

B. Related Sections:

1. Section 018113: Sustainable Design Requirements.
2. Section 019100/019110: Facilities Commissioning
3. Section 220500: Common Work Results for Mechanical
4. Section 220514A: Variable Frequency Drives (Constant Torque)
5. Section 237323: Custom Air Handling Units
6. Section 237324: Semi Custom Air Handling Units
7. Section 230900: Mechanical Systems Controls
8. Section 230593: Testing, Adjusting and Balancing
9. Division 26: Electrical

1.2 SUMMARY

A. Products specified in this section include the following:

1. Desiccant coated rotary air-to-air heat exchangers for the recovery of sensible and latent energy.
2. Rotary air-to-air heat exchangers for the recovery of sensible energy.

1.3 SUBMITTALS

A. Product Data: For each energy recovery wheel indicated, provide the following:

1. Complete performance data including sensible, latent and total effectiveness as well as pressure drops, cross-leakage (EATR & OACF) at scheduled conditions using an AHRI certified software shall be provided. In the case of unbalanced airflows (supply/return), the wheel manufacturer shall confirm that the energy recovery wheel meets the ASHRAE 90.1 minimum 50% Enthalpy Recovery Ratio.
2. AHRI component official certificates shall be provided to confirm model number, certification software name and version.
3. Motor ratings, manufacturer, electrical characteristics, and motor accessories.
4. Belt, gear reducer, coupling, and tensioner, or direct drive data.
5. Identify the minimum and maximum rotor speed and the design frequency of the variable frequency drive associated with each speed. A minimum of 80:1 speed ratio shall be achieved by the motor/VFD package. To ensure constant torque operation, VFD's shall be used in vector mode. Volt-Frequency (V/f) mode shall be avoided for its limited low speed performance.
6. Rotation detection device
7. Certified bearing calculations demonstrating that air handler quality minimum L-10 200,000 hour rotor bearings will be provided.
8. Materials, gages and anti-corrosion finish data.

B. Shop Drawings:

1. Project specific drawings with dimensions of each wheel assembly.

ASHRAE 84 DATA WILL PROVIDE DATA CLOSE TO OR AT PROJECT DESIGN CONDITIONS V. EXTRAPOLATED DATA BASED UPON AHRI CERTIFICATION AND THEREFORE IT IS IMPORTANT TO REQUIRE ASHRAE 84 DATA TO ASSURE WHEEL PERFORMANCE.

C. Submit AHRI Certification sheet for each specific wheel model proposed. Also submit independent testing in accordance with the full ASHRAE Standard 84 requirements showing, as required, recovery efficiencies at 400 to 1000 ft/min in 100 cfm increments and for flow ratios from 1.0 to 0.5 in 0.1 ratio increments.

CROSS CONTAMINATION DATA IS REQUIRED IF THE WHEEL IS TO BE USED FOR A LABORATORY. IF NOT USED IN A LAB APPLICATION, DELETE THE BELOW PARAGRAPH.

D. Using the design static pressure values, the official AHRI 1060 performance data shall not exceed the limits of ASHRAE 62.1 for air class 1, 2 or 3. For projects requiring lower EATR values (less than 5%), the energy recovery wheel certified data shall not exceed the maximum value.

E. The wheel media shall not promote the growth of mold or bacteria. Official test results per AATCC30 (mold) & ISO 846c (bacteria) shall be provided upon request.

F. Installation, operation, and maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts to be provided (belt driven wheels only):

1. One spare rotor belt.

1.5 QUALITY ASSURANCE

A. Manufacturers and Products: The products and manufacturers specified in this Section establish the standard of quality for the Work. Subject to compliance with all requirements, provide specified products from the manufacturers named in Part 2.

B. Reference Standards: Products in this section shall be built, tested, and installed in compliance with the specified quality assurance standards; latest editions, unless noted otherwise.

1. AHRI 1060 - Performance Rating for Air-to-Air Exchangers for Energy Recovery Ventilation Equipment
2. ASHRAE Standard 111 Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation and Air-Conditioning Systems
3. ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality
4. ASHRAE 84 - Method of Testing Air-to-Air Heat/Energy Exchangers
5. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems
6. ASTM E84 - Standard Test Method of Surface Burning Characteristics of Building Materials
7. UL 1812 - Standard for Ducted Heat Recovery Ventilators
8. NFPA 70 - National Electric Code.
9. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
10. NEMA MG-1 - National Electrical Manufacturers Association Motor Standards.
11. SMACNA - HVAC Duct Construction Standards- Metal and Flexible
12. AABC - National Standards for Field Measurement and Instrumentation - Total System Balance", Current Volume and Supplements
13. NEBB - Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems

1.6 DELIVERY, STORAGE AND HANDLING

A. Ship all components in weather-proof wrap for storage outdoors. Protect wheels, housings, control panels, and any other sensitive components with heavy plastic or other durable means to ensure cleanliness and prevent damage during shipping and storage. Maintain protection during installation.

1.7 WARRANTY

A. Provide a complete warranty for **parts and labor** for a minimum of **ten** years from the date of Substantial Completion. Exception: Belts shall be warranted 1 year.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:

1. Semco LLC
2. Innergytech Inc

2.2 ENTHALPY ENERGY RECOVERY WHEELS

A. General

ROTARY AIR-TO-AIR HEAT EXCHANGERS SHOULD NOT BE USED IN HAZARDOUS EXHAUST SYSTEMS.

THIS SPECIFICATION IS WRITTEN ASSUMING THE ENERGY RECOVERY WHEEL WILL BE INSTALLED IN AN AIR HANDLER/ENERGY RECOVERY UNIT, AND THEREFORE ACCESS DOORS WILL BE PROVIDED ON ALL FOUR SIDES OF THE WHEEL PER THE SPECIFICATION FOR THAT EQUIPMENT. IF THE WHEEL IS TO BE INSTALLED IN DUCTWORK, THE DESIGNER MUST DESIGNATE ACCESS DOORS OR PANELS UPSTREAM AND DOWNSTREAM OF BOTH SIDES OF THE WHEEL TO PERMIT ACCESS.

FAN LOCATIONS SHOULD BE CAREFULLY SELECTED TO CREATE A POSITIVE PRESSURE DIFFERENTIAL AT THE WHEEL (HIGHER STATIC ON THE SUPPLY VS RETURN SIDE).

1. The recovery wheel assembly shall be furnished in an air handler casing. Recovery wheel casing construction and performance shall match that of the associated air handler/energy recovery unit of which the recovery wheel is a component.
2. Recovery wheel manufacturer shall provide a complete sequence of operation to allow the Owner's Direct Digital Control System to provide proper recovery wheel control. The sequence shall include how motors speed is to be adjusted to optimize heat recovery, the minimum and maximum motor frequency/speed, summer/winter change-over, economizer mode, and defrost control.

B. Performance

1. The energy recovery wheel manufacturer must participate in the AHRI certification program, and the energy recovery wheel performance submitted must come from AHRI certified selection software. The recovery wheel shall bear the AHRI Certification Seal and be UL 1812 listed.
2. The submitted performance data must meet or exceed both the sensible and latent performance requirements indicated on the project equipment schedule. The pressure loss data must be no greater than indicated on the project equipment schedule.
3. The recovery wheel shall meet NFPA 90A requirements for flame spread and smoke generation when tested per ASTM E84.

4. The manufacturer shall guarantee that the performance requirements stated below and scheduled on the project drawings will be met by the recovery wheel as installed at the project site, when tested per ASHRAE Standard 84 and AHRI STANDARD 1060. The manufacturer similarly guarantees all Application Ratings submitted for review. The Owner reserves the right to field verify that the performance requirements and Application Ratings were met by testing in accordance with ASHRAE Standard 84/AHRI STANDARD 1060, utilizing an independent testing agency. The Owner may also field verify seal leakage and purge volume at the actual wheel pressure differentials by measurement and calculation, utilizing NEBB or AABC air flow measurement procedures. The Owner has exclusive right to select the testing agency. Recovery wheels found deficient of any performance requirement shall be corrected and retested by the manufacturer (utilizing the testing agency that performed the original tests) without additional cost to the Owner until all the requirements are achieved.
5. The Exhaust Air Transfer Ratio (EATR) shall be less than 1 percent at the scheduled air flow and pressure conditions. The purge volume required to achieve this EATR shall not exceed the purge volume indicated by the scheduled air flows.

THE BELOW PARAGRAPH REQUIRES THAT LESS THAN 10% LEAKAGE OCCUR FROM THE EXHAUST TO THE SUPPLY SIDE OF THE RECOVERY WHEEL WITH THE PURGE SET TO ZERO. ASHRAE 62.1-2010 PERMITS UP TO 10% LEAKAGE OF AIR THAT IT DEFINES AS CLASS 2, FOR EXAMPLE TOILET EXHAUST. THIS ALLOWS THE RECOVERY WHEEL TO BE USED IN CLASS 2 AIR WITHOUT THE NEED FOR PURGE AIR, WHICH WASTES ENERGY AND REQUIRES THAT APPLICABLE AIR HANDLING UNIT FANS BE OVERSIZED TO ACCOMMODATE THE PURGE. HOWEVER, THE DESIGNER NEEDS TO WEIGH ANY DISADVANTAGES THAT MAY OCCUR IF THE PURGE SECTOR IS SET TO ZERO. FOR LOW RISK APPLICATIONS INVOLVING CLASS 2 AIR, DESIGNERS SHOULD STRONGLY CONSIDER SPECIFYING THAT THE PURGE BE SET TO ZERO. FOR HIGH RISK APPLICATIONS SUCH AS HOSPITAL AND LABORATORY GENERAL EXHAUST A PURGE ANGLE SHOULD BE SET. ALSO NOTE THAT THE WORDING BELOW "RECIRCULATION FROM LEAKAGE, CARRYOVER, OR TRANSFER FROM THE EXHAUST SIDE SHALL NOT EXCEED 10.0 PERCENT OF THE OUTDOOR INTAKE FLOW" IS TAKEN FROM ASHRAE 62.1 AND SHOULD NOT BE MODIFIED INDISCRIMINATELY.

6. With the adjustable purge sector set to zero degrees (zero purge), recirculation from leakage, carryover, or transfer from the exhaust side shall not exceed 10.0 percent of the outdoor intake flow at a differential pressure between the supply and exhaust/return air streams at the recovery wheel location of up to 12 inches water column.

C. Rotor Media:

FOR CORROSIVE SERVICE A MORE ROBUST COATING THAN MFR.'S STANDARD ANTI-CORROSION COATING MAY BE APPROPRIATE. CONTACT MFR. FOR OPTIONS.

1. The heat transfer substrate shall be constructed of aluminum formed into a honeycomb media structure. Non-metallic substrates made from paper, plastic, synthetic or glass fiber media are not acceptable.

2. The faces of the substrate surfaces shall have an anti-corrosion and anti-microbial coating.
3. The faces of the recovery wheel shall be sealed with a two part acid resistant coating that limits surface oxidation.
4. Dry particles up to 800 microns shall pass freely through the media.
5. The media shall be cleanable with hot water and mild detergent, without degrading the sensible or latent recovery capabilities of the energy recovery wheel system.
6. Desiccant coating:
   a. All substrate surfaces shall be coated with a non-migrating solid absorbent desiccant layer prior to being formed into the honeycomb.
   b. The desiccant coating shall be applied to both surfaces of the aluminum substrate.
   c. The desiccant shall be an inorganic 3Å molecular sieve type certified by the manufacturer to have an internal pore diameter distribution which limits adsorption to materials not larger than the critical diameter of a water molecule (2.8 Å).

DO NOT DELETE EQUAL SENSIBLE AND LATENT PARAGRAPH BELOW. EQUAL SENSIBLE AND LATENT HEAT TRANSFER CAPABILITY ALLOWS THE WHEEL TO OPERATE AT MUCH LOWER TEMPERATURES WITHOUT FROSTING, INCREASING HEAT RECOVERY SAVINGS SIGNIFICANTLY.

   d. Provide official software selection data for the selected unit at the 100% cooling and heating conditions demonstrating that desiccant loading delivers equal sensible and latent heat transfer from the rotor assembly.
   e. An independent test from a credible test laboratory shall document that the desiccant material utilized does not transfer pollutants typically encountered in the indoor environment. The independent test report shall document the ability of the media to limit the transfer of chemical pollutants to within OSHA PEL's for acetaldehyde, isopropyl alcohol, propane, methane, MIBK, methanol and xylene.

THE BELOW SAMPLE LANGUAGE (IN HIDDEN TEXT) FOR AN ANTIMICROBIAL AGENT MAY BE APPROPRIATE FOR HOSPITAL AND OTHER CRITICAL APPLICATIONS. IF REQUIRED, VERIFY WITH WHEEL MFR.S EXACTLY WHAT CAN BE SUPPLIED, THEN REVISE THE BELOW AFTER UN-HIDING THE TEXT.

   f. The media shall be treated with an antimicrobial agent, tested and certified by an independent testing agency for effective antimicrobial action and bacteria-static properties in an energy recovery wheel (or functionally equivalent) application. .

D. Rotor Assembly

FOR CORROSIVE SERVICE A MORE ROBUST COATING THAN MFR.'S STANDARD ANTI-CORROSION COATING MAY BE APPROPRIATE. CONTACT MFR. FOR OPTIONS.

1. Rotor media shall be supported in a spoked rotor-wheel system constructed of an extruded aluminum ring and extruded aluminum spokes and welded or bolted construction. All rotor assembly surfaces shall be coated with an anti-corrosion coating except aluminum and stainless steel components.

2. The rotor media shall be provided in segments to allow for field erection or replacement of one section of media at a time by removal from the rotor face. Provide as many segments as necessary to allow the media segment to be removed through the air handler/energy recovery unit rotor section access door. Media segments shall be compressed in place independent of other segments and shall not be secured with adhesives or silicone.
3. The rotor shall be supported by grease lubricated or lubricated for life air handler quality tapered roller or ball bearings in pillow block housings. The bearings shall be selected to provide a minimum L-10 life of 200,000 hours at maximum operating speed and horsepower. Bearing calculations shall be provided. It shall be possible to replace the bearings without removing the rotor or rotor shaft. Shaft journals shall be machined to proper tolerance as specified by the bearing manufacturer. The Shaft shall be machined to provide a shoulder against the bearings to eliminate any lateral movement of the rotor due to axial bearing loads. When provided, grease fittings shall be easily accessible.
4. The rotor structural support framework shall be aluminum, galvanized or epoxy painted tubular steel, welded construction, and suitably braced for rigging and operation to assure all performance requirements are achieved.
5. The deflection of the entire rotor assembly, as measured at the outer radius for wheels under 10 foot in diameter, shall not exceed 1/32" at the scheduled maximum rotor air pressure drop and at the maximum pressure difference between the exhaust/return and the supply side of the recovery unit.
6. Provide a field adjustable purge sector, factory set. Mark the factory set purge sector position.
7. Rotor seals shall be non-contact multi-pass labyrinth type, secured and field adjustable via an aluminum retainer or stainless steel or aluminum clips, adjustable by means of slots and bolts, and factory set to the rotor manufacturer's specified gap required to achieve the specified leakage values. When subjected to a pressure difference up to 12 in. w.c., the seal system shall be undamaged and shall achieve the specified leakage rates and all other performance requirements when the pressure difference is restored to the design operating range.

E. Rotor Drive System

1. Provide motor, speed reducer, and enclosed/beltless direct drive system or V-belt riding in a groove in the rotor rim to eliminate side-to-side movements and slippage. Provide a spare belt for belt driven wheels.
2. Speed reducers shall be grease lubricated and easily removable from motor.

RE. BELOW PARAGRAPH: A RECOVERY WHEEL THAT CAN'T BE SLOWED ENOUGH RESULTS IN LESS ENERGY SAVINGS BECAUSE IT MUST BE TURNED OFF EARLIER DURING MILD OUTSIDE AIR CONDITIONS TO AVOID OVER-RECOVERY AND OVER-SHOOT OF THE AIR TEMPERATURE SET POINT. THE DESIGNER SHOULD ESTABLISH PROJECT SPECIFIC MINIMUM AND MAXIMUM ROTOR SPEEDS WITH THE WHEEL MFR. AND SCHEDULE BOTH ON THE DRAWINGS. ASSURE THE MINIMUM ROTOR SPEED IS LOW ENOUGH TO ALLOW CONTINUED RECOVERY UNDER FROST AVOIDANCE AND MILD CONDITIONS. A

MODULATING DAMPER IN A BYPASS AROUND THE WHEEL ON THE EXHAUST SIDE MAY BE A BETTER SOLUTION THAN TRYING TO OPERATE THE ROTOR AT VERY LOW SPEED.

3. The motor/speed reducer/belt or direct drive system shall provide smooth control of the rotor speed throughout the minimum and maximum rotor speed range scheduled. The gear reducer motor speed in all cases shall be adjustable between a range of not less than 0.75-60 hertz without motor or speed reducer damage, when operated with a variable frequency drive that complies with Related Section 220514A.
4. Locate the motor and gear reducer in the supply air stream in an easily accessible location.
5. Provide a rotor rotation detection device compatible with the Owner's Building Automation System (BAS) that provides a dry electrical contact that automatically closes when the rotor rotates and automatically opens when the rotor stops. Provide conduit routed from the detection device to the exterior of the air handler to allow connection to Owner's BAS.

F. Variable Frequency Drive

1. Energy recovery wheel manufacturer shall provide a variable frequency drive for variable speed control of the energy recovery wheel. The inverter shall include all digital programming with a manual speed adjustment on the front of the inverter. The drive system shall allow for an energy recovery wheel turndown ratio of 80:1 (20 rpm to 1/4 rpm).
2. Refer to specification section 220514A for further requirements.

2.3 SENSIBLE ENERGY RECOVERY WHEELS

A. Provide sensible energy recovery wheels matching all the requirements specified for Enthalpy Energy Recovery wheels with the exception that desiccant coating shall not be provided and replaced with phenol-epoxy coated aluminum.

2.4 SOURCE QUALITY CONTROL

A. Recovery wheels shall be assembled with the respective air handling equipment and factory tested prior to shipping to validate the performance requirements indicated below. Provide all temporary equipment required to perform testing. Correct deficiencies at the factory prior to shipping.

B. Testing shall comply with ASHRAE Standard 111. Submit proposed test procedure to the University representative for approval, detailing methods, equipment, and techniques to be employed for each specific test. Equipment will not be considered approved until written approval of testing procedures is attained. Testing must also be in accordance with Quality Assurance Standards section.

C. Tests shall meet the required acceptance criterion without the use of temporary seals.

D. At the conclusion of factory testing, a formal written report of results shall be submitted to the University Representative for approval.

E. Factory test the following:

1. Verify that supply, return, and exhaust airflow rates are within the range of 100 percent to 110 percent of the scheduled CFM requirements when operating at scheduled design total static pressure and fan brake horsepower.
2. Verify that leakage (at the design pressure differentials) between the supply and return/exhaust is less than scheduled. Rotors shall be rotated at maximum speed when taking air flow measurements to determine leakage rates.
3. Calculate the Outside Air Correction Factor (as defined by AHRI 1060). Variation from design shall be the same allowance permitted by AHRI 1060.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Store units protected from weather, dirt, water, and construction debris, and per manufacturer’s recommendations.

3.2 INSTALLATION

A. Install Energy Recovery Wheel assemblies in strict compliance with manufacturer's installation instructions and Related Sections. Maintain manufacturer's recommended clearances for service and maintenance.

B. Rig units with spreader bars and at adequate lifting points to prevent twisting and bending of the recovery wheel assembly.

C. Verify the orientation of the purge sector relative to the direction of the supply air stream.

D. Install rigid card board of plywood over both wheel faces to prevent media damage. Maintain this protection until the point the wheel is started for testing.

E. Install a complete set of filters of the same quality and efficiency as the specified permanent filters for the project, if the system into which the recovery wheel is installed is to be run for temporary service. Continuously maintain all filters and replace when pressure drop exceeds 1 inch w.c., or at manufacturer's recommended change-out pressure drop, whichever is lower.

F. The Test and Balance Contractor shall verify purge volumes and adjust the purge sector, if required, to achieve the required purge volumes. Before adjusting the purge sector consult with the wheel manufacturer for adjustment instructions.

3.3 START-UP

A. Provide a qualified service technician from the Manufacturer's staff to perform recovery wheel start-up, prior to any temporary use. Coordinate start-up of recovery wheel to occur in conjunction with air handler/energy recovery unit start-up. Coordinate visit with Test and Balance contractor. The manufacturer’s service technician shall perform the following tasks:

1. Verify correct installation of recovery wheel.
2. Grease bearings, verify motor direction and adjust belt tension if required.
3. Adjust recovery wheel seals.
4. Caulk all energy wheel components at locations recommended by the wheel manufacturer.
5. Verify purge volumes and cross wheel leakage in cooperation with the Test and Balance contractor. Adjust purge and make other corrections to achieve specified unit performance.
6. Perform any other manufacturer's recommended prestart activities.
7. Start-up wheel and verify proper operation. Verify that the rotor drive system when controlled by the variable speed drive operates across the entire speed range without motor, gear reducer, or belt problems.
8. Before leaving premises, provide the Owner’s representative a start-up report certifying that all start-up activities were completed and that the energy recovery wheel operates properly.

3.4 COMMISSIONING

A. Perform Commissioning activities per Related Sections above.

3.5 TRAINING

A. Provide a qualified service technician from the Manufacturer's staff to provide training.

B. Train Owner's maintenance personnel on start-up and shutdown, trouble-shooting, servicing and preventative maintenance procedures, minimum of 1 hour or 30 minutes per unit if multiple units were supplied. Review the data contained in the Operating and Maintenance Manuals with Owner's personnel. Training shall include belt and rotor seal adjustment, bearing greasing, motor, belt and bearing replacement, media removal, media cleaning methods, and a description of purge sector operation and what position the purge sector should be set at for the project’s particular application.

C. Schedule training with Owner with at least seven (7) days prior notice. Training and start up services are separate functions - training shall not be combined with startup services.

END OF SECTION 237213