

COMMISSIONING SPECIFICATION

This specification outlines a preliminary list of items for each individual technology or ECM task that is to be addressed as part of the Commissioning process. These items shall establish the degree of rigor required by NORES CO for complete Commissioning and are not intended to either replace or duplicate traditional construction practices, code requirements, manufacturer, and vendor prescribed measures.

NORES CO will review these specifications with all contractors and vendors to coordinate the specific actions and quality control measures that will be used to ensure each item is fully addressed.

1. LIGHTING

General Requirements

- Verify that all lighting retrofit components match project specifications.
- Confirm that all post retrofit group light levels meet or exceed pre retrofit group light levels.
- Document dates, times, operating conditions and names of parties involved with any tests performed.
- Each test form shall be reviewed and signed by the party with overall responsibility for the test as well as Customer representative if it is identified as a test that must be witnessed.
- Document procedures, forms and submissions required to initiate & maintain manufacturer's warranty.
- Provide written copies of all applicable Operation & Maintenance instructions.
- List all rejected items, failed tests, abnormalities observed or remedial action required by others that were not completely rectified during construction punchlist process.
- Document all training provided with names and signatures of parties who received training.

Electrical Items

- Any non-permanent or disposable batteries have been installed and tested and all battery locations, types, and recommended replacement intervals have been documented.
- Emergency egress and exit lights have been tested for proper sequencing from normal to emergency mode on battery and/or emergency power as applicable.
- Confirm all battery condition pilot lights and test switches are fully functional.

Mechanical and Physical Items

- Verify that new fixtures and/or existing fixture retrofit kits have been installed per specifications.
- If applicable, confirm support posts or brackets are adequately sized for weight of replacement fixture.
- If exterior installation, ensure enclosure penetrations are watertight and/or do not void weather rating.
- During operation, check that all fixtures and ballast are free of abnormal vibration or unusual noises.
- Confirm equipment, component, and device labels, tags or signs have been installed per specifications.

Additional Commissioning measures may be required for work under this section to confirm proper operation and interaction with other ECMs in integrated system tests.

2. LIGHTING CONTROLS

General Requirements

- Verify that all lighting controls components match project specifications.
- Document dates, times, operating conditions and names of parties involved with any tests performed.
- Each test form shall be reviewed and signed by the party with overall responsibility for the test as well as Customer representative if it is identified as a test that must be witnessed.
- Document procedures, forms and submissions required to initiate & maintain manufacturer's warranty.
- Provide written copies of all applicable Operation & Maintenance instructions.
- List all rejected items, failed tests, abnormalities observed or remedial action required by others that were not completely rectified during construction punchlist process.
- Document all training provided with names and signatures of parties who received training.

Electrical Items

- Any non-permanent or disposable batteries have been installed and tested and all battery locations, types, and recommended replacement intervals have been documented.
- Confirm wiring has been completed and protection devices, (fuses, breakers, etc.), have been installed to meet applicable codes and specifications.
- Verify all disconnect and/or H-O-A switches have been installed and tested. Hand=On, Off=Off, Auto=EMCS state.
- Ensure all pilot lights, control switches, touchpads and operating displays are fully functional.

Control Items

- Verify placement, orientation and field of view for Occupancy Sensors provides optimum operation, test, confirm, and adjust all sensitivity and time delay settings. Provide list of all final delay settings.
- Confirm location and adjustment of all sensors and controls used for Daylight Harvesting or Lumen Maintenance provide desired light levels at work surfaces and are free from unwanted interference.
- Adjust sequencing, start time, stop time and override processing for all Sweep-Off controllers.
- Set upper and lower limits of Manual Dimming controls as appropriate.
- Check all schedules and interfaces of EMCS controls with EMCS contractor.
- Provide copies of all programming settings and schedules.

Mechanical and Physical Items

- Verify that controls have been installed per specifications.
- If exterior installation, ensure enclosure penetrations are watertight and/or do not void weather rating.
- Check that adequate clearances exist for fixture cooling air and routine service.
- Ensure that all guards, shields and protective covers have been re-installed.
- Confirm components are not installed in locations subject to temperatures beyond manufacturer's published operating limits.
- Verify panel and enclosure locations are not subject to excessive moisture, spray, or dirt.
- Confirm equipment, component, and device labels, tags or signs have been installed per specifications.

Additional Commissioning measures may be required for work under this section to confirm proper operation and interaction with other ECMs in integrated system tests.

3. BUILDING AUTOMATION CONTROLS UPGRADES

General Requirements

- Provide an outline of individual EMS test forms to show how testing will be completed for each component added to the EMS and ensure that all components are fully commissioned.
- Outline should cover logical portions of EMS and indicate items tested, (Operator Workstation, AHU Point-to-Point Checkout, Existing Components, CHW Sensor Calibration Sheets, etc.)
- Document dates, times, operating conditions and names of parties involved with any tests performed.
- Each test form shall be reviewed and signed by the party with overall responsibility for the test as well as Customer representative if it is identified as a test that must be witnessed.
- Verify new EMS components were constructed, shipped and installed with all options specified. (Manual HOA Transducer Outputs, Workstation Data Backup, Pneumatic Valve Positioners, etc.)
- Document procedures, forms and submissions required to initiate & maintain manufacturer's warranty.
- Provide written copies of all applicable Operation & Maintenance instructions.
- List all rejected items, failed tests, abnormalities observed or remedial action required by others that were not completely rectified during construction punchlist process.
- Document all training provided with names and signatures of parties who received training.
- Provide list of all new EMS component Nameplate Data, Software and Firmware Versions, and Serial Numbers.
- As-built points lists shall include description of all equipment added, point descriptors, point numbers, wire numbers, pneumatic tube numbers, and location of each wire and tube termination.
- Document EMS architecture, network and location of new components and network cables.
- List the specific types and locations of spare points required by project specifications.
- If applicable, provide a troubleshooting logbook by the Operator Workstation for use by facility operators and EMS technicians to document facility issues and contractor responses to ongoing fine-tuning.

Electrical Items

- Confirm wiring has been completed and protection devices, (fuses, heaters, breakers, etc.), have been installed to meet applicable codes and specifications for EMS components installed.
- Ensure wire or panel grounding and shielding has been checked and meets device specifications for new components.
- Provide convenience receptacle for 120v power inside control panel per specifications.
- Verify all new disconnect and/or H-O-A switches have been installed and tested. Hand=On, Off=Off, Auto=EMS state. If H-O-A switch is to be wired in series with isolation valve end switch, verify this interlock has been wired and is working correctly as well.
- Verify all pilot lights, control switches, touchpads and operating displays are fully functional.
- Document remote start/stop, operating control, and feedback signals have been tested and calibrated.
- Document all new sensors have been calibrated and ranges match system or medium to be measured.
- Document all new feedback or proof devices, (flow switches, pressure switches, current sensors, valve end switches, etc.), have been calibrated and tested for system or equipment monitored.
- Document all new outputs and transducers have been calibrated and ranges match devices to be controlled.
- If applicable, verify interface and monitoring of any OEM equipment, (Variable Frequency Drive, Chiller Control Panel, etc.), operating parameters, faults or alarms have been completed and tested.
- Confirm any VFD critical speeds have been identified, blocked by programming, and labeled on drive.
- Ensure EMS factory recommended start-up and check-out procedures have been completed.
- Any non-permanent or disposable batteries have been installed and tested and all battery locations, types, and recommended replacement intervals have been documented.
- If applicable, document remote monitoring of EMS through dial-up or Internet connection has been completed and tested with lists of all phone numbers, modem settings, IP addresses, passwords, etc.

Pneumatic Items

- If applicable, confirm that existing control air compressor has sufficient reserve capacity to handle new EMS components without excessive cycling or run times.
- If applicable, ensure new control air compressor has been constructed and installed per specifications.
- Verify all new control air filters, dryers and regulators have been checked for adequate sizing, are free of audible leaks, and all disposable or replaceable elements have been serviced.
- Document all new tubing and piping has been installed and pressure tested per specifications.
- Confirm pressure gauges have been installed on new main supply line, at new pressure reducing stations, at entrance to all new panels, on new transducer branch lines, and at new end devices as required by specifications.
- Check and adjust control air supply pressure under normal load at all pressure reducing stations.
- Document that spring ranges of all new end devices and pilot positioners have been tested, calibrated and permanently marked on each controlled end device per specifications.

Programming and Software Items

- Document all new EMS programming sequences and strategies implemented for each piece of equipment and provide electronic copies and/or firmware of actual programming code on site for crash recovery.
- Provide lists of all new user defined system variables, (occupancy schedules, reset schedules, changeover setpoints, control loop tuning parameters, etc.), to facilitate future modifications and fine-tuning.
- Collect and print trends for all new dynamic control loops to demonstrate proper control, (timely and smooth response, lack of hunting, close to setpoint, minimal overshoot, etc.), over each range of system loads, (weather conditions, start-up, shut-down, etc.), encountered during normal operation.
- If applicable, review graphic screens to ensure they accurately reflect all equipment and systems controlled, include output ranges for controlled devices, have sufficient transfers or links to quickly navigate through related subsystems, and include narrative explanation of any non-intuitive sequences.
- If applicable, enable password protection of EMS programming and confirm password matrix of access levels and privileges has been approved and implemented per Customer requirements.
- Provide copies of programming code, software settings, and software addresses for all new field devices.
- Verify all new user-defined ramp times, staging sequences and lead lag have been reviewed with Customer representative to ensure they are compatible with facility Standard Operating Procedures.
- Confirm that all new EMS and Equipment failure modes, (Power Failure, Sensor Failure, Pump Failure, Signal or Communication Loss, Freezestat, etc.), and alarm responses have been reviewed with Customer representative to ensure they meet facility Standard Operating Procedures.
- Document that EMS and controlled equipment failure modes and alarms have been tested.
- Check that minimum operating speeds for VFD controlled equipment have been programmed.
- Confirm all new devices with clocks or calendar functions have been checked for proper dates and times.
- Verify all programming code has been synchronized between field panels and Operator Workstation.
- Check that any intermediate or test versions of programming code saved for future reference or re-use have been clearly labeled and moved to separate folders so they are not errantly re-loaded on EMS.
- Ensure a document control system is defined, documented and in place for software and firmware revisions and upgrades and that operating and maintenance staff have been trained in its application.

Mechanical and Physical Tests

- Confirm all equipment converted to automatic start/stop control by EMS has been reviewed with Customer representative to ensure that equipment is properly labeled and life safety protection measures, (horns, lights, etc.), are compatible with facility Standard Operating Procedures.
- Verify that adequate clearances exist around all new EMS components for cooling air and routine service.
- Review component locations to ensure they are not subject to temperatures beyond manufacturer's published operating limits.
- Check that panel and enclosure locations are not subject to excessive moisture, spray, or dirt.
- If exterior installation, confirm enclosure penetrations are watertight and/or do not void weather rating.
- If EMS scope includes converting flow or capacity modulation to a new strategy, (Inlet guide vanes to VFD, Three way valve to Two-way valve, etc.), document that original flow control devices have been removed and/or decommissioned as outlined in specifications.
- Check that valves and sensors are free of leaks and all valve packings have been adjusted.
- Document all new sensor locations and inputs have been tested to ensure that readings are stable and accurately reflect medium being measured, (no stratification, excessive pulsations, system effects, etc.).
- Confirm locations of devices in occupied spaces have been checked to be free of interference from furnishings or Customer owned equipment, (Printers, Computers, Copiers, etc.).
- Document all new flow control devices, (Valves, Dampers, etc.), have been tested through full range of motion to ensure complete shut off when closed, unrestricted flow when open, and smooth operation.
- Confirm equipment, component, and device labels, tags or signs have been installed per specifications.

Additional Commissioning measures may be required for work under this section to confirm proper operation and interaction with other ECMs in integrated system tests.

4. WATER SOURCE HEAT PUMP OPTIMIZATION

General Items

- Verify that all equipment was shipped and installed with all options specified.
- Provide a complete list of all equipment nameplate data and serial number(s). (This should include any available coil, pump, and motor data.)
- Document dates, times, operating conditions and names of parties involved with any tests performed.
- Each test form shall be reviewed and signed by the party with overall responsibility for the test as well as Customer representative if it is identified as a test that must be witnessed.
- Document procedures, forms and submissions required to initiate and maintain manufacturer's warranty.
- Provide written copies of all applicable Operation & Maintenance instructions.
- Document that all factory recommended start-up and check-out procedures have been completed.

- List all rejected items, failed tests, abnormalities observed or remedial action required by others that were not completely rectified during construction punchlist process.
- Document all training provided with names and signatures of parties who received training.

Heat Exchanger Items

- Verify that the total system capacity agrees with design.
- Confirm back-up loop heat source (gas boiler, oil boiler, electric boiler, etc.).
- Confirm back-up loop cooling source (closed circuit or open circuit cooling tower, other).
- Review the test and balance report for flows.
- Check that there is adequate access for service.
- Confirm that delta water temp (entering - leaving) is within design specs (heating and cooling).
- Confirm that the piping configuration is correct.
- Check that condensate drains are unobstructed, properly sloped, & trapped.
- Confirm that there are no visible water leaks, unusual noise or vibration.
- If the loop pump is equipped with a VFD check that automatic 2-way valves are installed at heat pumps.

Controls Items

- Confirm that outdoor air sensor or thermostat, computer input signal or setpoint controlled action occurs and agrees with design specifications.
- Check that loop temperature sensor or stat, computer input signal or setpoint controlled action occurs.
- Confirm that loop temperature sensor is correct.

Pump Items

- Confirm wiring has been completed and protection devices, (fuses, heaters, breakers, etc.), have been installed to meet applicable codes and specifications for new motor installed.
- Verify all disconnect and/or H-O-A switches have been installed and tested. Hand=On, Off=Off, Auto=EMCS state.
- Check motor rotation, if applicable, has been checked prior to connecting coupling or belt drive.
- If applicable, ensure that emergency power has been provided to pump and all ancillary equipment or controls that are required for unit to operate as intended during emergency mode.
- Verify that pump has been installed and supported, (Housekeeping pads, vibration isolators, seismic restraints, etc.), per specifications.
- Document that pump and motor have been aligned, grouted, or doweled per specifications.
- Confirm all piping has been completed per specifications and drawing details, (Strainers, Balance Valves, Gauges, Thermometers, Flex Connectors, Test Ports, EMCS Sensors, Insulation, etc.).

- Ensure that any required system over-pressure protection devices have been installed and match the sizes and settings called for in the specifications.
- Verify that system operating fluid has been properly tested and treated.
- Confirm all Rotating Parts are found to be free and smooth when turned by hand.
- Ensure that both pump and motor have been lubricated, if necessary.
- If belt driven, confirm that belts have been installed and tensioned per specifications.
- Check to see that all guards, shields and protective covers have been installed.
- During operation, verify pump and motor are free of abnormal vibration or unusual noises.
- If a variable speed application, ensure pump and motor are free of vibration or unusual noises through entire range of operating speeds.
- During operation, confirm that pump and associated piping are free of abnormal leaks.
- If applicable, ensure that seal or stuffing box flushing fluids are adjusted per specifications.
- Document that required NPSH is available at pump during all operating speeds and system flows.
- Verify adequate clearances exist for motor cooling air and routine service of pump.
- Review all pressure gauge and temperature sensor locations to ensure they can be read from floor level and are of proper scale or range for medium being measured.
- Confirm equipment, component, and device labels, tags or signs have been installed per specifications.

Additional Commissioning measures may be required for work under this section to confirm proper operation and interaction with other ECMs in integrated system tests.

5. AIR HANDLING UNIT (AHU) INSTALLATION

General Requirements

- Verify that AHU was constructed, shipped and installed with all options specified. (Flow Sensors, Damper Actuators, Gauges, Filters, Reheat Coils, etc.)
- Provide a complete list of all AHU nameplate data and serial number(s). (This should include any available coil, fan, and motor data.)
- Document dates, times, operating conditions and names of parties involved with any tests performed.
- Each test form shall be reviewed and signed by the party with overall responsibility for the test as well as Customer representative if it is identified as a test that must be witnessed.
- Document procedures, forms and submissions required to initiate and maintain manufacturer's warranty.
- Provide written copies of all applicable Operation & Maintenance instructions.
- Document that all factory recommended start-up and check-out procedures have been completed.
- List all rejected items, failed tests, abnormalities observed or remedial action required by others that were not completely rectified during construction punchlist process.
- Document all training provided with names and signatures of parties who received training.

Electrical Items

- Confirm wiring has been completed and protection devices, (fuses, heaters, breakers, etc.), have been installed to meet applicable codes and specifications for AHU installed.
- Verify all disconnect and/or H-O-A switches have been installed and tested. Hand=On, Off=Off, Auto=EMCS state.
- Check motor rotation prior to connecting any couplings or belt drives. If applicable, verify VFD controlled fans have been checked for proper rotation in both drive and by-pass modes.
- If applicable, ensure emergency power has been provided to AHU and all ancillary equipment and controls that are required for unit to operate as intended during emergency mode.
- Ensure all internal compartment light fixtures have been installed as specified.

Control Items

- Confirm proper operation, (Full Open = 100% Open, Full Closed = Tight Shutoff, etc.), of all valves, dampers, inlet guide vanes, and pilot positioners through full range of motion.
- Review types and locations of all AHU temperature sensors for accurate sensing, free of stratification or radiant coil energy, and documentation that they have been calibrated per specifications.
- Test operation of all Freezestats and low temperature protection devices to ensure they have been adjusted and programmed to meet facility standard operating procedures.
- Document all programming settings and test results for all low temperature protection devices.
- Review types and location of all AHU pressure sensors and airflow stations for accurate sensing and manufacturer recommended distances to adjacent fittings or transitions.
- Verify proper operation of all humidifiers and associated controls through full range of operating AHU operating speeds and humidifier output levels. Test all humidifier high limits and safeties.
- If applicable, check AHU operation through full range of operating speeds to identify any harsh vibrations or critical frequencies. Document any critical frequencies and ensure they are blocked.
- Confirm AHU Valve and Damper Failure modes (No power, Broken Belts, Freezestat, etc.) have been reviewed with Customer representative to ensure they meet facility Standard Operating Procedures.
- Test and document all AHU Valve and Damper failure modes.

Mechanical and Physical Items

- Verify AHU has been installed, (Duct configuration, section orientation, condensate pan pitch, etc.), and supported, (Housekeeping pads, vibration isolators, seismic restraints, etc.), per specifications.
- Review ductwork connections and accessories for installation issues that might prevent the AHU from operating properly, (No loose flex connectors, sharp inlet/outlet transitions, etc.).
- Ensure motor and drive components have been aligned and tensioned to specifications.
- Check to see that all enclosures, shrouds, guards or access panels are securely in place.

- If applicable on high-pressure VAV units, document that pressure relief panels of proper size and pressure rating have been installed in specified locations.
- Confirm adequate clearances exist for routine service of all Motors, Controls, Dampers, Valves, etc.
- Review outside air intake openings to ensure they are free of pollution sources such as trash, cooling tower mists, building exhaust, vehicle exhaust, or other sources that could impact indoor air quality.
- Verify AHU location is not subject to excessive moisture, spray, vibration, or dirt. If exterior unit, confirm adjacent structures will not cause damage from falling snow or ice.
- Ensure all AHU Coil piping and piping accessories, (Strainers, control valves, balance valves, Pete's plugs, etc.) have been installed and/or cleaned per specifications and are free of leaks.
- Check all access doors for proper sealing and that door swings open against system pressure.
- Confirm all specified access doors or access panels have been provided for routine service.
- On units with cooling coils, check that condensate piping has been trapped per specifications, that provisions have been made for priming traps, and that traps have been primed prior to testing.
- Verify all thermal insulation and sound attenuation has been installed per specifications.
- Confirm motor has been lubricated, if necessary, and all remote grease, oil or vent lines specified for continued preventive maintenance have been installed.
- Ensure that proper type and efficiency of filters have been installed, are clean, and fit properly.
- Confirm there are no abnormal noises or vibrations during fan operation through full range of speeds.
- Review all pressure gauge and temperature sensor locations to ensure they can be read from floor level and are of proper scale or range for medium being measured.
- Verify piping to and from all coils has been installed per specifications and with all accessories shown on drawing detail sheets.
- Confirm equipment, component, and device labels, tags or signs have been installed per specifications.

Additional Commissioning measures may be required for work under this section to confirm proper operation and interaction with other ECMs in integrated system tests.

6. VARIABLE FREQUENCY DRIVE (VFD) INSTALLATION

General Requirements

- Verify that drive was constructed, shipped and installed with all options specified. (Manual or Electronic By-Pass, Line Reactors, Manual Speed Control, etc.)
- Provide a complete list of all VFD, (and By-Pass if applicable), nameplate data and serial number(s).
- Document dates, times, operating conditions and names of parties involved with any tests performed.
- Each test form shall be reviewed and signed by the party with overall responsibility for the test as well as Customer representative if it is identified as a test that must be witnessed.
- Document procedures, forms and submissions required to initiate & maintain manufacturer's warranty.
- Provide written copies of all applicable Operation & Maintenance instructions.

- List all rejected items, failed tests, abnormalities observed or remedial action required by others that were not completely rectified during construction punchlist process.
- Document all training provided with names and signatures of parties who received training.

Electrical Items

- Confirm wiring has been completed and protection devices, (fuses, heaters, breakers, etc.), have been installed to meet applicable codes and specifications for VFD installed.
- Measure cable length between drive output and motor terminal and confirm that it does not exceed specified minimum without approved compensating filtration.
- Verify all disconnect and/or H-O-A switches have been installed and tested. Hand=On, Off=Off, Auto=EMCS state.
- If a service disconnect is installed between the VFD and motor, confirm that disconnect has been provided with specified supervisory relays and that interlock wiring has been completed to prevent VFD from operating if disconnect switch is opened.
- Ensure all pilot lights, control switches, touchpads and operating displays are fully functional.
- Document that unit has been programmed for the specific type of equipment, (Fan, Pump, Conveyor, etc.), and motor (Volts, Phase, Amps, etc.), it serves.
- Confirm user-defined ramp times have been reviewed with Controls Contractor and Customer representative to ensure they are compatible with facility Standard Operating Procedures.
- Verify drive failure modes, (Power failure, Restart, Automatic By-Pass engage, etc.), have been reviewed with Customer representative to ensure they meet facility Standard Operating Procedures.
- Check and document that all Drive failure modes and By-Pass modes have been tested.
- Confirm and document that all minimum operating speeds have been identified and programmed.
- Document that remote start/stop, operating control, & feedback signals have been tested and calibrated.
- If applicable, document that all remote monitoring or EMCS network interfaces with drive operating parameters, faults or alarms have been tested and calibrated.
- Ensure all critical speeds have been identified, blocked by programming, and labeled on drive.
- If applicable, enable password protection of drive programming and confirm password matrix of access levels and privileges has been approved and implemented per Customer requirements.
- Provide list of all VFD and By-Pass programming parameters and settings.
- Document that all factory recommended start-up and check-out procedures have been completed.
- Verify motor rotation, in both Drive and By-Pass modes if applicable, has been checked prior to connecting coupling or belt drives.

Mechanical and Physical Items

- Verify motor has been installed and drive components are aligned per specifications.
- Ensure all bearings or gearboxes have been checked for proper type and quantity of lubricant.

- Check to see that all enclosures, shrouds and guards for rotating equipment are in place.
- During operation, verify motor is free of abnormal vibration or unusual noises.
- Confirm adequate clearances exist for VFD cooling air and routine service.
- Ensure drive location is not subject to temperatures beyond manufacturer's published operating limits.
- Verify drive location is not subject to excessive moisture, spray, or dirt.
- If exterior installation, confirm enclosure penetrations are watertight and/or do not void weather rating.
- If drive is replacing another form of flow or capacity modulation, (Inlet guide vanes, By-pass valve, etc.), document original devices were removed and/or decommissioned as outlined in specifications.
- Confirm equipment, component, and device labels, tags or signs have been installed per specifications.

Additional Commissioning measures may be required for work under this section to confirm proper operation and interaction with other ECMs in integrated system tests.

7. WINDOW UPGRADES/REPLACEMENTS

General Requirements

- Verify that all window components and accessories match project specifications.
- Document dates, times, operating conditions and names of parties involved with any tests performed.
- Each test form shall be reviewed and signed by the party with overall responsibility for the test as well as Customer representative if it is identified as a test that must be witnessed.
- Document procedures, forms and submissions required to initiate & maintain manufacturer's warranty.
- Provide written copies of all applicable Operation & Maintenance instructions.
- List all rejected items, failed tests, abnormalities observed or remedial action required by others that were not completely rectified during construction punchlist process.
- Document all training provided with names and signatures of parties who received training.

Mechanical and Physical Items

- Confirm the physical layout and orientation of each window matches the approved design drawings.
- If applicable, review structural framing to verify that any additional structural supports required to frame opening or support the window have been installed.
- Ensure that all windows have been installed per the manufacturer's installation instructions.
- Inspect window housing after all flashings have been installed to confirm that unit is set plumb and square with proper flashing and sealants between new materials and existing wall structure.
- Check that adequate clearances exist for routine service or cleaning.
- Verify all exterior enclosure penetrations are watertight and/or do not void weather ratings.

- If units are tested with water, confirm that window installation and adjacent flashings are pitched properly and are free of pooled water after test.
- Confirm equipment, component, and device labels, tags or signs have been installed per specifications.
- Ensure that mounting hardware does not subject modules to physical stress, i.e. check that structural elements are straight and not twisted.
- Perform visual inspection of all windows to check for cracked glass or deformed frame structures.

Additional Commissioning measures may be required for work under this section to confirm proper operation and interaction with other ECMs in integrated system tests.

8. BUILDING ENVELOPE IMPROVEMENTS

General Items

- Verify that all equipment was shipped and installed with all options specified.
- Provide a complete list of all equipment nameplate data and serial number(s). (This should include any available coil, pump, and motor data.)
- Document dates, times, operating conditions and names of parties involved with any tests performed.
- Each test form shall be reviewed and signed by the party with overall responsibility for the test as well as Customer representative if it is identified as a test that must be witnessed.
- Document procedures, forms and submissions required to initiate and maintain manufacturer's warranty.
- Provide written copies of all applicable Operation & Maintenance instructions.
- Document that all factory recommended start-up and check-out procedures have been completed.
- List all rejected items, failed tests, abnormalities observed or remedial action required by others that were not completely rectified during construction punchlist process.
- Document all training provided with names and signatures of parties who received training.

Mechanical and Physical Items

- Identify the R-value of the new insulation; confirm that it agrees with the ECM specifications.
- Confirm that the insulation is securely mounted to building structure.
- Validate that the existing area is dry.
- Validate that the insulation is sized properly to fit the exposed area.
- Validate the insulation is the proper thickness to meet or exceed the equipment specifications.

Additional Commissioning measures may be required for work under this section to confirm proper operation and interaction with other ECMs in integrated system tests.

9. WATER CONSERVATION RETROFITS

General Requirements

- Verify that all water conservation retrofit components match project specifications.
- Document dates, times, operating conditions and names of parties involved with any tests performed.
- Each test form shall be reviewed and signed by the party with overall responsibility for the test as well as Customer representative if it is identified as a test that must be witnessed.
- Document procedures, forms and submissions required to initiate & maintain manufacturer's warranty.
- Provide written copies of all applicable Operation & Maintenance instructions.
- List all rejected items, failed tests, abnormalities observed or remedial action required by others that were not completely rectified during construction punchlist process.
- Document all training provided with names and signatures of parties who received training.

Mechanical and Physical Items

- Verify that water conservation retrofits have been installed per specifications.
- Check that fixtures and components are free of leaks and any packing glands have been adjusted.
- Ensure that finished surfaces are patched or repaired as outlined in project specifications.
- During operation, check that all fixture components are free of abnormal vibration or unusual noises.
- Verify adequate clearances exist for routine service of fixture.
- Confirm equipment, component, and device labels, tags or signs have been installed per specifications.

Additional Commissioning measures may be required for work under this section to confirm proper operation and interaction with other ECMs in integrated system tests.

10. PHOTOVOLTAIC (PV) SYSTEM INSTALLATION

General Requirements

- For this document, PV System is defined as all components required for a complete installation per project specifications, (Photovoltaic Panels, Panel Mounting Racks, Inverters, Inverter Interfaces, Disconnects, Isolation Transformers, Safeties, Meters, Alarms, Displays, Wiring, Conduit, etc.)
- Verify that PV System was constructed, shipped and installed with all options specified.
- Provide a complete list of nameplate data and serial number(s) for all PV System components.
- Document dates, times, operating conditions and names of parties involved with any tests performed.
- Each test form shall be reviewed and signed by the party with overall responsibility for the test as well as Customer representative if it is identified as a test that must be witnessed.
- Document procedures, forms and submissions required to initiate & maintain manufacturer's warranty.
- Provide written copies of all applicable Operation & Maintenance instructions.

- List all rejected items, failed tests, abnormalities observed or remedial action required by others that were not completely rectified during construction punchlist process.
- Document all training provided with names and signatures of parties who received training.

Electrical Items

- Confirm wiring has been completed and protection devices, (fuses, heaters, breakers, etc.), have been installed to meet applicable codes and specifications for all PV System components installed.
- Verify all disconnect and/or H-O-A switches have been installed and tested.
- Ensure all pilot lights, control switches, touchpads and operating displays are fully functional.
- Document that unit has been programmed for the specific type of installation outlined in specifications.
- Verify PV System failure modes, (Power failure, Over current, Under voltage, etc.), have been reviewed with Customer representative to ensure they meet facility Standard Operating Procedures.
- Check and document that all PV System start-up, transfer to grid, transfer from grid, shutdown and failure modes have been tested.
- If applicable, document that all remote monitoring or EMCS network interfaces with PV System operating parameters, faults or alarms have been tested and calibrated.
- If applicable, enable password protection of PV System programming and confirm password matrix of access levels and privileges has been approved and implemented per Customer requirements.
- Provide list of all PV System programming parameters and settings.
- Any non-permanent or disposable batteries have been installed and tested and all battery locations, types, and recommended replacement intervals have been documented.
- Document that all factory recommended start-up and check-out procedures have been completed.
- Measure and document both DC open circuit voltage (Voc), short circuit current (Isc), and peak power (Pp), and AC voltage, frequency, amperage, and power factor at multiple sunlight and temperature conditions to establish an operating baseline and ensure they are within manufacturer's specifications. Ensure that factory performance test results of all modules have been received and properly recorded.
- If applicable, document monitoring of PV System through dial-up or Internet connection has been completed and tested with lists of all phone numbers, modem settings, IP addresses, passwords, etc.

Mechanical and Physical Items

- Confirm layout, orientation and slope/tilt of PV Panel Modules & Grid System match specifications.
- Ensure all PV System component locations are not subject to temperatures beyond manufacturer's published operating limits.
- Check that adequate clearances exist for cooling air and routine service of all PV System components.
- Verify locations of electronic enclosures are not subject to excessive moisture, spray, or dirt.
- Make sure all exterior enclosure penetrations are watertight and/or do not void weather ratings.
- Confirm equipment, component, and device labels, tags or signs have been installed per specifications.
- Ensure that mounting hardware does not subject modules to physical stress, i.e. check that structural elements are straight and not twisted.
- Perform visual inspection of all modules to check for cracked cells.

Data Acquisition System Items (If Applicable)

- Check the location and orientation of all sensors, (anemometers, air temperature, PV cell temp, pyranometer, etc.) to ensure they are installed per manufacturer's instructions and will not experience interference from adjacent surfaces or structures.
- Document calibration of all sensors through full range of operating conditions.

Additional Commissioning measures may be required for work under this section to confirm proper operation and interaction with other ECMs in integrated system tests.

11. ELECTRICAL MOTOR REPLACEMENT

General Requirements

- Verify that motor and any options or accessories match project specifications.
- Provide a complete list of all motor nameplate data and serial number.
- Document dates, times, operating conditions and names of parties involved with any tests performed.
- Each test form shall be reviewed and signed by the party with overall responsibility for the test as well as Customer representative if it is identified as a test that must be witnessed.
- Document procedures, forms and submissions required to initiate & maintain manufacturer's warranty.
- Provide written copies of all applicable Operation & Maintenance instructions.
- List all rejected items, failed tests, abnormalities observed or remedial action required by others that were not completely rectified during construction punchlist process.
- Document all training provided with names and signatures of parties who received training.

Electrical Items

- Confirm wiring has been completed and protection devices, (fuses, heaters, breakers, etc.), have been installed to meet applicable codes and specifications for new motor installed.
- Verify motor rotation, if applicable, has been checked prior to connecting coupling or belt drive.
- Check motor operating temperature under full load to confirm it is within manufacturer's limits.

Mechanical Items

- Document that motor has been installed and drive components are aligned per specifications.
- Confirm adjustable motor base is adequately sized for new motor and in serviceable condition.
- Verify all Rotating Parts are found to be free and smooth when turned by hand.
- Ensure that motor has been lubricated, if necessary, and all measures have been taken to re-connect any remote grease, oil or vent lines required for continued preventive maintenance.
- If belt driven, confirm that new belts have been installed and tensioned per specifications.
- Check to see that all guards, shields and protective covers have been re-installed.
- During operation, verify motor is free of abnormal vibration or unusual noises.
- Confirm adequate clearances exist for motor cooling air and routine service.

Additional Commissioning measures may be required for work under this section to confirm proper operation and interaction with other ECMs in integrated system tests.

12. DRY TYPE TRANSFORMER REPLACEMENT

General Requirements

- For this document, energy efficient transformers are defined as all components required for a complete installation per project specifications, (Transformers, Mounting Equipment, Electrical Interconnection Equipment, Safeties, Meters, Alarms, Displays, Wiring, Conduit, etc.)
- Verify that Transformer System was constructed, shipped and installed with all options specified.
- Provide a complete list of nameplate data and serial number(s) for all Transformer System components.
- Document dates, times, operating conditions and names of parties involved with any tests performed.
- Each test form shall be reviewed and signed by the party with overall responsibility for the test as well as Customer representative if it is identified as a test that must be witnessed.
- Document procedures, forms and submissions required to initiate & maintain manufacturer's warranty.
- Provide written copies of all applicable Operation & Maintenance instructions.
- List all rejected items, failed tests, abnormalities observed or remedial action required by others that were not completely rectified during construction punchlist process.
- Document all training provided with names and signatures of parties who received training.

Electrical Items

- Confirm wiring has been completed and protection devices, (fuses, heaters, breakers, etc.), have been installed to meet applicable codes and specifications for all Transformer System components installed.
- Verify all disconnect switches have been installed and tested.
- Check and document that all Transformer start-up, loading, unloading, shutdown and failure modes have been tested.
- If applicable, document that all remote monitoring or EMCS network interfaces with Transformer operating parameters, faults or alarms have been tested and calibrated.
- Document that all factory recommended start-up and check-out procedures have been completed.
- Measure and document the input and output voltage and current to establish an operating baseline and ensure they are within manufacturer's specifications. Ensure that factory performance test results of all modules have been received and properly recorded.

Mechanical and Physical Items

- Confirm that layout, orientation, and foundation level match specifications.
- Ensure all transformer component locations are not subject to temperatures beyond manufacturer's published operating limits.
- Check that adequate clearances exist for cooling air and routine service of all Transformer components.
- Verify locations of electronic enclosures are not subject to excessive moisture, spray, or dirt.
- Make sure all exterior enclosure penetrations are watertight and/or do not void weather ratings.
- Confirm equipment, component, and device labels, tags or signs have been installed per specifications.
- Ensure that mounting hardware does not subject modules to physical stress, i.e. check that structural elements are straight and not twisted.
- Ensure that any mounting bolts are secured with the proper torque.

Data Acquisition System Items (If Applicable)

- Check the location and orientation of any applicable sensors and/or meters to ensure they are installed per manufacturer's instructions.
- Document calibration of all sensors and/or meters through full range of operating conditions.

Additional Commissioning measures may be required for work under this section to confirm proper operation and interaction with other ECMs in integrated system tests.