SECTION 20 08 13 – fire supression/Plumbing/HVAC systems prefunctional checklist and start-ups

1. GENERAL
   * + 1. RELATED DOCUMENTS
          1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
          2. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.
          3. Related sections include, but are not limited to the following:

20 08 00 Fire Suppression, Plumbing and HVAC Systems Commissioning

25 08 00 BJC BAS Commissioning

* + - 1. SUMMARY
         1. This Section expands on and defines responsibilities of the Contractor regarding Prefunctional Checklists and Start-up portions of the Commissioning process and addresses validation of proper and thorough installation of mechanical, plumbing and fire protection systems.
         2. Contractor shall oversee the Commissioning activities with the Contractor’s Subcontractors and the Architect/Engineer (AE).
         3. Contractor shall completely install, thoroughly inspect, Start-up, test, adjust and integrate air and water balance by Owner’s TAB firm on systems and equipment. All activities shall be documented on specific, procedural forms developed for that purpose. Contractor shall notify AE and Owner in writing that systems are complete and ready for verification and Functional Performance Tests.
         4. Completed Prefunctional Checklists for all pieces of equipment shall be submitted to the Owner prior to Functional Performance Tests.
         5. Responsibilities of the various parties involved in the Commissioning process are defined in Section 20 08 00 Fire Suppression, Plumbing, and HVAC Systems Commissioning.
         6. Refer to Attachments A, B, C, and D at the end of this Section for example forms that indicate level of documentation required for the Commissioning process.
      2. REFERENCE STANDARDS
         1. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
         2. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
         3. All materials, installation and workmanship shall comply with all applicable requirements and standards.
      3. SUBMITTALS
         1. Prefunctional Checklists, Prefunctional Tests, and Start-up documents are the normal procedure of ensuring that the mechanical, plumbing, and fire protection system components are properly installed.
         2. The Subcontractor in cooperation with the AE and Contractor shall develop Prefunctional Checklists and Prefunctional Tests during the Construction Phase.
         3. Completeness of Prefunctional Checklists: This Section summarizes the minimum standard for systems and equipment checkout. A record of testing and acknowledgement that a procedure has been completed and that it checks out acceptably must be included in the Prefunctional Checklists. The Prefunctional Checklist shall identify in columnar format each device, location, test method, control sequence of operation reference, device code reported, and other data as appropriate.
         4. Equipment Data Documentation: Provide completed, as-installed, specific product nameplate data, product numbers, serial numbers, etc. to fully define the asset for Owner’s use in maintenance management and asset tracking. This data shall be incorporated within the Equipment List/Matrix.
         5. Submit the equipment data documentation with the draft Prefunctional Checklists to the Owner for approval. AE and Owner will review the Prefunctional Checklists and request any additional information required to meet the Commissioning Plan criteria.
         6. Written Certification: The Contractor shall certify that the installation, Start-up, Prefunctional Checklist, and initial operation of the system or component is in accordance with the Contract Documents, Commissioning Plan, and manufacturer’s requirements, and that the system is ready for Functional Performance Tests. Any outstanding items or non-conformance shall be clearly indicated and highlighted on the Prefunctional Checklist and an action item shall have been initiated. Refer to Division 01 for specific details on non-conformance issues relating to Prefunctional Checklists.
         7. Refer to Section 20 08 00 for additional documentation requirements.

1. PRODUCTS
   * + 1. GENERAL
          1. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
          2. The Prefunctional Checklist procedures described in this Section provide minimum guidelines for development of Prefunctional Checklists; Start-up procedures, and Prefunctional Tests. Contractor shall prepare the Prefunctional Checklists using these procedures and that of the manufacturers and/or applicable codes and standards.
          3. The Prefunctional Checklist form shall acknowledge that installation and Start-up procedures were successfully adhered to and completely performed and shall document relevant parameters (panel and equipment connections, measured values, ground faults, trip settings, etc.). When indicated as performing a checkout on multiple items or multiple procedure items, Prefunctional Checklist forms shall itemize each individual item.
       2. test equipment
          1. Refer to Section 20 08 00 – HVAC/Plumbing/Fire Suppression System Commissioning.
2. EXECUTION
   * + 1. PREFUNCTIONAL CHECKLIST PROCEDURES

**[Edit the following as appropriate for the Project:]**

* + - * 1. Valves:

Operate all manual and automatic valves through their full stoke. Ensure smooth operation through full stroke and appropriate sealing or shutoff.

Verify that actuators are properly installed with adequate clearance.

For automatic, pneumatically-operated valves, verify spring range and adjust pilot positioners where applicable.

* + - * 1. Meters and Gauges:

Adjust faces of meters and gauges to proper angle for best visibility.

Clean windows of meters and gauges, including factory-finished surfaces. Replace cracked and broken windows and repair scratched and marred surfaces with manufacturer's touch-up paint. For meters and gauges that require temporary manual connection of read-out device such as pressure taps on a flow measuring device, ensure that threads are clean and that connection can be easily made.

Meters and gauges requiring manual connection of readout device shall be installed with adequate access to allow connection of device with normal tools.

* + - * 1. Mechanical Identification:

Verify that all valve tags, piping, duct, and equipment labeling corresponds with the Drawings and indexes and meets requirements specified. Correct any deficiencies for all piping and duct systems.

Adjusting: Relocate any mechanical identification device which has become visually blocked by Work of this Division or other Divisions.

Cleaning: Clean the face of identification devices and glass frames of valve charts.

* + - * 1. Mechanical Insulation:

Examine all systems and equipment specified to be insulated.

Patch and repair all insulation that has been damaged after installation.

Ensure the integrity of the vapor barrier around all cold surfaces.

* + - * 1. Fire Suppression Systems:

Additional procedures required for Testing and inspection of Fire Protection Systems are specified within individual Specification Sections. Testing of fire protection systems will generally be conducted by the Fire Protection Subcontractor with Contractor and Owner witnessing.

Check operation prior to, during, and after a power outage to ensure required sequences and system restart.

Fire Protection Subcontractor shall submit forms to the Contractor for approval in concert with the appropriate mechanical system Prefunctional Checklist forms. All procedures and results shall be documented in the approved forms.

* + - * 1. Piping:

The following applies to all installed piping systems including underground Site utilities. Responsibility for preparation of the Prefunctional Checklist and testing of the piping systems generally lies with the installing Subcontractor.

Inspect all piping for proper installation, adequate support with appropriate vibration isolation where applicable, and adequate isolation valves for required service.

Flush and treat all piping as appropriate to the application and clean all strainers.

Ensure that adequate drainage is provided at low points and venting is provided at high points. Ensure that air is thoroughly removed from the system as applicable.

Ensure that all piping is adequately supported and anchored to allow expansion. As applicable, bump across the line pumps and inspect for excessive pipe movement.

Pressure and/or leak test all applicable systems in accordance with requirements in the applicable Specification Sections. Record pressure testing results and certification that piping meets the Specification and submit with the Prefunctional Checklist.

Sterilize applicable piping systems as specified in the individual Specification Sections and as required by regulatory authorities. Record the results of sterilization and all parameters during this process and certify that the piping meets the Specification. Include results with Prefunctional Checklist.

Submit test reports that document testing results and certification of results with the Prefunctional Checklist.

Verify the operation of applicable safety relief valves, operating controls, safety controls, etc. to ensure a safe installation. Document setting and actual trip points of all such controls.

Set and adjust fill, pressure, or level controls to the required setting.

Compare installation with mark-up as-built Drawings to ensure the drawing accuracy.

* + - * 1. AC Motors:

The following applies to all AC motors serving equipment.

Verify proper alignment, installation, and rotation.

Measure the insulation resistance, phase balance, and resistance to ground. These measurements will generally be the responsibility of the mechanical Subcontractor who is connecting the motor. The motor manufacturer will be responsible to correct any deficiencies. When electrical Subcontractor wires to a single point of a packaged device that is shipped with multiple motors, electrical Subcontractor shall check all motors in the package.

Verify that properly sized overloads are in place.

Measure voltage available to all phases at the time of initial connection and after the motor has been placed in operation under load measure amps and RPM.

Record all motor nameplate data.

* + - * 1. Variable Frequency Drives:

General: Provide the services of a factory‑authorized service representative to inspect unit installation, provide Start-up service, and demonstrate and train Owner's personnel***.*** Contractor shall also provide the services of an independent harmonic testing agency as specified.

Start-up Checks: Perform the following checks before Start-up and as specified in manufacturer's Start-up instructions:

Check unit for shipping damage.

Perform a point-to-point continuity test for all field-installed wiring interconnections. Verify terminations of field-installed wiring.

Check for proper torque on connections.

Verify use of shielded cable where specified and check that shields have been terminated properly.

Verify grounding.

Check motor nameplate against drive input rating.

Manually rotate motor shaft to ensure free rotation.

Check that motor leads are not grounded.

Verify that factory test documentation is on file at the Project Site.

Starting procedures: Follow the manufacturer’s printed procedures with the following as a minimum:

Ensure device and system that the drive is serving, is configured to withstand the device operation specified as follows.

Verify, test and document safety circuits are active. Tag the safety circuit termination at the VFD and safety device with the trip value.

Set all parameters required and verify all parameters have been programmed consistently for all VFDs on the project. Coordinate with the BAS relative to the interfaces (hard wired or software) and failure restart, status interfaces, acceleration rates, feedback, alarm states etc.

Adjust the minimum voltage adjustment to enable starting but not to draw excessive power at start.

Adjust the Volts/Hz adjustment to the proper setting.

Adjust the accel and decel rates to the specified times.

Adjust current limiting to coordinate with the overcorrect device and protect the motor.

Set the maximum and minimum speed points.

Manually ramp fan speed from minimum to maximum and check for excessive noise and vibration.

Identify any critical speeds to avoid and set these in the drive.

With the independent harmonic testing agency, check for acceptable voltage and current distortion on the power system. Record the input and output voltages and currents showing the harmonic content as a percentage of the base frequency.

Measure and record overall efficiency at 50 percent, 75 percent, and 100 percent.

Record the motor terminal voltage.

Check operation prior to, during, and after a power outage to ensure required sequences and system restart.

* + - * 1. Laboratory Gas Piping Systems:

Contractor shall provide the services of a gas testing laboratory (GTL) to test the system in strict accordance with NFPA-45 and 99. GTL shall be routinely engaged in the certification of the type and extent of the systems installed for this Project. Testing shall include at a minimum: pressure, flow at outlets, purity, and cross contamination as applicable.

Clean and disinfect piping per Contract Documents.

Provide a draft test report for approval in concert with Prefunctional Checklist draft process. Provide full completed test reports at the completion of testing.

* + - * 1. Laboratory Air Compressors and Vacuum Pumps:

General: Provide the services of a factory authorized representative to inspect equipment installation, Start-up equipment, and train Owner’s personnel.

Operate and adjust safety controls. Replace damaged and malfunctioning controls and equipment.

Refer to AC Motors in this Section.

Start-up Checks: Perform the following checks before Start-up:

Verify that pressure tests of piping systems are complete.

Check that laboratory air compressor inlets are properly located for clean air supply and that laboratory vacuum exhausts are properly located to prevent contamination of public spaces.

Check that laboratory air compressor inlet filters and piping and laboratory vacuum pump filters and discharge piping are clear.

Check for lubricating oil for lubricated-type equipment.

Check V-belts for proper tension. Record belt tension parameters.

Check equipment vibration control supports and flexible pipe connectors and that equipment is properly attached to substrate.

Check that safety (pressure relief) valves are properly set.

Adjust vacuum relief valves.

Drain laboratory air and vacuum receiver tanks.

Check for proper seismic restraints.

Check for adequate room ventilation.

Check that all factory tests are filed at the Project Site.

Check that all documentation required for O&M and Start-up are filed at the Project Site.

Starting Procedures: Follow the manufacturer’s printed procedures as a minimum:

Energize circuits.

Start and run equipment through complete sequence of operations. Check for lead-lag operation, compressor minimum run and off times, sequencing etc. per the Specification and manufacturer’s recommendations.

Check for excessive vibration and noise.

Check air and vacuum pressures.

Manually operate safety valves and vacuum relief valves.

Adjust operating controls including pressure and vacuum settings per direction of Owner.

Check operation prior to, during, and after a power outage to ensure required sequences and system restart.

* + - * 1. High Purity Water System

General: Provide the services of a factory authorized representative to inspect equipment installation, Start-up equipment, and train the Owner’s personnel.

Start-up Checks: Perform the following checks before Start-up:

Ensure piping is properly installed, sterilized, and tested.

Fill brine tank.

Ensure three (3) valve bypass, pressure gauges, and sample valve are installed on the UV sterilizer and Pre and Final Filters.

Ensure isolation valves are installed throughout the system as required by the Specifications.

Ensure that proper power source is provided and connected to the UV sterilizer. Verify the BAS interface for on/off, high temperature alarm, and no flow alarm.

At the DI Columns, ensure that each can be isolated for service, that each column is properly secured to the frame, that the manual isolation valve is installed on the common discharge header, that the resistivity monitor is installed and connected to the BAS, and that the sample valve is provided.

Verify that storage tank fill and level controls are installed and functional.

Starting Procedures: Follow the manufacturer’s printed procedures as a minimum:

Start-up and check out booster pumps.

Run pretreatment through all regeneration and backwash cycles.

Demonstrate that blending valve is operational.

Test the storage tank make-up and fill and associated alarming function.

Calibrate all sensors including resistivity meters.

Run system through all modes of operation and ensure that the controls, alarms, and safeties are functional and properly adjusted.

Perform bacteria and Total Organic Content test as per applicable Specification Section.

Test operation of system prior to, during, and after power outage to ensure proper operation and system restart.

* + - * 1. Storage Tanks:

Inspect the tank for proper installation and support in conformance with the manufacturer’s recommendations.

Verify that all required instrumentation is provided and installed in accordance with the Contract Documents.

For pressurized tanks, pressure test the tanks per the requirements in the applicable Specification Section and per the ASME Code where applicable.

Non-pressure Testing: Fill non-pressure water storage tanks to water operating level to ensure structural integrity and freedom from leaks. Hold water level for 2 hours with no drop in water level.

Repair leaks and defects with new materials and retest system until satisfactory results are obtained.

Clean and disinfect water storage tanks for use with potable water systems as specified in the respective Section.

Prepare and submit reports for all testing, purging, and disinfecting activities.

Check that pressure relief valves have correct setting.

Test operation of tank accessories and devices.

Adjust vacuum relief valves.

Manually operate relief valves.

Adjust pressure and vacuum settings.

* + - * 1. Water Heaters:

General: Provide the services of a factory‑authorized service representative to test and inspect unit installation, provide Start‑up service, and demonstrate and train Owner's personnel as specified below.

Check for adequate steam supply and piping per manufacturer’s direction.

Check for leaks at piping connections.

Check that recirculation and control requirements are per manufacturer’s recommendations.

Check adequate condensate removal and venting of steam.

Verify that steam traps are working properly.

Verify that modulated steam is not being lifted.

Set and test relief valves and record test parameters.

Test and adjust operating and safety controls. Replace damaged and malfunctioning controls and equipment.

Record all Start-up procedures and parameters in Prefunctional Checklists.

* + - * 1. Compressed Air Systems:

General: Provide the services of a factory‑authorized service representative or qualified technician to test and inspect unit installation, provide Start-up service, and to demonstrate and train Owner's personnel as specified below.

Refer to AC Motors in this Section.

Preparation: Perform the following final checks before Start-up.

Piping System Tests: Complete system test in accordance with the respective Section.

Inspect the installation and access/clearance for service and maintenance to ensure it meets the Contract Document and manufacturer’s requirements.

Check for leaks at piping connections.

Check lubricating oil for lubricated‑type equipment.

Check V‑belts for proper tension.

Check that compressor inlet filters and piping are clear.

Check equipment vibration‑control supports and flexible pipe connectors and that equipment is properly attached to substrate.

Check for proper seismic restraints.

Check that safety valves have correct setting; greater than compressor discharge pressure, but less than the pressure rating of system components.

Test operation of equipment safety controls and devices.

Check water supply to water‑cooled equipment.

Check water supply to liquid‑ring air compressors.

Drain receiver tanks.

Check for adequate room ventilation.

Starting Procedures: Follow the manufacturer's written procedures and the following as a minimum:

Energize circuits.

Check for proper rotation of 3-phase motors.

Start and run equipment through complete sequence of operations.

Verify air dryer is hardwired interlocked to prevent the compressor from running unless the dryer is running.

Check for excessive vibration and noise. Correct deficiencies.

Check air pressures.

Manually operate safety valves.

Adjust operating controls including pressure settings.

* + - * 1. Hydronic Piping:

Refer to Piping Section.

Prepare hydronic and test piping in accordance with applicable Specification Section and ASME B 31.9 and/or B 31.1.

Flush system with clean water. Clean strainers.

Chemical Treatment: Provide a water analysis prepared by the chemical treatment supplier to determine the type and level of chemicals required for prevention of scale and corrosion. Perform initial treatment after completion of system testing.

Check expansion tanks to verify that tanks are not air bound and that the system is completely full of water.

Set automatic fill valves for required system pressure.

Check air vents at high points of systems and determine if air vents are installed and operating freely (automatic type) or to bleed air completely (manual type).

Set and coordinate automatic fill pressure and relief valve settings.

* + - * 1. Steam and Condensate Piping:

Refer to Piping Section.

Prepare and test steam and condensate piping in accordance with applicable Section and ASME B 31.9 and or B31.1 as applicable.

Flush the system with clean water. Remove, clean, and replace strainer screens.

Gradually warm-up piping and connected equipment. Introduce steam to piping system by throttling valves.

Take precautions to prevent water hammer or slugging in piping.

Vent air and non-condensable gases from system.

Supervise condensate removal at system traps. Temporarily bypass traps, if required.

Verify complete condensate removal from piping and equipment and that traps are functioning properly.

* + - * 1. Pumps:

Check suction line connections for tightness to avoid inducing air into the pump.

Clean and lubricate all bearings.

Refer to AC Motors in this Section.

Check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.

Check that pump is free to rotate by hand. For pumps handling hot liquids, pump shall be free to rotate with the pump hot and cold. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.

Clean associated strainers.

Verify that OSHA approved coupling guards are in place.

Check that the proper overloads have been installed in the starter and that overloads are the correct size.

Verify that the integrity of the vibration isolation is maintained throughout the support and the piping connections.

Align pump within manufacturer’s recommended tolerances.

Ensure that all associated piping has been cleaned, tested and deaerated.

Start the pump and check that all seal piping/installation is per manufacturer’s instructions.

Check the general mechanical operation of the pump and motor.

Verify that all thermometers and gauges are installed, are clean and undamaged, and are functional.

Verify that the check valve seal is appropriate for the application.

Check noise and vibration levels and ensure that they are within the manufacturer’s recommended tolerances.

Check that the NPSH is within the allowable parameters for the operating condition.

* + - * 1. Steam To Hot Water Converters:

Verify clearances for maintenance.

Flush and clean converters upon completion of installation in accordance with manufacturer's Start-up instructions.

Hydrostatically test assembled converter and piping in accordance with applicable Sections of the ASME Boiler and Pressure Vessel Code.

Check that the heat exchanger is properly supported and restrained and that it is installed with sufficient slope to the condensate outlet.

Check for adequate steam removal. Verify that modulated steam is not being lifted.

Check that vents and vacuum breakers are installed as required by the Contract Documents and that they are clear.

Verify sequencing, stroke, and range of valves. Coordinate ranges with the Building Automation System (BAS).

Start-up converters in accordance with manufacturer's Start-up instructions. Verify high temperature cut out switch is set and hardwired interlocked to close all valves on a trip. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

Record all parameters (flow, temperatures, pressures, etc.) and tests and submit with Prefunctional Checklist Test form.

* + - * 1. Steam Condensate Pumps:

General: Start-up condensate pumping equipment in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements.

Check for free and adequate inlet flow of condensate. Validate that condensate pressure/temperature does not cause pump cavitation.

Check for adequate venting of the receiver.

Refer to AC Motors in this Section.

Set and test level controls and alarm contacts as applicable.

Validate lead/lag and back-up of pumps and control for multiple pump systems.

Validate that overflows are piped safely as applicable.

* + - * 1. Factory-Fabricated Cooling Towers:

Cleaning: Clean inside of cooling tower thoroughly before filling for Start-up. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

Start-up: Comply with manufacturer's instructions for filling and Start-up of operation, including, but not limited to, the following:

Inspect the installation and access/clearance for service and maintenance to ensure it meets the Contract Documents and manufacturer’s requirements.

Check manufacturer’s required clearances for airflow.

Check that all required O&M documentation has been provided and that the documentation is filed at the Project Site.

Verify that fill is not damaged.

Check that the tower is installed level and plumb.

Verify that the tower is properly supported.

Check any vibration isolation and ensure that it is not compromised.

Verify lubrication of rotating parts; lubricate as needed.

Verify fan rotation direction.

Verify that motor amperage is in accordance with manufacturer's data. Verify that vibration and/or all required safety hardwired interlock are functioning correctly.

Refer to AC Motors of this Section.

Refer to Fans of this Section.

Check that make-up is of adequate capacity and properly protected from freezing.

Balance condenser water flow to each tower and to each inlet for multiple inlet towers.

Adjust water level control for proper operating level.

Ensure water outlet does not have entrained air.

Adjust temperature controls and verify operation.

Check sumps and basins to ensure they are clean and free of debris.

* + - * 1. Terminal Units:

General: After construction and painting is completed, clean exposed surfaces of the terminal unit and vacuum clean terminal coils and inside of cabinets.

Retouch any marred or scratched surfaces of factory-finished cabinets using finish materials furnished by the manufacturer.

Ensure that the unit is properly supported.

Verify adequate access for maintenance.

Verify that the unit is installed per manufacturer’s instructions and details.

Install new filters for terminal units that require filters.

Open vents to ensure that the coil is properly vented.

Check that the unit is properly labeled and/or a ceiling marker has been provided for concealed terminal units.

Check power and control voltages.

Check for proper condensate drainage as applicable.

Check rotation of fan where applicable.

Check calibration and operation of the controlling elements.

Check control valves for required close off and fail position.

Temporary Closure: Verify terminal units which are not scheduled to operate are provided temporary closure of polyethylene film or other covering that will prevent entrance of dust and debris unit is scheduled to operate.

Verify that thermostats or temperature sensors are in a proper location to adequately represent space temperature. Verify temperature sensors not scheduled to be installed are secured properly on the top of the unit

* + - * 1. VAV Terminal Units:

General: After construction and painting is completed, clean exposed surfaces of terminal units and vacuum clean terminal coils and inside of cabinets.

Retouch any marred or scratched surfaces of factory-finished cabinets using finish materials furnished by the manufacturer.

Ensure unit is properly supported and that integrity of vibration isolation has been maintained where applicable.

Verify that proper access has been provided to the airflow control devices and any heat exchange surfaces.

Ensure that the air velocity sensor is correctly installed and that inlet/outlet restrictions for accurate measurements have been met.

Check all dampers and linkages and wiring and tubing as applicable for tightness of the connections and terminations.

Refer to associated zone checkout procedures when applicable.

Ensure air inlet is free of obstructions. Start fans and ensure proper rotation (as applicable). Measure and record motor amperage and voltage.

Install new filters where required.

Calibrate and adjust the airflow control parameters. Set applicable minimum and maximum setpoints. Coordinate with the BAS provider as necessary to obtain required flow parameters.

Check the heating device and control to ensure functionality and proper installation. Check stroke and range on the valve and ensure that it closes and seals tightly. Ensure the coils are undamaged, combed, and vented.

Ensure any hydronic heating elements are properly vented and that any associated strainers are clean.

Verify the integrity of any vibration isolation devices.

Verify that thermostats or temperature sensors are in a proper location to adequately represent space temperature. Verify temperature sensors not scheduled to be installed are secured properly on the top of the unit

Temporary Closure: Verify VAV terminal units which are not scheduled to operate are provided temporary closure of polyethylene film or other covering that will prevent entrance of dust and debris unit is scheduled to operate

* + - * 1. Air Handling Units:

Manufacturer's Field Inspection or Custom Units: Arrange and pay for a factory-authorized service representative to inspect the field assembly of components and installation of custom air-handling units including piping, ductwork, and electrical connections.

Ensure that all O&M data for all components is provided and available at the Project Site.

Ensure that all access doors are provided and that they swing against pressure.

Check that all required service receptacles and light fixtures are installed and operating.

Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Ensure that volatile irritants are contained and kept out of occupied spaces.

Vacuum clean the fan wheel, fan cabinet, and entering air face of coils.

Adjust and lubricate dampers and linkages for proper damper operation.

For field fabricated units, ensure the components are properly connected within acceptable tolerances.

Check that all sound attenuating devices are clean and properly installed.

Verify temperature sensing elements are secured properly with correct support devices as recommended by manufacturer.

Verify any high static cut out switches are properly installed with copper tubing, calibrated, tagged with trip set point, and wired.

Verify low temperature detection switches are hard wired interlocked to turn off fan and close OA damper.

Seal all penetrations air tight and ensure access doors seat tightly. Pressure tests the units to verify that they meet specified leakage.

Verify that the unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify that proper thermal overload protection is installed in motors, starters, and disconnects.

Ensure vibration isolation integrity is maintained throughout the air handling unit installation and the connections to it.

Refer to AC Motors in this Section.

Refer to Fans in this Section.

Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align belts, and install belt guards.

Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.

Comb coil fins.

Inspect coil piping connections and ensure that they are per the Contract Documents. Validate that all thermometers, pressure gauges, test ports, and balancing device connections are provided, accessible, and not plugged.

Install clean filters. Provide new filters at completion of Functional Performance Tests.

Ensure that condensate drains properly and that the trap is adequate.

Stroke all valves and dampers to ensure free and full travel.

Pressure test units as required in the air handling unit Specification.

Refer to Division 25, BAS Commissioning, for procedures on starting controls related to air handling units.

* + - * 1. Fans – General Across Systems:

Manufacturer's Field Inspection: Arrange and pay for a factory-authorized service representative to inspect the field assembly of components and installation of fans including ductwork, and electrical connections.

Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Ensure that volatile irritants are contained and kept out of occupied spaces.

Vacuum clean the fan wheel, fan cabinet, and entering air face of coils.

Adjust and lubricate dampers and linkages for proper damper operation.

Verify that the unit is secure on mountings and supporting devices and that connections for ductwork and electrical are complete. Verify that proper thermal overload protection is installed in motors, starters, and disconnects.

Ensure that vibration isolation integrity is maintained with the fan installation and connections to the fan.

Refer to AC Motors in this Section.

Properly align and tension all belts. Record tensioning parameters in the Prefunctional Checklists.

Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align belts, and install belt guards.

Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.

Stroke all dampers to ensure free and full travel.

Refer to Division 25, BAS Commissioning, for procedures on starting controls related to fans.

* + - * 1. Energy Recovery Wheels:

Manufacturer's Start-up: Arrange and pay for a factory-authorized service representative to inspect the field assembly of components and installation of wheel, drive, controls, and electrical connections.

Start-up Checks: Perform the following checks before Start-up and as specified in manufacturer's Start-up instructions.

Check for damage to the wheel and that media and ensure media is evenly/thoroughly impregnated.

Ensure that the wheel rotates freely.

Ensure that all drive components are correctly installed, aligned, and lubricated.

Ensure that air seals are tight and properly installed and that purge angles are set per the manufacturer’s recommendations.

Meet and coordinate with the BAS Provider to review the application for proper control of the wheel and interface of hardware.

Verify that all controls are in place and that they are properly interfaced.

Energize circuits:

Check belt installation, tension, and alignment.

Check for proper rotation in all modes of operation.

Start and run the wheel through complete sequence of operations.

Measure and record the sensible and latent recovery efficiency.

Measure and record air pressure drop.

Estimate purge volume.

Check all interfaces to the BAS.

Adjust operating controls.

Provide services of an independent testing agency to test the cross contamination. Document all procedures and results.

* + - * 1. Air Cleaning:

Inspect installation and check for air leakage of unfiltered air while system is operating.

Check access for filter installation.

Check that filter efficiencies are per the Specifications.

Validate that airflow is adequately even across the face.

Provide new filters as required throughout construction and provide new filters at the completion of functional testing.

* + - * 1. Metal Ductwork:

Inspect all ductwork for damage and dents and correct any deficiencies.

Check ductwork system to ensure that all required dampers, vanes, access doors, testing ports, and other appurtenances are required per the Contract Documents.

Check all penetrations through building elements and ensure tightness and integrity of fire ratings.

Leakage Tests: After each ductwork system that is constructed for ductwork pressure classification over 3 inches is completed, test for ductwork leakage in accordance with Section 23 31 00 Ductwork.

Clean ductwork internally of dust and debris, unit by unit as it is installed. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.

Strip protective paper from stainless steel ductwork surfaces and repair finish wherever the finish has been damaged.

Temporary Closure: At ends of ductwork which are not connected to equipment or air distribution devices at the time of ductwork installation, provide temporary closure of polyethylene film or other covering that will prevent entrance of dust and debris until final ductwork connections are to be completed.

Check pressure class of ductwork against fan dead head to verify adequacy.

* + - * 1. Ductwork Accessories:

Inspect and operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leak proof performance.

Develop a checkout sheet for all fire dampers. Physically inspect and operate every fire damper.

Install fusible links in fire dampers and adjust for proper action.

Label access doors in accordance with Contract Documents.

Fire Damper Testing: Coordinate with the local authority. For every fire damper, remove the fusible link and verify that the damper operates freely and closes tightly. Reinstall the fusible link.

Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

* + - * 1. Building Automation System:

Start-Up: Refer to Division 25, BAS Commissioning. This Division requires the manufacturer’s authorized representative to Start-up, test, adjust, and calibrate DDC control systems and to demonstrate compliance with Contract Document requirements. This will include verification of sequences, normal and emergency operations, calibration, interfaces, and interlocks, etc.

Inspect installation for conformance to manufacturer’s requirements.

Verify controls for seasonal isolation and for modulation.

Verify discharge high limit controls are installed and functioning. Record limit setpoint and operating parameters.

* + - * 1. Plate And Frame Heat Exchangers:

Inspect installation for conformance to the manufacturer’s requirements.

Check piping connections to ensure that connections are per the Contract Documents.

Verify that all labeling is affixed and that all appurtenances are install and accessible.

Confirm that all required O&M documentation is at the Project Site.

Verify that plates are tight and that bolts are evenly torqued.

Check inlet and outlet terminations to verify that piping is properly connected.

* + - 1. acceptance criteria
         1. Acceptance criteria for tests are indicated in the Specification Sections applicable to the systems being tested. Unless indicated otherwise, acceptance criteria will be specified with the individual system, equipment, component, or device.
      2. Training
         1. Training requirements are specified in Division 01 Specifications and in Section 20 08 00 – HVAC, Plumbing, and Fire Suppression System Commissioning.

END OF SECTION 20 08 13

**Request for Start-up/fUNCTIONAL PERFORMANCE TEST**

(Check applicable request below)

Request for Initial Startup \_\_\_\_\_\_ Request for Owner’s Demonstration \_\_\_\_\_\_

**Project**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **Project** #:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Identification of Equipment or System:*** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Location of Equipment or System: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Specification Section: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Detail/Drawing Number: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Manufacturer / Supplier: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***This Date:*** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ***Inspection Requested for (Date):*** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***════════════════════════════════════════════════════════════***

**CONTRACTOR'S CERTIFICATION OF PERFORMANCE:**

*I hereby certify that the above described equipment or system, has been energized, operated, adjusted, and balanced in accordance with the requirements of the Contract Documents and the manufacturer's recommendations for a sufficient period to confirm that operation complies in all respects with the Contract Requirements.*

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_

*Signature Printed Name Date*

**Installing Subcontractor:**

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_

*Signature Printed Name Date*

**Manufacturer's Representative:** *I hereby certify that I have been personally and actively involved with energizing, operational checkout, adjustments, and balancing of the above described equipment or system; and that such has been accomplished in accordance with the manufacturer's recommendations and is operating correctly.*

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_

*Signature Printed Name Date*

*════════════════════════════════════════════════════════════*

**CONFIRMATION or COMMENTS from BJC:**

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Results of Test Acceptable? \_\_\_\_YES \_\_\_\_NO Re-Test Required? \_\_\_\_YES \_\_\_\_NO

Punch List: \_\_\_\_Attached \_\_\_\_To Follow \_\_\_\_N/A

System Acceptable for "User Training"? \_\_\_\_Yes \_\_\_\_No

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*Signature(s) – BJC –Facility Manager Printed Name(s) – BJC Date*

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*Signature(s) – BJC – Project Manager Printed Name(s) – BJC Date*

**EXAMPLE - PREFUNCTIONAL CHECKLIST**

**HVAC Pumps**

**Project**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **Project** #:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Identification of Equipment or System:*** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Location of Equipment or System: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Specification Section: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Detail/Drawing Number: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Manufacturer / Supplier: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***This Date:*** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ***Inspection Requested for (Date):*** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***════════════════════════════════════════════════════════════***

### Prefunctional Checklist Number: \_\_\_\_\_\_\_\_\_\_\_

Components Included:

\_\_\_ Valves, \_\_\_ Gauges, \_\_\_ Strainer, \_\_\_Vibration isolators, \_\_\_Base

Associated Prefunctional Checklists:

\_\_\_Piping, \_\_\_Tubing, \_\_\_Other\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. General:
   1. Submittal. The above systems and components integral to this equipment are complete and ready for Functional Performance Tests. The Prefunctional Checklist items are complete and have been checked off only by parties having direct knowledge of the event, as indicted below, respective to each responsible contractor. This Prefunctional Checklist is submitted for approval and is subject to the attached list of outstanding items not completed successfully. Submit a Deficiency Form upon completion of any outstanding or deficient items. None of the outstanding items preclude safe and reliable functional tests being performed.
   2. \_\_\_ Deficiency Form attached.
   3. This Prefunctional Checklist does not take the place of the manufacturer’s recommended checkout and start-up procedures or report.
   4. Contractors assigned responsibility for sections of the Prefunctional Checklist shall be responsible to ensure that their subcontractors complete and check off their Checklist items.
   5. Prefunctional Checklist items shall be completed as part of start-up & initial checkout, preparatory to functional testing.

| **Contractor/Entity** | **Company** | **Abbreviation** |
| --- | --- | --- |
| Architect/Engineer |  | AE |
| General Contractor / Construction Manager |  | GC |
| Mechanical Contractor |  | MC |
| Electrical Contractor |  | EC |
| Building Automation System Provider |  | BAS |
| Test, Adjust, and Balance Firm |  | TAB |
| Commissioning Consultant |  | CA |

1. Requested Documentation Submitted:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Specified Requirement** | | **Yes** | **No** | **Date to be Submitted** |
| a) | Manufacturer’s Product Data including Performance Data and Shop Drawings, as approved by Architect/Engineer |  |  |  |
| b) | Required Test Reports and/or Certifications |  |  |  |
| c) | Installation and Start-up Manual and Plan |  |  |  |
| d) | Wiring Diagrams, Control Schematics and Sequences |  |  |  |
| e) | Operating and Maintenance Manual Content for Applicable System |  |  |  |
| f) | Equipment List/Matrix |  |  |  |

1. Equipment Verification:

|  |  |  |  |
| --- | --- | --- | --- |
| **Item** | **Specified** | **Submitted** | **Installed** |
| Manufacturer |  |  |  |
| Model Number |  |  |  |
| Serial Number |  |  |  |
| Service |  |  |  |
| GPM |  |  |  |
| Head (Ft) |  |  |  |
| Motor Horsepower (hp) |  |  |  |
| Voltage/Phase |  |  |  |

1. Installation Checks:

| **a) Unit and General Installation** | | **Yes** | **No** | **Comments** |
| --- | --- | --- | --- | --- |
| 1. | Permanent labels affixed |  |  |  |
| 2. | Housing condition good – no leaks |  |  |  |
| 3. | Pumps mounted on base |  |  |  |
| 4. | Alignment appears correct |  |  |  |
| 5. | Vibration isolation equipment installed and active |  |  |  |
| 6. | Maintenance access acceptable |  |  |  |
| 7. | Coupling guard(s) installed |  |  |  |
| 8. | Pump lubricated |  |  |  |
| 9. | Instrumentation installed correctly per Contract Documents (thermowells, thermometers, pressure gages, flow meters, transmitters, sensors) |  |  |  |
| 10. | Equipment clean |  |  |  |

| **b) Valves and Piping (immediately around pump)** | | **Yes** | **No** | **Comments** |
| --- | --- | --- | --- | --- |
| 1. | Pipe fittings complete and pipes properly supported |  |  |  |
| 2. | Pipe pressure test compete and acceptable |  |  |  |
| 3. | Flexible pipe installed at pump connections |  |  |  |
| 4. | Pipes properly insulated |  |  |  |
| 5. | Pipes properly labeled |  |  |  |
| 6. | Piping system properly flushed |  |  |  |
| 7. | Piping system charged |  |  |  |
| 8. | No leaking evident around fittings or components |  |  |  |
| 9. | Strainer(s) installed |  |  |  |
| 10. | Strainer(s) clean |  |  |  |
| 11. | Valves properly labeled |  |  |  |
| 12. | Valves installed in proper direction |  |  |  |
| 13. | Isolation valves open and close |  |  |  |

| **c) Electrical and Controls** | | **Yes** | **No** | **Comments** |
| --- | --- | --- | --- | --- |
| 1. | HOA switch installed and functioning |  |  |  |
| 2. | Panel power source identified |  |  |  |
| 3. | Panel labeled with permanent label |  |  |  |
| 4. | Power disconnect in place and labeled |  |  |  |
| 5. | Low voltage wiring in separate conduit as 120 vac |  |  |  |
| 6. | 120 vac lightning protection installed |  |  |  |
| 7. | Low voltage lightning protection installed (underground only) |  |  |  |
| 8. | Pneumatic devices separated from controller and electronics |  |  |  |
| 9. | End-of-line devices labeled and wiring tagged per Contract Documents |  |  |  |
| 10. | Panel devices labeled and wiring tagged per Contract Documents |  |  |  |
| 11. | I/O devices labeled and wiring tagged per Contract Documents |  |  |  |
| 12. | Digital inputs and outputs operational |  |  |  |
| 13. | Controller drawing and point summary log in panel |  |  |  |
| 14. | All electric connections tight |  |  |  |
| 15. | Proper grounding installed for components and unit |  |  |  |
| 16. | Safeties in place and operable |  |  |  |
| 17. | Starter overload breakers installed and correct size |  |  |  |
| 18. | Sensors calibrated (see below) |  |  |  |
| 19. | Control system interlocks hooked up and functional |  |  |  |
| 20. | All control devices, pneumatic tubing and wiring complete |  |  |  |

| **d) Variable Frequency Drive** | | **Yes** | **No** | **Comments** |
| --- | --- | --- | --- | --- |
| 1. | VFD Prefunctional Checklist complete and approved |  |  |  |
|  |  |  |  |  |

| **e) Final** | | **Yes** | **No** | **Comments** |
| --- | --- | --- | --- | --- |
| 1. | Start-up report completed and attached with this Prefunctional Checklist |  |  |  |
| 2. | Safeties and safe operating ranges for this equipment have been reviewed and accepted |  |  |  |
| 3. | Sequence of operation adequately indicates all information |  |  |  |
| 4. | System is ready for Functional Performance Test |  |  |  |

1. Operational Checks:
   1. These checks supplement the manufacturer’s list. This is not the Functional Performance Test.

| **Operational Checks** | | **Yes** | **No** | **Comments** |
| --- | --- | --- | --- | --- |
| 1. | Pump(s) rotation correct |  |  |  |
| 2. | Pump Phase Checks (%Imbalance = 100 x (avg. – lowest) / avg.). Imbalance less than 2%? |  |  |  |
| 3. | All pumps running less than maximum FL amps |  |  |  |
| 4. | Pump noise and vibration acceptable |  |  |  |
| 5. | Cavitation exists |  |  |  |
| 6. | Valves stroke fully and easily |  |  |  |
| 7. | Specified sequences of operation and operating schedules have been implemented with all variations documented |  |  |  |
| 8. | Specified point-to-point checks have been completed and documentation record submitted for this system |  |  |  |
| 9. | Record full load running amps for each pump.  Pump No. \_\_\_\_: \_\_\_\_\_rated FL amps x \_\_\_\_\_\_srvc factor = \_\_\_\_\_\_\_ (Max amps)  Pump No. \_\_\_\_: \_\_\_\_\_rated FL amps x \_\_\_\_\_\_srvc factor = \_\_\_\_\_\_\_ (Max amps)  Pump No. \_\_\_\_: \_\_\_\_\_rated FL amps x \_\_\_\_\_\_srvc factor = \_\_\_\_\_\_\_ (Max amps)  Pump No. \_\_\_\_: \_\_\_\_\_rated FL amps x \_\_\_\_\_\_srvc factor = \_\_\_\_\_\_\_ (Max amps)  Pump No. \_\_\_\_: \_\_\_\_\_rated FL amps x \_\_\_\_\_\_srvc factor = \_\_\_\_\_\_\_ (Max amps)  Pump No. \_\_\_\_: \_\_\_\_\_rated FL amps x \_\_\_\_\_\_srvc factor = \_\_\_\_\_\_\_ (Max amps) | | | |

1. Sensor and/or Actuator Calibration:
   1. All field-installed temperature sensors, pressure sensors, and gages, and all actuators and valves on this piece of equipment shall be calibrated. Sensors installed in the unit at the factory with calibration certification provided are not required to be field calibrated.
   2. All test instruments have had a certified calibration within the last 12-months: Y / N
   3. Sensor/Actuator Verification Table

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sensor or Actuator** | **Correct Location (Y/N)**  **(1)** | **Thermometer or Gage Value** | **BAS Value**  **(2)** | **Instrument Measured Value (3)** | **Pass (Y/N)** |
| Discharge Pressure |  |  |  |  |  |
| Suction Pressure |  |  |  |  |  |
| Differential Pressure |  |  |  |  |  |
|  |  |  |  |  |  |

1. Thermometer/Gage reading is the reading of the permanently mounted instrument on the equipment.

2. BAS is the Building Automation System. Instrument = testing instrument.

##### 3. All sensors are calibrated within required tolerances \_\_\_ YES \_\_\_ NO

##### FINAL SIGN-OFF

**Contractors attest that the above items have been verified and meet the requirements of the Contract Documents except as noted on the attached Deficiency form.**

|  |  |  |
| --- | --- | --- |
| General Contractor: | Print Name: |  |
| Signature: |  |
| Title: |  |
| Date: |  |
|  | | |
| Mechanical Subcontractor | Print Name: |  |
| Signature: |  |
| Title: |  |
| Date: |  |
|  | | |
| Other Subcontractor: | Print Name: |  |
| Signature: |  |
| Title: |  |
| Date: |  |

**Prefunctional Checklist received and reviewed for completeness by BJC HealthCare representatives. Functional Performance Test can proceed.**

|  |  |  |
| --- | --- | --- |
| BJC: | Print Name: |  |
| Signature: |  |
| Title: |  |
| Date: |  |
|  | | |
| BJC: | Print Name: |  |
| Signature: |  |
| Title: |  |
| Date: |  |

**EXAMPLE - PREFUNCTIONAL CHECKLIST**

**Air Handling Units - Modular**

**Project**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **Project** #:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Identification of Equipment or System:*** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Location of Equipment or System: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Specification Section: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Detail/Drawing Number: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Manufacturer / Supplier: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***This Date:*** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ***Inspection Requested for (Date):*** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***════════════════════════════════════════════════════════════***

### Prefunctional Checklist Number: \_\_\_\_\_\_\_\_\_\_\_

Components Included:

\_\_\_ Supply Fan, \_\_\_ Return Fan, \_\_\_ Cooling Coil(s), \_\_\_Valves, \_\_\_Control Dampers

Associated Prefunctional Checklists:

\_\_\_Chilled Water Piping, \_\_\_Hot Water Piping, \_\_\_Exhaust Fans, \_\_\_Terminal Units, \_\_\_VFD, \_\_\_Smoke Dampers, \_\_\_Fire Dampers, \_\_\_Other\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. General:
   1. Submittal. The above systems and components integral to this equipment are complete and ready for Functional Performance Tests. The Prefunctional Checklist items are complete and have been checked off only by parties having direct knowledge of the event, as indicted below, respective to each responsible contractor. This Prefunctional Checklist is submitted for approval and is subject to the attached list of outstanding items not completed successfully. Submit a Deficiency Form upon completion of any outstanding or deficient items. None of the outstanding items preclude safe and reliable functional tests being performed.
   2. \_\_\_ Deficiency Form attached.
   3. This Prefunctional Checklist does not take the place of the manufacturer’s recommended checkout and start-up procedures or report.
   4. Contractors assigned responsibility for sections of the Prefunctional Checklist shall be responsible to ensure that their subcontractors complete and check off their Checklist items.
   5. Prefunctional Checklist items shall be completed as part of start-up & initial checkout, preparatory to functional testing.

| **Contractor/Entity** | **Company** | **Abbreviation** |
| --- | --- | --- |
| Architect/Engineer |  | AE |
| General Contractor / Construction Manager |  | GC |
| Mechanical Contractor |  | MC |
| Electrical Contractor |  | EC |
| Building Automation System Provider |  | BAS |
| Test, Adjust, and Balance Firm |  | TAB |
| Commissioning Consultant |  | CA |

1. Requested Documentation Submitted:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Specified Requirement** | | **Yes** | **No** | **Date to be Submitted** |
| a) | Manufacturer’s Product Data including Performance Data and Shop Drawings, as approved by Architect/Engineer |  |  |  |
| b) | Required Test Reports and/or Certifications |  |  |  |
| c) | Installation and Start-up Manual and Plan |  |  |  |
| d) | Wiring Diagrams, Control Schematics and Sequences |  |  |  |
| e) | Operating and Maintenance Manual Content for Applicable System |  |  |  |
| f) | Equipment List/Matrix |  |  |  |

1. Equipment Verification:

|  |  |  |  |
| --- | --- | --- | --- |
| **Item** | **Specified** | **Submitted** | **Installed** |
| Manufacturer |  |  |  |
| Model Number |  |  |  |
| Serial Number |  |  |  |
| Service |  |  |  |
| Sensible Capacity (BTU/hr) |  |  |  |
| Total Capacity (BTU/hr) |  |  |  |
| Fan CFM (Total) |  |  |  |
| Fan Motor Horsepower (hp) |  |  |  |
| Voltage/Phase |  |  |  |

1. Installation Checks:

| **a) Unit and General Installation** | | **Yes** | **No** | **Comments** |
| --- | --- | --- | --- | --- |
| 1. | Permanent labels affixed |  |  |  |
| 2. | Casing condition good – no dents, leaks; door gaskets installed |  |  |  |
| 3. | Access doors close tightly – no apparent leaks |  |  |  |
| 4. | Flexible duct between unit and rigid duct tight; in good condition |  |  |  |
| 5. | Vibration isolation equipment installed and active |  |  |  |
| 6. | Maintenance access acceptable |  |  |  |
| 7. | Thermal insulation installed properly |  |  |  |
| 8. | Instrumentation installed correctly per Contract Documents (thermowells, thermometers, pressure gages, flow meters, transmitters, sensors) |  |  |  |
| 9. | Equipment clean |  |  |  |
| 10. | Filters clean with correct efficiency or MERV installed |  |  |  |
| 11. | Filter frame housing installation allows for easy filter replacement |  |  |  |
| 12. | Filter pressure differential measuring device installed and functional (magnahelic, etc.) |  |  |  |
| 13. | Electronic filtration installed |  |  |  |
| 14. | Electronic filtration operational |  |  |  |
|  |  |  |  |  |

| **b) Valves, Piping, and Coils** | | **Yes** | **No** | **Comments** |
| --- | --- | --- | --- | --- |
| 1. | Pipe fittings complete and pipes properly supported |  |  |  |
| 2. | Pipes properly labeled |  |  |  |
| 3. | Pipes properly insulated |  |  |  |
| 4. | Piping system properly flushed |  |  |  |
| 5. | Piping system charged |  |  |  |
| 6. | No leaking evident around fittings or components |  |  |  |
| 7. | Coils are clean, fins are in good condition |  |  |  |
| 8. | Condensate drain pan(s) installed, clean, sloped properly |  |  |  |
| 9. | Condensate drain line(s) installed and supported correctly |  |  |  |
| 10. | Control valve and isolation valves installed |  |  |  |
| 11. | Valves properly labeled |  |  |  |
| 12. | Valves installed in proper direction |  |  |  |
| 13. | Isolation valves open and close |  |  |  |
| 14. | Outside air (OA) temperature, mixed air temperature, supply air temperature, return air temperature, chilled water supply/return sensors properly located and secure (related OA temperature sensor shielded) |  |  |  |
| 15. | Sensors calibrated (see calibration section below) |  |  |  |
| 16. | Pressure/temperature plugs and isolation valves installed per Contract Documents |  |  |  |

| **c) Fans and Dampers** | | **Yes** | **No** | **Comments** |
| --- | --- | --- | --- | --- |
| 1. | Supply fan and motor alignment correct |  |  |  |
| 2. | Supply fan belt tension and condition good |  |  |  |
| 3. | Supply fan protective shrouds for belts in place and secure |  |  |  |
| 4. | Supply fan area clean |  |  |  |
| 5. | Supply fan and motor lube lines installed and lubed |  |  |  |
| 6. | Return fan and motor alignment correct |  |  |  |
| 7. | Return fan belt tension and condition good |  |  |  |
| 8. | Return fan protective shrouds for belts in place and secure |  |  |  |
| 9. | Return fan area clean |  |  |  |
| 10. | Return fan and motor lube lines installed and lubed |  |  |  |
| 11. | Exhaust fan Checklists for service area complete |  |  |  |
| 12. | Smoke and fire dampers installed properly per Contract Documents (proper location, access doors, appropriate ratings verified) |  |  |  |
| 13. | All isolation and smoke dampers close and seal properly |  |  |  |
| 14. | All dampers (outside air, return air, supply air) stroke fully without binding |  |  |  |
| 15. | All damper linkages have minimum play |  |  |  |
|  |  |  |  |  |

| **d) Duct** | | **Yes** | **No** | **Comments** |
| --- | --- | --- | --- | --- |
| 1. | Sound attenuators installed |  |  |  |
| 2. | Duct joint sealant properly installed |  |  |  |
| 3. | No apparent severe duct restrictions |  |  |  |
| 4. | Turning vanes in square elbows as per Contract Documents |  |  |  |
| 5. | Outside air intakes located away from pollutant sources and exhaust outlets |  |  |  |
| 6. | Pressure leakage tests completed |  |  |  |
| 7. | Branch duct control dampers operable |  |  |  |
| 8. | Ducts cleaned as per Contract documents |  |  |  |
| 9. | Terminal units installed, Checklist complete |  |  |  |
| 10. | Balancing dampers installed per Contract Documents and TAB Firm’s direction |  |  |  |
| 11. | Supply and return air devices installed |  |  |  |
|  |  |  |  |  |

| **e) Electrical and Controls** | | **Yes** | **No** | **Comments** |
| --- | --- | --- | --- | --- |
| 1. | HOA switch installed and functioning |  |  |  |
| 2. | Panel power source identified |  |  |  |
| 3. | Panel labeled with permanent label |  |  |  |
| 4. | Power disconnect in place and labeled |  |  |  |
| 5. | Low voltage wiring in separate conduit as 120 vac |  |  |  |
| 6. | 120 vac lightning protection installed |  |  |  |
| 7. | Low voltage lightning protection installed (underground only) |  |  |  |
| 8. | Pneumatic devices separated from controller and electronics |  |  |  |
| 9. | End-of-line devices labeled and wiring tagged per Contract Documents |  |  |  |
| 10. | Panel devices labeled and wiring tagged per Contract Documents |  |  |  |
| 11. | I/O devices labeled and wiring tagged per Contract Documents |  |  |  |
| 12. | Digital inputs and outputs operational |  |  |  |
| 13. | Controller drawing and point summary log in panel |  |  |  |
| 14. | All electric connections tight |  |  |  |
| 15. | Proper grounding installed for components and unit |  |  |  |
| 16. | Safeties in place and operable |  |  |  |
| 17. | Starter overload breakers installed and correct size |  |  |  |
| 18. | Sensors calibrated (see below) |  |  |  |
| 19. | Control system interlocks hooked up and functional |  |  |  |
| 20. | Smoke detectors in place |  |  |  |
| 21. | All control devices, pneumatic tubing and wiring complete |  |  |  |
| 22. | All casing wall penetrations including control wiring are properly sealed |  |  |  |

| **f) Variable Frequency Drive** | | **Yes** | **No** | **Comments** |
| --- | --- | --- | --- | --- |
| 1. | VFD Prefunctional Checklist complete and approved |  |  |  |
|  |  |  |  |  |

| **h) Final** | | **Yes** | **No** | **Comments** |
| --- | --- | --- | --- | --- |
| 1. | Start-up report completed and attached with this Prefunctional Checklist |  |  |  |
| 2. | Safeties and safe operating ranges for this equipment have been reviewed and accepted |  |  |  |
| 3. | Sequence of operation adequately indicates all information |  |  |  |
| 4. | Fire/smoke dampers and terminal units are open |  |  |  |
| 5. | Construction filters installed on return air devices to minimize dirt in ductwork and coils and in any finished areas |  |  |  |
| 6. | Verification of potential moisture migration has been performed via inspection of wall/building construction and review of operating sequences for all make-up air, outside air, supply, return, and exhaust fans |  |  |  |
| 7. | System is ready for Functional Performance Test |  |  |  |

1. Operational Checks:
   1. These checks supplement the manufacturer’s list. This is not the Functional Performance Test.

| **Operational Checks** | | **Yes** | **No** | **Comments** |
| --- | --- | --- | --- | --- |
| 1. | Supply fan rotation correct |  |  |  |
| 2. | Fans > 5 Hp Phase Checks (%Imbalance = 100 x (avg. – lowest) / avg.). Imbalance less than 2%? |  |  |  |
| 3. | All fans running less than maximum FL amps |  |  |  |
| 4. | Return fan noise and vibration acceptable |  |  |  |
| 5. | Supply fan has no unusual noise or vibration |  |  |  |
| 6. | Valves stroke fully and easily |  |  |  |
| 7. | Valves verified not to leak through coils when closed at normal operating pressure |  |  |  |
| 8. | The HOA switch properly activates and deactivates the unit |  |  |  |
| 9. | Specified sequences of operation and operating schedules have been implemented with all variations documented |  |  |  |
| 10. | Specified point-to-point checks have been completed and documentation record submitted for this system |  |  |  |
| 11. | Record full load running amps for each pump.  SF Fan No. \_\_\_\_: \_\_\_\_\_rated FL amps x \_\_\_\_\_\_srvc factor = \_\_\_\_\_\_\_ (Max amps)  SF Fan No. \_\_\_\_: \_\_\_\_\_rated FL amps x \_\_\_\_\_\_srvc factor = \_\_\_\_\_\_\_ (Max amps)  SF Fan No. \_\_\_\_: \_\_\_\_\_rated FL amps x \_\_\_\_\_\_srvc factor = \_\_\_\_\_\_\_ (Max amps)  RF Fan No. \_\_\_\_: \_\_\_\_\_rated FL amps x \_\_\_\_\_\_srvc factor = \_\_\_\_\_\_\_ (Max amps)  RF Fan No. \_\_\_\_: \_\_\_\_\_rated FL amps x \_\_\_\_\_\_srvc factor = \_\_\_\_\_\_\_ (Max amps)  RF Fan No. \_\_\_\_: \_\_\_\_\_rated FL amps x \_\_\_\_\_\_srvc factor = \_\_\_\_\_\_\_ (Max amps) | | | |

1. Sensor and/or Actuator Calibration:
   1. All field-installed temperature sensors, pressure sensors, and gages, and all actuators and valves on this piece of equipment shall be calibrated. Sensors installed in the unit at the factory with calibration certification provided are not required to be field calibrated.
   2. All test instruments have had a certified calibration within the last 12-months: Y / N
   3. Sensor/Actuator Verification Table (AHU in Operation)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sensor or Actuator** | **Correct Location (Y/N)**  **(1)** | **Thermometer or Gage Value** | **BAS Value**  **(2)** | **Instrument Measured Value (3)** | **Pass (Y/N)** |
| Supply air discharge |  |  |  |  |  |
| Return air |  |  |  |  |  |
| Outside air |  |  |  |  |  |
| CHWR (at AHU) |  |  |  |  |  |
| CHWS (at AHU) |  |  |  |  |  |
| Duct SP (at SA discharge) |  |  |  |  |  |
| CHW Control Valve Position |  |  |  |  |  |
| HWR (at AHU) |  |  |  |  |  |
| HWS (at AHU) |  |  |  |  |  |
| HW Control Valve Position |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

1. Thermometer/Gage reading is the reading of the permanently mounted instrument on the equipment.

2. BAS is the Building Automation System. Instrument = testing instrument.

##### 3. All sensors are calibrated within required tolerances \_\_\_ YES \_\_\_ NO

##### FINAL SIGN-OFF

**Contractors attest that the above items have been verified and meet the requirements of the Contract Documents except as noted on the attached Deficiency form.**

|  |  |  |
| --- | --- | --- |
| General Contractor: | Print Name: |  |
| Signature: |  |
| Title: |  |
| Date: |  |
|  | | |
| Mechanical Subcontractor | Print Name: |  |
| Signature: |  |
| Title: |  |
| Date: |  |
|  | | |
| Other Subcontractor: | Print Name: |  |
| Signature: |  |
| Title: |  |
| Date: |  |

**Prefunctional Checklist received and reviewed for completeness by BJC HealthCare representatives. Functional Performance Test can proceed.**

|  |  |  |
| --- | --- | --- |
| BJC: | Print Name: |  |
| Signature: |  |
| Title: |  |
| Date: |  |
|  | | |
| BJC: | Print Name: |  |
| Signature: |  |
| Title: |  |
| Date: |  |

**EXAMPLE - PREFUNCTIONAL CHECKLIST**

**Terminal Units**

**Project**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **Project** #:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Identification of Equipment or System:*** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Location of Equipment or System: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Specification Section: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Detail/Drawing Number: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Manufacturer / Supplier: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***This Date:*** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ***Inspection Requested for (Date):*** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***════════════════════════════════════════════════════════════***

### Prefunctional Checklist Number: \_\_\_\_\_\_\_\_\_\_\_

Components Included:

\_\_\_ Damper, \_\_\_ Temperature Sensor, \_\_\_ Heating Coil, \_\_\_Fan

Associated Prefunctional Checklists:

\_\_\_AHU- \_\_\_\_\_\_, \_\_\_Other\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. General:
   1. Submittal. The above systems and components integral to this equipment are complete and ready for Functional Performance Tests. The Prefunctional Checklist items are complete and have been checked off only by parties having direct knowledge of the event, as indicted below, respective to each responsible contractor. This Prefunctional Checklist is submitted for approval and is subject to the attached list of outstanding items not completed successfully. Submit a Deficiency Form upon completion of any outstanding or deficient items. None of the outstanding items preclude safe and reliable functional tests being performed.
   2. \_\_\_ Deficiency Form attached.
   3. This Prefunctional Checklist does not take the place of the manufacturer’s recommended checkout and start-up procedures or report.
   4. Contractors assigned responsibility for sections of the Prefunctional Checklist shall be responsible to ensure that their subcontractors complete and check off their Checklist items.
   5. Prefunctional Checklist items shall be completed as part of start-up & initial checkout, preparatory to functional testing.

| **Contractor/Entity** | **Company** | **Abbreviation** |
| --- | --- | --- |
| Architect/Engineer |  | AE |
| General Contractor / Construction Manager |  | GC |
| Mechanical Contractor |  | MC |
| Electrical Contractor |  | EC |
| Building Automation System Provider |  | BAS |
| Test, Adjust, and Balance Firm |  | TAB |
| Commissioning Consultant |  | CA |

1. Requested Documentation Submitted:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Specified Requirement** | | **Yes** | **No** | **Date to be Submitted** |
| a) | Manufacturer’s Product Data including Performance Data and Shop Drawings, as approved by Architect/Engineer |  |  |  |
| b) | Required Test Reports and/or Certifications |  |  |  |
| c) | Installation and Start-up Manual and Plan |  |  |  |
| d) | Wiring Diagrams, Control Schematics and Sequences |  |  |  |
| e) | Operating and Maintenance Manual Content for Applicable System |  |  |  |
| f) | Equipment List/Matrix |  |  |  |

1. Equipment Verification:

|  |  |  |  |
| --- | --- | --- | --- |
| **Item** | **Specified** | **Submitted** | **Installed** |
| Manufacturer |  |  |  |
| Model Number |  |  |  |
| Serial Number |  |  |  |
| Service |  |  |  |
| Capacity (CFM) |  |  |  |
| Maximum CFM |  |  |  |
| Minimum CFM |  |  |  |
| Fan Motor Horsepower (hp) |  |  |  |
| Fan Voltage/Phase |  |  |  |
| Electric Heat (kW) if applicable |  |  |  |

1. Installation Checks:

| **a) Unit and General Installation** | | **Yes** | **No** | **Comments** |
| --- | --- | --- | --- | --- |
| 1. | Permanent labels affixed |  |  |  |
| 2. | Permanent label affixed within building space identifying location |  |  |  |
| 3. | Casing condition good – no dents, leaks; door gaskets installed |  |  |  |
| 4. | Access doors close tightly – no apparent leaks |  |  |  |
| 5. | Hard duct connecting high/medium pressure duct to unit |  |  |  |
| 6. | Vibration isolation equipment installed and active |  |  |  |
| 7. | Maintenance access acceptable |  |  |  |
| 8. | Sound attenuation installed properly |  |  |  |
| 9. | Instrumentation installed correctly per Contract Documents |  |  |  |
| 10. | Equipment clean |  |  |  |
|  |  |  |  |  |

| **b) Heating Coil** | | **Yes** | **No** | **Comments** |
| --- | --- | --- | --- | --- |
| 1. | Pipe fittings complete and pipes properly supported |  |  |  |
| 2. | Pipes properly labeled |  |  |  |
| 3. | Pipes properly insulated |  |  |  |
| 4. | No leaking evident around fittings or components |  |  |  |
| 5. | Coils are clean, fins are in good condition |  |  |  |
| 6. | Valves properly labeled |  |  |  |
| 7. | Control valve installed and wired properly |  |  |  |
| 8. | Valves installed in proper direction |  |  |  |
|  |  |  |  |  |

| **c) Fans and Dampers** | | **Yes** | **No** | **Comments** |
| --- | --- | --- | --- | --- |
| 1. | Fan and motor alignment correct |  |  |  |
| 2. | Fan area clean |  |  |  |
| 3. | Fan responds to temperature sensor settings |  |  |  |
| 4. | Damper installed properly |  |  |  |
| 5. | Damper closes and opens properly |  |  |  |
| 6. | Damper linkages have minimum play |  |  |  |
|  |  |  |  |  |

| **d) Electrical and Controls** | | **Yes** | **No** | **Comments** |
| --- | --- | --- | --- | --- |
| 1. | Temperature sensor location accessible for maintenance |  |  |  |
| 2. | Temperature sensor not damaged |  |  |  |
| 3. | Temperature sensor labeled with respect to terminal unit and air handler |  |  |  |
| 4. | Panel power source identified |  |  |  |
| 5. | Power disconnect for electric heating coil and/or fan in place and labeled |  |  |  |
| 6. | Panel devices labeled and wiring tagged per Contract Documents |  |  |  |
| 7. | I/O devices labeled and wiring tagged per Contract Documents |  |  |  |
| 8. | Digital inputs and outputs operational |  |  |  |
| 9. | Controller drawing and point summary log in panel |  |  |  |
| 10. | All electric connections tight |  |  |  |
| 11. | Proper grounding installed for components and unit |  |  |  |
| 12. | Safeties in place and operable |  |  |  |
| 13. | Sensors calibrated (see below) |  |  |  |
| 14. | Control system interlocks hooked up and functional |  |  |  |
| 15. | All control devices and wiring complete |  |  |  |
| 16. | All control devices, pneumatic tubing and wiring complete |  |  |  |
|  |  |  |  |  |

| **f) Variable Frequency Drive** | | **Yes** | **No** | **Comments** |
| --- | --- | --- | --- | --- |
| 1. | VFD Prefunctional Checklist complete and approved |  |  |  |
|  |  |  |  |  |

| **h) Final** | | **Yes** | **No** | **Comments** |
| --- | --- | --- | --- | --- |
| 1. | Start-up report completed and attached with this Prefunctional Checklist |  |  |  |
| 2. | Safeties and safe operating ranges for this equipment have been reviewed and accepted |  |  |  |
| 3. | Sequence of operation adequately indicates all information |  |  |  |
| 4. | Terminal unit damper open |  |  |  |
| 5. | System is ready for Functional Performance Test |  |  |  |
|  |  |  |  |  |

1. Operational Checks:
   1. These checks supplement the manufacturer’s list. This is not the Functional Performance Test.

| **Operational Checks** | | **Yes** | **No** | **Comments** |
| --- | --- | --- | --- | --- |
| 1. | Acuated damper(s) responds to sensor temperature settings |  |  |  |
|  | Fan rotation correct |  |  |  |
| 2. | Record full load running amps for fan: |  |  |  |
|  | Fan No. \_\_\_\_: \_\_\_\_\_rated FL amps x \_\_\_\_\_\_srvc factor = \_\_\_\_\_\_\_ (Max amps) |  |  |  |
| 3. | Fan running less than maximum FL amps |  |  |  |
| 4. | Fan noise and vibration acceptable |  |  |  |
| 5. | Fan responds to temperature sensor settings |  |  |  |
| 6. | Heating coil responds to temperature sensor settings |  |  |  |
| 8. | Disconnect switch properly activates and deactivates the heating coil |  |  |  |
| 9. | Specified sequences of operation and operating schedules have been implemented with all variations documented |  |  |  |
| 10. | Specified point-to-point checks have been completed and documentation record submitted for this system |  |  |  |
|  |  |  |  |  |

1. Sensor and/or Actuator Calibration:
   1. All field-installed temperature sensors, pressure sensors, and gages, and all actuators and valves on this piece of equipment shall be calibrated. Sensors installed in the unit at the factory with calibration certification provided are not required to be field calibrated.
   2. All test instruments have had a certified calibration within the last 12-months: Y / N
   3. Sensor/Actuator Verification Table

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sensor or Actuator** | **Correct Location (Y/N)**  **(1)** | **Thermometer or Gage Value** | **BAS Value**  **(2)** | **Instrument Measured Value (3)** | **Pass (Y/N)** |
| Temperature Sensor |  |  |  |  |  |

1. Thermometer/Gage reading is the reading of the permanently mounted instrument on the equipment.

2. BAS is the Building Automation System. Instrument = testing instrument.

##### 3. All sensors are calibrated within required tolerances \_\_\_ YES \_\_\_ NO

##### FINAL SIGN-OFF

**Contractors attest that the above items have been verified and meet the requirements of the Contract Documents except as noted on the attached Deficiency form.**

|  |  |  |
| --- | --- | --- |
| General Contractor: | Print Name: |  |
| Signature: |  |
| Title: |  |
| Date: |  |
|  | | |
| Mechanical Subcontractor | Print Name: |  |
| Signature: |  |
| Title: |  |
| Date: |  |
|  | | |
| Other Subcontractor: | Print Name: |  |
| Signature: |  |
| Title: |  |
| Date: |  |

**Prefunctional Checklist received and reviewed for completeness by BJC HealhCare representatives. Functional Performance Test can proceed.**

|  |  |  |
| --- | --- | --- |
| BJC: | Print Name: |  |
| Signature: |  |
| Title: |  |
| Date: |  |
|  | | |
| BJC: | Print Name: |  |
| Signature: |  |
| Title: |  |
| Date: |  |