

INSTALLATION VERIFICATION:

Instructions: Under each unit write "Y" for yes, "N" for no, "NA" for not applicable, or a number to refer to any needed comments. If other information is requested such as voltage or frequency, write the appropriate values. "Accessories" includes chilled water and condenser water pumps, cooling towers, etc. It does not include air handling systems or secondary pumping systems.

Criteria for Acceptance: Items #1 - 13 require answers of "Y" (or "NA", where relevant) except where other criteria are noted.

Caution: Only qualified personnel familiar with the operation of the installed chillers, and the hazards involved, should adjust, operate, test, and/or service the equipment. The commissioning agent should become familiar with the installation, operation, and maintenance manuals prior to starting commissioning work. Failure to observe proper safety precautions could result in damage to equipment, severe bodily injury, and/or loss of life.

DESCRIPTION	CHILLER #		
1. Factory start-up sheet completed and attached. (For new construction, this sheet <u>must</u> be completed before proceeding.)			
2. Test and balance report reviewed for chiller system flows			
3. Chiller and accessory environment clean			
4. Adequate chiller & accessory access for maintenance			
5. No visible water or oil leaks			
6. No unusual noise or vibration			
7. Chilled water piping insulation in good condition where visible			
8. P/T plugs installed where specified			
9. Pressure gauges & thermometers installed where specified			
10. Chilled water setpoint (panel readout). Acceptance: ±2 F deg from design			
11. Electrical current limit setpoint (panel readout). Acceptance: ±5% from design			
12. Record & explain any diagnostic codes in control panel memory. Acceptance: Causes of all serious codes have been corrected.			
13. O&M manual on site			
14.			
15.			

COMMENTS ON INSTALLATION VERIFICATION CHECKLIST ITEMS (add more sheets if needed):

ITEM #	UNIT #	COMMENT
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

CONTROLS CALIBRATION:

Instructions: All control points listed under each chiller refer to sensors and stats that are dedicated to that chiller system, and for the most part physically located close to or in the chiller, not global (building-level) points. For thermostats, slowly adjust the setpoint until the controlled response begins (i.e. contact make or break). Note the setpoint when that occurs and the simultaneous measured value on a calibrated instrument held in close proximity to the sensing bulb. If sensor location is improper, explain in comments. Enter other chiller control points that are critical to the control sequence in the blank spaces for each chiller, as appropriate. It is not necessary to repeat any calibration that was documented in the Standard Commissioning Procedure for EMSs, but refer to that document where relevant.

Criteria for Acceptance: Temperature sensors, EMS or contact make/break values ± 2 F degrees from measured values.

CONTROL TYPE	SENSOR / STAT LOCATION	CONTROL LOCATION OK?	MEASURED VALUE	EMS VALUE or MAKE/BRK VALUE	ACCEPTABLE? / COMMENTS
Outdoor air temp., global (EMS)					
Chiller-____:					
Evap. water temp. in					
Evap. water temp. out					
Cond. water temp. in					
Cond. water temp. out					
Chiller-____:					
Evap. water temp. in					
Evap. water temp. out					
Cond. water temp. in					
Cond. water temp. out					
Chiller-____:					
Evap. water temp. in					
Evap. water temp. out					
Cond. water temp. in					
Cond. water temp. out					

COMMENTS ON CALIBRATION ITEMS (add more sheets if needed):

UNIT # COMMENT

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

FUNCTIONAL PERFORMANCE VERIFICATION:

The following sections are a series of field tests that are intended to verify that the chillers, as installed, operate as they were intended to operate by the manufacturer and designer. If the field observation does not correspond to the intended design operation, write a comment number that refers to an explanatory comment in the comments section or on attached comments sheets. If a test does not apply, write "NA" for not applicable. If you were not able to complete a test, write "ND" for not done, and explain in a comment.

Criteria for Acceptance: All measured values must be within $\pm 15\%$ of the design values, unless otherwise noted under a specific test. Measured amps must be less than the rated full load amps. Measured voltage imbalance must be less than 2%.

Full Load Test: Perform the following tests and measurements by forcing the chiller to its maximum capacity. Any false loading should be done gradually to avoid overloading systems. Loading can be done by some combination of increasing the building load (lowering cooling setpoints), heating the building, manipulating cross-over valves between the chilled water and condenser water piping, or manipulating the chilled water mixing valve on the chilled water return line.			
CHILLER #			
1. Chiller FLA, design	/ /	/ /	/ /
2. Chiller amps, measured	/ /	/ /	/ /
3. Volts, phase to phase	/ /	/ /	/ /
4. Voltage imbalance, (max of (a,b,c - avg))/avg			
5. Is voltage imbalance < 2%?			
6. Leaving chilled water (CHW) temp, design			
7. Leaving CHW temp, measured			
8. Entering CHW temp, design			
9. Entering CHW temp, measured			
10. Delta (entering - leaving) CHW temp, design			
11. Delta CHW temp, measured			
12. Evaporator water flow rate, design gpm			
13. Evaporator water flow rate, measured ΔP /gpm	/	/	/
For Water-Cooled Condensers & Towers:			
14. Ambient air temperature, deg F			
15. Entering condenser water (CW) temp, design			
16. Entering CW temp, measured			
17. Leaving CW temp, design			
18. Leaving CW temp, measured			
19. Delta (leaving - entering) CW temp, design			
20. Delta CW temp, measured			
21. Condenser water flow rate, design gpm			
22. Condenser water flow rate, measured ΔP /gpm	/	/	/
For Air-Cooled & Evaporative Condensers:			
23. Ambient air temperature, deg F			
24.			
25.			

Chiller System Controls Tests: The following are a series of tests that verify proper operation of the chiller and its auxiliaries under normal system control. If the actual control sequence differs from that implied by the tests, attach a description of the control sequence, the tests that were done to verify the sequence, and your conclusions. Use of datalogging instrumentation is recommended to implement and document these tests, though visual observation is acceptable. Annotate any data and graphs so that it is clear what the data are proving. Attach annotated data and graphs to this test sheet. Energy Management System (EMS) trend logs of EMS outputs, program print-outs, or schedule and setpoint print-outs are not acceptable as proof of operation, though trend logs of sensor inputs to the EMS are acceptable.

Criteria for Acceptance: Items #26 - 35 require answers of "Y" (or "NA", where relevant) except where other criteria are noted.

CHILLER #			
26. Chiller appears to meet load (no complaints)			
27. Chiller operates without unusual number of trips			
28. Chiller enabled under time-of-day control ¹			
29. OSA temperature lockout functions properly ¹			
30. If CHW temperature is reset, what is the controlling independent variable? (e.g. warmest zone temp, valve position, etc.)			
31. CHW temperature follows reset schedule ¹			
32. Chiller maintains CHW at setpoint ± 1 °F over a 2 hour operating period ¹			
33. Gradually remove the chiller load and verify the chiller & accessory shutdown sequence ² Acceptance: Sequence verified.			
34. Gradually add load and verify the chiller & accessory start-up sequence ² Acceptance: Sequence verified.			
35. Shut-down and start-up sequences stage multiple chillers & accessories properly ²			
36.			
37.			

Notes to System Controls Test:

¹ Attach to this test form field documentation in support of your answer. For CHW temperature reset, attach either monitored data and graphs showing temperature variation over at least 1/2 of the reset range, or field notes showing the CHW temperature and concurrent independent variable value at two points that span at least 1/2 of the reset range. It is permissible to force the independent variable in order to facilitate gathering the required data.

² Attach to this test form field documentation in support of your answer. Loading and unloading may be done by some combination of starting/stopping air handler units, starting/stopping secondary chilled water pumps, changing the CHW setpoint, etc. Be careful, though, not to simulate loading/unloading by manipulating equipment that is directly interlocked with the chiller(s). If there are multiple chillers that are staged together, verify not only each chiller's shut-down and start-up, but also the staging of all of the chillers.

COMMENTS ON FUNCTIONAL PERFORMANCE VERIFICATION TESTS (add more sheets as needed):

ITEM #	UNIT #	COMMENT
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Building Name: _____

I certify that the data and test results as recorded herein are accurate.

Signature, Commissioning Agent

Date

Firm Name

(Area Code) Phone Number

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