|  |  |
| --- | --- |
| FT: | **23 74 13** |
| **ITEM:** | **Packaged Rooftop HVAC Units** |
| **ID:** |  |
| **AREA SERVED:** |  |

Form Filled Out By:

|  |  |  |
| --- | --- | --- |
|  | **Name & Company** | **Date** |
| GC |  |  |
| MC |  |  |
| EC |  |  |
| BC |  |  |
| CC |  |  |
| OR |  |  |
| A/E |  |  |
| CA |  |  |

GC = General Contractor; MC = Mechanical Contractor; EC = Electrical Contractor; BC = Balancing Contractor; CC = Controls Contractor; OR = Owner Representative; A/E = Architect/Engineer; CA = Commissioning Agent

XX = No Initials Required

# TEST PREREQUISITES

The following items have been completed and the equipment is ready for Functional Testing.

Check if OK. Enter Outstanding Item Note number if deficient.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Item | **GC** | **MC** | **EC** | **BC** | **CC** | **OR** | **A/E** | **CA** |
| Unit startup completed | XX |  | XX | XX | XX |  |  |  |
| Start-up report submitted | XX |  | XX | XX | XX |  |  |  |
| Test and Balance (TAB) completed | XX |  | XX |  | XX |  |  |  |
| SOO programmed | XX |  | XX | XX |  |  |  |  |
| Prefuctional Checklist completed | XX |  | XX | XX | XX |  |  |  |

# SENSOR CALIBRATION VERIFICATIONS

* Check a representative sample of sensors for calibration and adequate location.
* Test the packaged controls and RMCS readings.
* Use the same test instruments as used for the original calibration, if possible.
* Verify that the sensor reading (via the permanent thermostat, gage, packaged control panel or building automation system (BAS)) compared to the test instrument-measured value is within the tolerances specified in the contract requirements. (\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_).
  + "In calibration" means making a reading with a calibrated test instrument within 6 inches of the site sensor.
  + For items out of calibration or adjustment, fix now if easy, via an offset in the BAS, calibration or replacement of sensor.

| **Sensor &**  **Location** | **Location OK1** | **1st Gage / Pkg**  **& BAS Value** | **Test Inst**  **Value** | **Final Gage / Pkg**  **& BAS Value** | **Pass**  **Y/N?** |
| --- | --- | --- | --- | --- | --- |
| Outside Air Temperature |  | Pkg:  BAS: |  | Pkg:  BAS: |  |
| Return Air Temperature |  | Pkg:  BAS: |  | Pkg:  BAS: |  |
| Discharge Air Temperature |  | Pkg:  BAS: |  | Pkg:  BAS: |  |
|  |  | Pkg:  BAS: |  | Pkg:  BAS: |  |
|  |  | Pkg:  BAS |  | Pkg:  BAS |  |

1Sensor location is appropriate and away from causes of erratic operation.

# DEVICE CALIBRATION VERIFICATIONS

* Check a representative sample of actuators and devices for calibration and adequate operation.
  + "In calibration" means observing a readout in the BAS and going to the actuator or controlled device and verifying that the BAS reading is correct.
  + For items out of calibration or adjustment, fix now if easy, via an offset in the BAS, or a mechanical fix.

| **Device / Actuator &**  **Location** | **Procedure** | **1st BAS**  **Value** | **Site**  **Observation** | **Final BAS**  **Value** | **Pass**  **Y/N?** |
| --- | --- | --- | --- | --- | --- |
| OSA Damper Actuator |  |  |  |  |  |
| RA Damper Actuator |  |  |  |  |  |
| Control Valve Actuator |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

# FUNCTIONAL PERFORMANCE VERIFICATIONS

**Demonstrate operation of equipment per Contract Documents including the following:**

1. Record of All Values for Current Setpoints (SP), Control Parameters, Limits, Delays, Lockouts, Schedules, Etc. Changed to Accommodate Testing:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | | | | | | | **Pre-Test Values** | | | **Returned to Pre-Test Values √** | | | |
|  | | | | | | |  | | |  | | | |
|  | | | | | | |  | | |  | | | |
|  | | | | | | |  | | |  | | | |
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|  | | | | | | |  | | |  | | | |
|  | | | | | | |  | | |  | | | |
| **Sequence of Operations Checks:** | | | | |  | |  |  | |  |  | | |
| The following is a step by step test to verify the system follows the design sequence of operation. The test procedure column indicates what adjustments are needed for testing. Each step is either pass or fail. | | | | | | | | | | | | | |
| **Step** | | | | **Test Procedure** | | | | | | | **Pass/Fail** | | |
| **Preliminary Checks** | | | | | | | | | | | | | |
| 1 | | | | Turn unit off. (Via Unit Disconnect) Initially examine each device below for proper "off" position. | | | | | | |  | | |
| 2 | | | | Supply fan off | | | | | | |  | | |
| 3 | | | | OSA damper closed/return air damper open conversely | | | | | | |  | | |
| 4 | | | | Compressors condensers off | | | | | | |  | | |
| 5 | | | | Heat Reclaim coil valve closed. | | | | | | |  | | |
| 6 | | | | Return air bypass damper closed | | | | | | |  | | |
| 7 | | | | Alarm notification at workstation | | | | | | |  | | |
| **Unoccupied** | | | | | | | | | | | | | |
| 8 | | | | Restore power to return unit to normal operation, override unit to unoccupied mode. | | | | | | |  | | |
| 9 | | | | Override space temperature to 23.9 C to satisfy the unit. If necessary override space dew point to ensure unit will not enter Dehumidification mode. | | | | | | |  | | |
| 10 | | | | Fan is powered back on and ramps to 50% capacity. Record VFD Fan speed \_\_\_\_\_\_\_ Record Unit LAT\_\_\_\_\_\_\_\_ | | | | | | |  | | |
| 11 | | | | Observe OA damper remains closed. RA damper open | | | | | | |  | | |
| 12 | | | | Damper shaft is marked correctly to reflect correct actual damper position without opening unit to observe blade position? | | | | | | |  | | |
| 13 | | | | All stages of heat and cooling are off. Record unit LAT\_\_\_\_\_\_\_ Unit RA temperature \_\_\_\_\_\_\_\_\_( Temperatures should be very close.) | | | | | | |  | | |
| 14 | | | | Override the space temperature to 17 C to trigger a call for unoccupied heat. | | | | | | |  | | |
| 15 | | | | OA/RA damper position remains un-changed | | | | | | |  | | |
| 16 | | | | Heat Reclaim coil & or Gas furnace are activated to satisfy space temperature.(based on actual return air temperature entering the unit) Once heating coil has come online. Record Unit RAT\_\_\_\_\_\_\_Record LAT\_\_\_\_\_ Leaving air temperature should not be more than(aprox) 11 degrees C above the room ambient temperature to prevent stratification. | | | | | | |  | | |
| 17 | | | | Override the space temperature to 14.5 C to trigger additional stage of heating coils, either reclaim or gas furnace or both. Record LAT\_\_\_\_\_\_\_ | | | | | | |  | | |
| 18 | | | | Override space temperature to 22 C to satisfy the unit again. | | | | | | |  | | |
| 19 | | | | Fan speed is reduced back to 50% speed. Record Unit VFD speed\_\_\_\_\_\_ | | | | | | |  | | |
| 20 | | | | OA/RA damper position remains un-changed | | | | | | |  | | |
| 21 | | | | Heating/cooling coils are off, LAT drops back to ambient. | | | | | | |  | | |
| **Morning Warm-up** | | | | | | | | | | | | | |
| 22 | | | | With unit running satisfied in unoccupied mode manipulate unit schedule or override time clock to force morning warm-up routine. (RMCS provider will demonstrate where morning warm-up appears in daily schedule.) Record Current RAT\_\_\_\_\_\_\_\_Record Current LAT\_\_\_\_\_\_\_ | | | | | | |  | | |
| 23 | | | | Override the space temperature to 19 C to trigger a call for heat. | | | | | | |  | | |
| 24 | | | | OA/RA damper position remains closed. | | | | | | |  | | |
| 25 | | | | Fan speed ramps to 100% Full speed. Record VFD Fan Speed\_\_\_\_\_\_hz | | | | | | |  | | |
| 26 | | | | Heating stages are activated as necessary to attempt to satisfy 20 C standby. Record Current RAT\_\_\_\_\_\_\_\_Record Current LAT\_\_\_\_\_\_\_ | | | | | | |  | | |
| 27 | | | | Override Space temperature to 23.9 C to satisfy warm-up, and return unit to standby operation | | | | | | |  | | |
| 28 | | | | Fan Speed speed returns to 50% speed | | | | | | |  | | |
| 29 | | | | Heating and cooling stages are off. Record current LAT\_\_\_\_\_\_ | | | | | | |  | | |
| 30 | | | | OA/RA damper position remains closed. | | | | | | |  | | |
| **Occupied Mode** | | | | | | | | | | | | | |
| 31 | | | | With unit running in morning warm-up mode manipulate unit schedule or override time clock to force changeover to occupied mode. With Space temperature remaining overridden to 23.9 C. If necessary force dew point under 11 to ensure Dehumidification sequence is not active. (RMCS provider will demonstrate programmable occupancy schedule.) Record Current RAT\_\_\_\_\_\_\_\_Record Current LAT\_\_\_\_\_\_\_ Current space Dew point\_\_\_\_\_\_\_C | | | | | | |  | | |
| 32 | | | | Fan speed ramps to 100% Full speed. Record VFD Fan Speed\_\_\_\_\_\_hz | | | | | | |  | | |
| 33 | | | | OSA damper modulates open to scheduled OSA airflow (\_\_\_\_\_\_\_\_\_\_LPS) | | | | | | |  | | |
| 34 | | | | Override Space Temperature Sensor in very small increments above setpoint to initiate the first stage of cooling. | | | | | | |  | | |
| 35 | | | | Heating stages are locked out | | | | | | |  | | |
| 36 | | | | OSA Damper position remains at scheduled flow. | | | | | | |  | | |
| 37 | | | | Stage 1 OSA Dehumidification coil is activated Record OSA intake Temp\_\_\_\_\_ Record RAT \_\_\_\_\_\_\_\_Record Current LAT from OSA path \_\_\_\_\_\_\_ Record Unit LAT\_\_\_\_\_\_\_\_ | | | | | | |  | | |
| 38 | | | | Slowly raise the space temperature incrementally to witness staged cooling Record OSA intake Temp\_\_\_\_\_ Record RAT \_\_\_\_\_\_\_\_Record Current LAT from OSA path \_\_\_\_\_\_\_ Record Unit LAT\_\_\_\_\_\_\_\_ | | | | | | |  | | |
| 39 | | | | Verify Stage-2 Pre-cooling OSA coil initiated Prior Stage 3 RA cooling coil. Record OSA intake Temp\_\_\_\_\_ Record RAT \_\_\_\_\_\_\_\_Record Current LAT from OSA path \_\_\_\_\_\_\_ Record Unit LAT\_\_\_\_\_\_\_\_ | | | | | | |  | | |
| 40 | | | | Release all overrides. | | | | | | |  | | |
| **Dehumidification Mode** | | | | | | | | | | | | | |
| 41 | | | | Record actual Space temperature\_\_\_\_\_\_\_\_\_ Record Actual Space Dew Point\_\_\_\_\_\_\_\_\_\_\_Record Ambient Outdoor Air Temp\_\_\_\_\_\_\_\_ | | | | | | |  | | |
| 42 | | | | Depending on actual space dew point override Dew point as necessary to activate Dehumidification sequence. > 11C | | | | | | |  | | |
| 43 | | | | supply fan remains 100% | | | | | | |  | | |
| 44 | | | | OSA Damper position remains at scheduled flow. | | | | | | |  | | |
| 45 | | | | Cooling coils stage up in sequence to lower space dew point (Note: verify Pre-cooling coil is locked out when ambient OSA temp is below 21C ) otherwise all stages of cooling may be used to satisfy demand Record OSA intake Temp\_\_\_\_\_ Record RAT \_\_\_\_\_\_\_\_Record Current LAT from OSA path \_\_\_\_\_\_\_ Record Unit LAT\_\_\_\_\_\_\_\_ | | | | | | |  | | |
| 46 | | | | With space dew point remaining overridden. Override space temperature to 20C to initiate a call for Re-heat. | | | | | | |  | | |
| 47 | | | | Verify Re-heat coil stages on. Gas furnace remains locked. Record OSA intake Temp\_\_\_\_\_ Record RAT \_\_\_\_\_\_\_\_Record Current LAT from OSA path \_\_\_\_\_\_\_ Record Unit LAT\_\_\_\_\_\_\_\_ | | | | | | |  | | |
| 48 | | | | Release all overrides | | | | | | |  | | |
| 49 | | | | Record OSA intake Temp\_\_\_\_\_ Record RAT \_\_\_\_\_\_\_\_Record Current LAT from OSA path \_\_\_\_\_\_\_ Record Unit LAT\_\_\_\_\_\_\_\_Record Actual Room temperature\_\_\_\_\_\_ | | | | | | |  | | |
| 50 | | | | Verify Unit returns to proper occupied sequence of operation based on actual conditions. Describe the mode. | | | | | | |  | | |
| **Alarm Verification** | | | | | | | | | | | | | |
| 51 | | With the unit running in occupied mode, Coordinate with RMCS operator to remove the fire and smoke alarm relays to simulate an activation of the Fire or Smoke alarms. | | | | | | | | | |  | | |
| 52 | | Unit Fan shuts down | | | | | | | | | |  | | |
| 53 | | OSA Damper modulates closed | | | | | | | | | |  | | |
| 54 | | All stages of heating & cooling are powered off. | | | | | | | | | |  | | |
| 55 | | Alarm notification at workstation | | | | | | | | | |  | | |
| 56 | | Return alarm state to normal, Reset unit and allow it to come back up to steady state. Including excessive compressor cycling safeties. | | | | | | | | | |  | | |
| 57 | | Have the BAS operator demonstrate a high duct static pressure condition. Manually trip the Dp by hand pump, Record the Dp at trip point\_\_\_\_\_\_\_" | | | | | | | | | |  | | |
| 58 | | Unit Fan shuts down | | | | | | | | | |  | | |
| 59 | | OSA Damper modulates closed | | | | | | | | | |  | | |
| 60 | | All stages of heating & cooling are powered off. | | | | | | | | | |  | | |
| 61 | | Alarm notification at workstation | | | | | | | | | |  | | |
| 62 | Return alarm state to normal Reset unit and allow it to come back up to steady state. Including excessive compressor cycling safeties. | | | | | | | | | |  | | |
| 63 | | | Have the BAS operator demonstrate a high filter differential pressure alarm (by adjusting scaling at filter DP device) | | | | | | | |  | | |
| 64 | | | Alarm notification at workstation unit remains in operation . Record Dirty filter limits\_\_\_\_\_\_\_\_\_\_\_OSA \_\_\_\_\_\_\_\_\_\_\_RA | | | | | | | |  | | |
| 65 | | | Reset scaling range back to normal, return alarm state back to normal | | | | | | | |  | | |
| 66 | | | Have RMCS operator override OSA intake temp to 4C to start test of Low limit safeties | | | | | | | |  | | |
| 67 | | | OSA Damper modulates closed RA damper modulates open | | | | | | | |  | | |
| 68 | | | Heating stages on to raise LAT, Record OSA intake Temp\_\_\_\_\_ Record RAT \_\_\_\_\_\_\_\_Record Current LAT from OSA path \_\_\_\_\_\_\_ Record Unit LAT\_\_\_\_\_\_\_\_ | | | | | | | |  | | |
| 69 | | | Override LAT to 0 C | | | | | | | |  | | |
| 70 | | | Unit Fan shuts down | | | | | | | |  | | |
| 71 | | | OSA Damper modulates closed | | | | | | | |  | | |
| 72 | | | All stages of heating & cooling are powered off. | | | | | | | |  | | |
| 73 | | | Alarm notification at workstation | | | | | | | |  | | |
| 74 | | | Units operates normally - End of Test | | | | | | | |  | | |

All points listed below which are control system monitored points shall be trended by the controls contractor at the same moment in time for the specific time interval indicated in the following table:

| Point | Time Interval (min.) | Minimum Time Period of Trend |
| --- | --- | --- |
| For each Unit being tested: | |  |
| Fan Status | 5 | 5 days incl. weekend |
| Fan Speed | 5 | 5 days incl. weekend |
| OSA Damper Position | 5 | 5 days incl. weekend |
| OSA CFM | 5 | 5 days incl. weekend |
| Return Air Damper Position | 5 | 5 days incl. weekend |
| Valve Position | 5 | 5 days incl. weekend |
| Space Temperature | 5 | 5 days incl. weekend |
| Space Temperature Setpoint | 5 | 5 days incl. weekend |
| Space Humidity | 5 | 5 days incl. weekend |
| Discharge Air Temperature | 5 | 5 days incl. weekend |
| OSA Temperature | 5 | 5 days incl. weekend |
| Return Air Temperature | 5 | 5 days incl. weekend |
| Mixed Air Temperature | 5 | 5 days incl. weekend |
| CO2 Level | 5 | 5 days incl. weekend |
| Mode of operation | 5 | 5 days incl. weekend |
| Stage of compressors & coils | 5 | 5 days incl. weekend |
| Duct static pressure | 5 | 5 days incl. weekend |
| All Alarms | 5 | 5 days incl. weekend |
| All Safeties | 5 | 5 days incl. weekend |

* AHU shall maintain the SA temperature within ±1 deg F of the setpoint without excessive hunting.
* AHU shall maintain the SA, RA, OA flows within ±5 percent of the setpoint without excessive hunting.
* AHU shall maintain the SA relative humidity within ±2 percent RA of the setpoint without excessive hunting.

# OUTSTANDING ITEMS

Note outstanding items in table below. Use numbers referenced above.

|  |  |  |
| --- | --- | --- |
| Resolved (Initial / Date) | **Note** | Description |
|  | **1.** |  |
|  | **2.** |  |
|  | **3.** |  |
|  | **4.** |  |
|  | **5.** |  |
|  | **6.** |  |
|  | **7.** |  |
|  | **8.** |  |
|  | **9.** |  |
|  | **10.** |  |

# FIELD NOTES

Fill in as appropriate.

|  |
| --- |
|  |
|  |
|  |
|  |
|  |

# SIGN OFF

System / Equipment have been installed in accordance with the Contract Documents and is ready for Owner acceptance.

|  |  |  |
| --- | --- | --- |
|  | **Signature** | **Date** |
| **Contractor’s Representative** |  |  |
| **A /E Representative** |  |  |
| **Commissioning Agent** |  |  |
| **Owner’s Representative** |  |  |

## END OF TEST