

The following standard specification is intended to be edited according to the specifics of the project. Brackets [] and areas shaded in gray [e.g. format] indicate requirements that are optional depending upon the type of system being provided or per instructions associated with the [] and project requirements. Consult with University's Representative and campus stakeholders.

DOCUMENT UTILIZES TRACK CHANGES TO RECORD YOUR CHANGES AS YOU EDIT.
DO NOT CHANGE THE FOOTER OF THE DOCUMENT

SECTION 25 08 00 COMMISSIONING OF DDC/EMS SYSTEM

PART 1- GENERAL

1.1 DESCRIPTION

- A. Commission all systems and equipment listed in the table below per the requirements of Section 01 91 00 Commissioning. The Installation/Start-up Verification (ISV) and Functional Performance Test (FPT) forms are required [and will be provided by the University]. Refer to the project website for standard commissioning forms.

[Edit the table and the checklists as required by the project.]

Equipment/System	ISV Form	FPT Form
DDC EMS General Requirements (Building EMS)	ISV-25 95 00	FPT-25 95 00
Laboratory Airflow Control System	ISV-25 95 05	FPT-25 95 05

1.2 RELATED WORK AND DOCUMENTS

- A. Section 01 91 00 Commissioning
B. Section 01 79 00 Demonstration and Training
C. Division 23 Heating, Ventilating, and Air Conditioning
D. Division 25 Integrated Automation

1.3 COMMISSIONING DEFINITIONS AND ABBREVIATIONS

- A. Refer to Section 01 91 00 Commissioning.

1.4 REFERENCE STANDARDS

- A. Sheet Metal and Air Conditioning Contractors National Association (SMACNA) Guidelines
B. American Society for Testing and Materials (ASTM)
C. Associated Air Balance Counsel (AABC) Guidelines for Balancing Procedures and Documentation

1.5 SUBMITTALS

- A. Submit commissioning documents for all equipment and systems listed in table above per the requirements of Section 01 91 00 Commissioning.

PART 2- PRODUCTS

2.1 INSTRUMENTATION

- A. Refer to Section 01 91 00 Commissioning. Instrumentation required to verify readings and test system and equipment performance shall be provided by Contractor and made available to University's Representative. Generally, no testing equipment shall be required beyond that required to perform Contractors Work under these Contract documents. All equipment used for

testing and calibration shall be NIST/NBS traceable and calibrated within the preceding 6 month period. Certificates of calibration shall be submitted for all instrumentation utilized during any testing or commissioning process.

PART 3- EXECUTION

3.1 INSTALLATION / START-UP VERIFICATION

- A. Perform all checks and tests included in the ISV checklists and complete the checklists as specified in Section 01 91 00 Commissioning. The Contractor shall provide all pre-commissioning testing, adjusting and calibration services as part of the initial installation and checkout prior to a point demonstration with the University. After all ISV checklists have been completed and approved, and all field devices are installed and DDC points programmed into the DDC EMS controllers, the Contractor shall perform start-up tests on each controller and test each of the devices associated with them.
- B. The University shall have the option to witness, with the Contractor present, the performance of the points validated in the ISV checklists. At this time, the Contractor must be able to demonstrate completion of the calibration and function ability of the components of the system. A 100 percent demonstration of points in primary systems (CHW, HW, Air Handlers) will be done, and 10 percent of the secondary systems (VAVs, Fan Coils, Monitoring, etc.).

3.2 PRE-COMMISSIONING TESTING, ADJUSTING, CALIBRATION

- A. Work and systems installed under this section shall be fully functioning prior to DDC EMS functional performance testing, and contract close-out. Contractor shall start, test, adjust, calibrate all work and systems under this Contract, and record this information and generate a Pre-Commissioning Report as described below:
 - 1. Verify proper pneumatic supply pressures and conditions.
 - 2. Verify proper electrical voltages and amperages, and verify all circuits are free from grounds or faults.
 - 3. Verify integrity/safety of all electrical and pneumatic connections.
 - 4. Verify proper interface with fire alarm system.
 - 5. Coordinate with TAB installer (when applicable) to obtain control settings that are determined from balancing procedures. Record the following control settings as obtained from TAB installer, and note any TAB deficiencies in the Pre-Commissioning Report:
 - a. Minimum outside air damper settings for air handling units;
 - b. VAV fan VFD minimum and maximum speed settings (where applicable);
 - c. VAV return fan VFD air volume (CFM) tracking settings (where applicable);
 - d. Optimum VAV duct pressure setpoints (where applicable);
 - e. VAV box minimum and maximum air volume (CFM) settings (where applicable);
 - f. Optimum differential pressure setpoints for variable speed (VFD) pumping systems (where applicable);
 - g. Pump VFD minimum and maximum speed settings (where applicable);
 - h. GPM/flow rates for all hydronic systems, including control valves, coils, etc.;
 - i. All other necessary system parameters/control settings not specifically listed above but required to provide system operation, stability, and efficiency.
 - 6. Test, calibrate, and set all digital and analog sensing, and actuating devices including existing instrumentation and control devices that are indicated to be reused. Calibrate each instrumentation device by making a comparison between the DDC EMS interface display and the reading at the device, using a standard traceable to the National Bureau of Standards, which shall be at least twice as accurate as the device to be calibrated (e.g., if field device is plus or minus 0.5 percent accurate, test equipment shall be plus or minus 0.25 percent accurate over same range). Record the measured value and displayed value for each DDC EMS device in the Pre-Commissioning Report. See Section 01660 Systems and Equipment

Start-up, Testing and Adjustment for further requirements of testing equipment including current calibration certification.

7. Check and set zero and span adjustments for all actuating devices. Manually activate new or existing damper and valve operators to verify free travel and fail condition. Check valve or damper to insure that it shuts off tight when the appropriate signal is applied to the operator. Adjust the operator spring compression as required. If a positioner or volume booster is installed on the operator, calibrate per manufacturer's procedure to achieve spring range indicated. Check split range positioners to verify proper operation. Record settings for each device in the Pre-Commissioning Report.
 8. Check each digital control point by making a comparison between the control command at the DDC EMS controller and the status of the controlled device. Check each digital input point by making a comparison of the state of the sensing device and the hand held operator terminal display. Record the results for each device in the Pre-Commissioning Report.
 9. Tune all control loops to obtain the fastest stable response without hunting, offset or overshoot. Record tuning parameters and response test results for each control loop in the Pre-Commissioning Report. Except for any system start-up, maximum allowable variance from set point for controlled variables shall be as follows:
 - a. Air Temperature Plus or Minus 0.5 Degrees Fahrenheit.
 - b. Water Temperature Plus or Minus 2 Degrees Fahrenheit.
 - c. Duct Pressure Plus or Minus 0.2 Inches W.G.
- B. Pre-Commissioning testing, adjusting, and calibration shall be completed and the Pre-Commissioning Report submitted for acceptance prior to DDC EMS commissioning testing/final acceptance.

3.3 TREND LOGS

- A. Prepare controller and workstation software to display graphical format trend logs during the Pre-Commissioning period. Refer the specific Contract Drawings for individual trend log matrix DDC EMS point requirements. Trend logs shall demonstrate compliance with Contract Documents. Trend logs shall be set up to meet the following requirements:
1. Trend logs shall include all analog and digital input values, analog and digital output values, and set points which are on a reset schedule.
 2. Lines shall be labeled and shall be distinguishable from each other by using either different line types, or different line colors.
 3. Indicate engineering units of the y-axis values; e.g. degrees Fahrenheit, inches w.g., Btu/lb, percent wide open, etc.
 4. The y-axis scale shall be chosen so that all trended values are in a readable range. Do not mix trended values on one graph if their unit ranges are incompatible.
 5. Trend outside air temperature, humidity, and enthalpy during each period in which any other points are trended.
 6. All points trended for one HVAC subsystem (e.g. air handling unit, chilled water system, etc.) shall be trended during the same trend period.
 7. Each graph shall be clearly labeled with HVAC subsystem title, date, and times.
- B. A complete set of trend logs shall consist of all required points, trended for the time period listed for each point category. Point values shall be recorded based on the change-of-value (COV) differentials listed. If the DDC EMS does not have the capability to trend based on COV, then point values shall be trended based on the time intervals as specified in the trend log matrix specified on each Contract Drawing.

3.4 FUNCTIONAL PERFORMANCE TESTS

- A. Perform all checks and tests included in the FPT checklists and complete the checklists as specified in Section 01 91 00 Commissioning.

- B. System Sequence Commissioning Checklists shall be submitted along with the point specific pre-commissioning checklists described above. These System Sequence Commissioning Checklists shall follow the format of the exhibits in Appendix A after this Section and shall be customized to prove, step-by-step, that the performance of each system controlled by the DDC EMS meets the requirements of the sequences described in the Contract Documents. There shall be a sequence checklist for each system involving the DDC EMS. Actual system testing for acceptance shall be scheduled at a minimum of 2 weeks after the filled-out pre-checklists have been submitted for approval by the University's Representative. System testing will only begin when the final balancing report has been submitted and the pre-checklists are approved for use. Systems such as air handlers shall have their prerequisite systems (e.g., the chilled water system and the hot water system) accepted and functioning before their tests can commence.
- C. When the System Sequence Commissioning Checklists have been completed successfully, the Contractor shall set up routines using the DDC EMS to automatically test and record the performance of each system. These operational tests shall involve proving that different temperature setpoints and changing pressure setpoints can be attained. These operational tests can be set up utilizing software routines, and documented with printouts of trend results. In addition, the systems shall be shown to activate and turn off under the proper circumstances (e.g., timeclock control, the need for chilled water). Trends shall be used to validate the successful performance of on/off control. Two operational tests shall be actively observed: satisfactory recovery from a system-wide power outage and satisfactory performance during fire alarm conditions. If an emergency generator is utilized, satisfactory performance during power transfers shall also be proved. All systems shall require operational tests. For systems with additional features (e.g., humidification), tests similar to those above shall be developed by the Contractor and shall also prove those systems' satisfactory performance. These operational tests shall be submitted along with the pre-commissioning forms and System Sequence Commissioning Checklists. Each submitted operational test shall describe its intent, the DDC EMS points used to prove this intent, and the method by which the operational test shall be executed. Operational tests shall not commence until they have been reviewed and approved by the University's Representative.
- D. Contractor shall assist the University's Representative in DDC EMS verification and performance testing. Assistance will generally include the following:
1. Demonstration of pre-commissioned system points as required by the University.
 2. Manipulate systems and equipment to facilitate testing.
 3. Provide instrumentation necessary for verification and performance testing.
 4. Manipulate control systems to facilitate verification and performance testing.
 5. Provide a control technician to work at the direction of University's Representative for software optimization assistance as specified in Part 3 Execution of this section.
 6. Train the University's Representatives in both systems operation and equipment maintenance and repair. Control system training shall be conducted by the Contractor. Control system training shall be as specified in Part 3 Execution of this section.
- E. Contractor shall also compensate the University's Representative for any additional site time necessitated by incompleteness of systems or equipment at time of functional performance testing.
- F. Contractor shall coordinate Work of other Sections such as controls and instrumentation, sheet metal, piping, and TAB in the DDC EMS commissioning process.

3.5 DDC EMS DEMONSTRATION

- A. Contractor shall demonstrate the operation of the DDC EMS hardware, software, and all related components and systems to the satisfaction of the University's Representative. Schedule the demonstration with the University's Representative a minimum of 2 weeks in advance. DDC EMS demonstration shall not be scheduled until all hardware and software submittals, and the Pre-Commissioning Report are approved.

- B. Contractor shall supply all personnel and equipment for the demonstration, including, but not limited to, instruments, ladders, etc. Contractor supplied personnel must be competent with and knowledgeable of all project-specific hardware, software, and the HVAC systems. All training documentation and submittals shall be at the job site.
- C. The system shall be demonstrated following the same basic procedures outlined in the Pre-Commissioning section by utilizing the commissioning checklists included with this specification section. DDC EMS demonstration shall include, but not necessarily be limited to, the following:
 - 1. Demonstrate that all required software is installed on DDC EMS workstations. The Contractor shall demonstrate that all graphic screens, alarms, trends, and reports are installed as submitted and approved.
 - 2. Demonstrate that all points specified and shown can be interrogated and/or commanded (as applicable) from all workstations, as specified.
 - 3. Demonstrate that remote dial-up communication abilities are in accordance with these Specifications (not applicable to sites with campus Ethernet access).
 - 4. Demonstrate correct calibration of input/output devices using the same methods specified for the Pre-Commissioning Report. A maximum of 10 percent of I/O points shall be selected at random by University's Representative for demonstration. Upon failure of any device to meet the specified end-to-end accuracy, an additional 10 percent of I/O points shall be selected at random by University's Representative for demonstration. This process shall be repeated until 100 percent of randomly selected I/O points have been demonstrated to meet specified end-to-end accuracy.
 - 5. Demonstrate and verify that all DDC EMS programs accomplish the proper sequence of operations by using the commissioning checklists included with these specifications to record results. Verify proper sequences of operation of all specified functions whether listed in the commissioning checklists or not.
 - 6. Demonstrate that the panels automatically recover from power failures as specified.
 - 7. Demonstrate that the stand-alone operation of panels meets the requirements of these Specifications. The Contractor shall demonstrate that the panels' response to LAN communication failures meets the requirements of these Specifications.
 - 8. Identify access to equipment selected by University's Representative. Demonstrate that access is sufficient to perform required maintenance.
 - 9. Demonstrate that required trend graphs and trend logs are set up per the requirements. Provide a sample of the data archive. Indicate the file names and locations.

3.6 TRAINING OF UNIVERSITY PERSONNEL

- A. Provide training of University's personnel for the number of hours specified in the table below and as specified in Section 01 79 00 Demonstration and Training.

[Edit the table as required by the project. Project Manager to coordinate with DCM Engineering and FM]

Equipment/System	Section Number	Orientation Hours	Training Hours	DVD Recording
DDC EMS General Requirements (Building EMS)	25 95 00	8	32	Y
Laboratory Airflow Control System	25 95 05	8	16	Y

- B. The Contractor's designated training personnel shall meet with the University's Representative for the purpose of discussing and fine-tuning the training agenda prior to the first training session. Training agenda shall be submitted in writing and approved by the University's Representative prior to the beginning of on-site operator training. The training agenda shall reflect the specific needs of on-site personnel in order to make them familiar with the equipment provided with the project and to allow them to operate it correctly. A sample training agenda is shown below:
 - 1. Day 1

- a. Brief walk-through of building, including identification of all controlled equipment and condensed demonstration of DDC controller local display capabilities.
 - b. Brief overview of the various parts of the O&M manual, including hardware and software programming and operating publications, catalog data, controls installation drawings, and DDC programming documentation.
 - c. Demonstration of workstation login/logout procedures, password setup, and exception reporting.
 - d. Demonstration of workstation menu penetration and broad overview of the various workstation features.
 - e. Summary of day's session.
2. Day 2
 - a. Introduction to DDC panel programming.
 - b. DDC programming examples and demonstrations.
 - c. Summary of day's session.
 3. Day 3, 4 & 5
 - a. Review of sequence of operation, DDC panel programming, standalone modes, fail modes and graphic workstation screen for each HVAC subsystem.
 4. Day 6
 - a. Review of alarm features.
 - b. Review of diagnostics features.
 - c. Review of I/O hardware testing, calibration, and replacement.
 - d. Summary of day's session.
 5. Day 7
 - a. Review of trend feature.
 - b. Review of workstation reports.
 - c. Review of setpoint optimization and fine-tuning concepts.
 - d. Summary of day's session.
 6. Day 8
 - a. Review of all remaining miscellaneous workstation features.
 - b. Question and answer period.
 - c. Overall review of DDC EMS system.

3.7 SOFTWARE OPTIMIZATION ASSISTANCE

- A. Contractor shall provide the services of a controls technician for 16 man-hours at the project site to be at the disposal of the University's Representative. The purpose of this requirement is to make changes, enhancements and additions to controller and workstation software that have been identified by the University's Representative during the construction and commissioning phases of the project and that are beyond the specified Contract requirements. This service shall be provided at no additional cost to the University. Requests for assistance shall be for contiguous or non-contiguous 8 hour days.
- B. The controls technician provided shall be thoroughly trained in the programming and operation of the controller and DDC EMS workstation software. If the controls technician provided cannot perform every software tasks requested by the University's Representative in a timely fashion, Contractor shall provide additional qualified personnel at the project site as requested by the University's Representative, to meet the total combined requirement of project specific man-hours on-site.

END OF SECTION 25 08 00