```
**************************************************************************
USACE / NAVFAC / AFCEC            UFGS-25 08 10 (May 2021)
                                  ------------------------------------
Preparing Activity:  USACE        Superseding
                                  UFGS-25 08 10 (April 2006)


                  UNIFIED FACILITIES GUIDE SPECIFICATIONS

          References are in agreement with UMRL dated January 2024
**************************************************************************
```

SECTION TABLE OF CONTENTS

DIVISION 25 - INTEGRATED AUTOMATION

SECTION 25 08 10

UTILITY MONITORING AND CONTROL SYSTEM TESTING

05/21

-- End of Section Table of Contents --

```
*************************************************************************
USACE / NAVFAC / AFCEC              UFGS-25 08 10 (May 2021)


                                    -------------------------------------
Preparing Activity:  USACE          Superseding
                                    UFGS-25 08 10 (April 2006)


               UNIFIED FACILITIES GUIDE SPECIFICATIONS

        References are in agreement with UMRL dated January 2024
*************************************************************************
```

SECTION 25 08 10

UTILITY MONITORING AND CONTROL SYSTEM TESTING
05/21

****
NOTE: This guide specification covers the requirements for testing of UMCS and field control systems. Requirements for a performance verification test (PVT) which incorporates an endurance test, and optional requirements for a factory test are included. The factory test is similar to the PVT, but performed at the factory prior to system installation while the PVT is performed on the installed system.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1   GENERAL

****
NOTE: The designer will need to edit this specification if only a portion of the testing is required on the project. The engineer must keep in mind there can be testing of 1) new UMCS, 2) building level controls, and/or 3) combined building level controls and UMCS.
****

1.1   REFERENCES

The publications listed below form a part of this specification to the
extent referenced. The publications are referred to within the text by
the basic designation only.

1.2   DEFINITIONS

In addition to the definitions provided in this Section, 23 09 00
INSTRUMENTATION AND CONTROL FOR HVAC and 25 10 10 UTILITY MONITORING AND
CONTROL (UMCS) FRONT END AND INTEGRATION contain definitions related to
this Section.

1.2.1   Algorithm

A set of well-defined rules or procedures for solving a problem or
providing an output from a specific set of inputs.

1.2.2   Analog

A signal that can take on continuous (as opposed to discrete) values.
Sensors (e.g. temperature, pressure, flow) typically provide analog
signals as outputs to represent the measured variable.   Within the UMCS,
analog signals are generally represented by either 0-10 volt or a 4-20
milliamp signal.

1.2.3   Binary

A two-state system where an "ON" condition is represented by a high signal
level and an "OFF" condition is represented by a low signal level.

1.2.4   Change-Of-Value (COV)

A type of data transmission over the network where the point   value is
transmitted over the network only when its value changes.   COV is an
efficient use of network bandwidth.

1.2.5   Control Wiring

This includes conduit, wire, and wiring devices to install complete HVAC control systems, including motor control circuits, interlocks, sensors, PE and EP switches, and like devices.   This also includes all wiring from node to node, and nodes to all sensors and points defined in the I/O summary shown on drawings or specified herein, and required to execute the sequence of operation.   Does not include line voltage power wiring.

1.2.6   Demand

The maximum rate of use of electrical energy averaged over a specific interval of time, usually expressed in kW.

1.2.7   Graphical User Interface (GUI)

Human-machine interfacing allows the operator to manage, command, monitor, and program the system.

1.2.8   Integration

Establishing communication between two or more systems to create a single system.

1.2.9   Protocol

In control systems, "protocol" is generally shorthand for "communication protocol"; a defined method by which digital information is exchanged electronically.   Often more than one protocol is used in a BAS, for example, a typical BACnet system will use at a minimum (in addition to BACnet/IP and BACnet MS/TP) IP, UDP, ARP, Ethernet, and RS-485 protocols (and this does not include any protocols used internally in the front end or for communication with front end client workstations).

1.3   ADMINISTRATIVE REQUIREMENTS

1.3.1   Sequencing

Performance Verification Testing required by this Section must be proceeded by successful and accepted "contractors field testing" or "start-up and start-up testing" of the control system to be tested.

1.3.2   Scheduling

Coordinate testing schedules with the Government and with work in other Sections performed on the components or systems to be tested.

1.4   SUBMITTALS

****
          **NOTE: Review submittal description (SD) definitions
          in Section** 01 33 00 **SUBMITTAL PROCEDURES and edit
          the following list, and corresponding submittal
          items in the text, to reflect only the submittals
          required for the project. The Guide Specification
          technical editors have classified those items that
          require Government approval, due to their complexity
          or criticality, with a "G." Generally, other
          submittal items can be reviewed by the Contractor's**

Government approval is required for submittals with a "G" or "S"
classification. Submittals not having a "G" or "S" classification are
[for Contractor Quality Control approval.][for information only. When
used, a code following the "G" classification identifies the office that
will review the submittal for the Government.] Submit the following in
accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

    SD-06 Test Reports

        PVT Plan; G[, [_____]]

        PVT Phase I Report; G[, [_____]]

        PVT Phase II Report; G[, [_____]]

    SD-07 Certificates

        Test Instrumentation Calibration Certificates; G[, [_____]]

1.5   TEST EQUIPMENT

  Provide all test equipment unless otherwise noted in the contract
  documents. Use only test equipment with current calibration traceable to
  the National Institute of Science and Technology (NIST). For each test
  instrument, submit Test Instrumentation Calibration Certificates
  demonstrating calibration traceable to NIST.   Use test equipment and test
  methods such that the overall accuracy of the test method, including all
  test instrumentation and any errors inherent in the test procedure, is at
  least 50 percent better than the accuracy specified for the sensor.   For
  example, if a temperature sensor has an accuracy requirement of plus or
  minus 0.5 degrees Celsius1 degree Farenheit degree overall accuracy of the
  test method, must be 0.25 Celsius0.5 degree Farenheit or better.

When validating sensor accuracy, the test instrument is treated as if it is perfectly accurate; that is, the measured value from the test instrument must lie within the bounds of the specified accuracy of the sensor. Expressed mathematically:

    Given:
        Sensor accuracy: Plus or minus X
        Sensor reading: Y
        Test equipment reading: Z
        Where X, Y and Z are real numberts.

    Then
        Sensor passes if: $(Y-X) <= Z <= (Y+X)$
        otherwise, sensor fails

PART 2   PRODUCTS

  Not applicable

PART 3   EXECUTION

3.1   PERFORMANCE VERIFICATION TEST (PVT)

  Perform a Performance Verification Test (PVT) to demonstrate that the installed control system meets all requirements of the project specifications. Coordinate scheduling of the PVT with the Government, and do not begin the PVT until the PVT Plan submittal is accepted.

3.1.1   PVT PLAN

  Provide a PVT Plan including system documentation and PVT Procedures.

3.1.1.1   PVT Plan System Documentation

  ****
          **NOTE: If Section 23 09 00 is part of the project,
          keep the bracketed text referencing Section 23 09
          00, otherwise remove it.**
  ****

  Include the following system documentation in the PVT Plan:

  a. Copies of the most recent as-built drawings for the system, including but not limited to one-line drawings and Points Schedules [as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC] showing device address, point descriptions, network point names and types, hardware point types, settings and ranges including units.

  b. Copies of manufacturer's product data sheets when needed to demonstrate compliance with project requirements. In particular, provide data sheets showing that surge protection requirements have been met.

  c. Operation or user manuals for all software and all DDC Hardware to be tested.

  d. List of test equipment.

3.1.1.2   PVT Equipment List

Include in the PVT procedures a control system performance verification
test equipment list that lists the equipment to be used during performance
verification testing. For each piece of equipment include manufacturer
name, model number, equipment function, the date of the latest
calibration, and the results of the latest calibration

3.1.1.3   PVT Procedures

Develop PVT procedures using the test procedures in this Section,
modifying the procedures and adding tests as appropriate to develop
procedures that test all requirements of the project specifications.   The
test procedures must consist of detailed instructions for test setup,
execution, and evaluation of test results.

When developing additional procedures, provide the same information and
fields as shown in the Test Template.

3.1.2   PVT Phases

Conduct PVT testing in two phases:

I. Field testing for devices, components, subsystems and the overall
   system using the approved PVT Procedures.

II. A one-week endurance test during which the system is operated
    continuously.

3.1.2.1   PVT Phase I (Field Tests)

Demonstrate compliance of the control system with the contract documents.
Using test plans and procedures approved by the Government, demonstrate
all physical and functional requirements of the project. Show,
step-by-step, the actions and results demonstrating that the control
systems fully and correctly implement the sequences of operation. PVT for
surge protection is not required to include introducing a surge to the
equipment; surge protection may instead be demonstrated through product
documentation.

Do not start the performance verification test until after receipt of
written permission by the Government, based on Government approval of the
PVT Plan and Draft As-Builts and completion of balancing of the HVAC
System. Do not conduct tests during scheduled seasonal off periods of
base heating and cooling systems. At the completion PVT Phase I and in
accordance with the project schedule and project sequencing provide a PVT
Phase I Report documenting all PVT testing including all approved test
procedures with test results indicated on the procedures, and a record of
all actions taken to address PVT test failures.

3.1.2.2   PVT Phase II (Endurance Test)

Complete an endurance test as part of the PVT in which the system is
operated contuinuously for [one-week][___] without failure. During the
endurance test trend all points shown as requiring a trend on the Points
Schedule for the entire duration of the endurance test. If insufficient
buffer or storage capacity exists to trend the entire endurance test,
offload trend logs during the course of the endurance test to ensure that
no trend data is lost. If the control system specification includes

bandwidth requirements for bandwidth usage on a non-IP network, measure
and record the network bandwidth usage on each non-IP channel during the
endurance test.

If the system experiences any failures during the endurance test portion
of the PVT, repair the system and repeat the endurance test portion of the
PVT until the system operates continuously and without failure for the
specified endurance test period. At the completion of PVT Phase II and in
accordance with the project schedule and project sequencing provide a PVT
Phase II Report documenting failures and repair actions taken during PVT
Phase II.

3.1.2.2.1   Temporary Trending Capability

Unless trending capability exists, either within the building control
system or through a connected Utility Monitoring and Control System (UMCS)
Front End, temporarily install hardware on the building control network to
perform trending during the endurance test as indicated. Remove the
temporary hardware at the completion of all testing and commissioning
activities.

3.2   FACTORY TEST

Perform a Factory Test to demonstrate the capability of the proposed
control system solution to meet the requirements of project
specifications. Coordinate scheduling of the Factory Test with the
Government, and do not begin the Factory Test unil the Factory Test Plan
submittal is accepted.

3.2.1   Factory Test Setup

Design the Factory Test Setup to represent the system as it will be
fielded and to demonstrate the capability of the system to meet the
requirements of the project specification. At a minimum:

a. Include at least one of each model of DDC hardware, instrumentation and
   control device to be used on the project.

b. Include at least one network of each type to bue used on the project.

c. Include a programmable controller programmed as it will be installed,
   or, if no programmable controller is to be installed on the project,
   include a programmable controller with a sample application.

d. Include sample hardware to provide a mock field control system for the
   front end to communicate with if the project requires a front end but
   does not require a field control system.

3.2.2   Factory Test Plan

Provide a Factory Test Plan documenting the test setup and procedures.

3.2.2.1   Factory Test Plan Setup Documentation

Include the following information, at a minimum, to document the factory
test setup:

a. System one-line block diagram of equipment used in the factory test
    identifying computers (servers and workstations), network hardware,

DDC hardware, and other instrumentation including, but not limited to, sensors, actuators, test signal generators, and meters.

b. System hardware description used in the factory test.

c. System software description used in the factory test.

****
          **NOTE: It is best to keep the first bracketed text
          to require the use of the Points Schedule format
          specified in UFGS 23 09 00.   If this is not
          feasible, the second bracketed text may used and
          edited to address additional specific requirements.**
****

d. Points Schedules for each controller showing the configuration to be used during the test. Points Schedules must [be as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC][include the following information at a minimum: device address, point descriptions, network point names and types, hardware point types, settings and ranges including units].

e. Required passwords for each operator access level.

f. List of other test equipment.

3.2.2.2   Test Procedures

Develop factory test procedures using the Test Procedures in this Section, modifying the procedures and adding tests as appropriate to develop test procedures that test all requirements of the specification.   The test procedures must consist of detailed instructions for test setup, execution, and evaluation of test results.   Factory test procedures must include testing of surge protection by introducing a surge to the equipment and demonstrating that the equipment survives.

When developing additional procedures, provide the same information and fields as shown in the Test Template.

3.2.3   Factory Test Report

Upon completion of the Factory Test provide a complete test report, consisting of a short summary of the factory test, a copy of the Factory Test Plan, and copies of the executed test procedures separated by test. For each test, include date performed and identify the Government representative who witnessed and approved the test.

If a portion of any test failed, document the failure and corrective action.

3.2.4   Fatory Test Execution

Conduct the Factory Test at a location and time approved by the Government. The Government will witness the factory test.

If the system fails a portion of a test, the Government will determine whether the entire test or only the portion that failed must be repeated.

3.3   TEST PROCEDURES

Develop test procedures using the template procedure in the Appendix. A test template and sample test procedures in electronic format are available at the Whole Building Design Guide page for this section: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-08-1 Refer to the Sample Test Procedures Table to view the existing sample tests.

Sample Test Procedures	
Test No.	Test Title
1	System Equipment Verification
2	System Start-up
3	Monitoring and Control (M&C) Software Passwords
4	Graphic Display of Data
5	Graphic Navigation Scheme
6	Command Functions
7	Command Input Errors
8	Special Functions
9	Software Editing Tools
10	Scheduling
11	Alarm function
12	Trending
13	Demand Limiting
14	Report Generation
15	Uninterruptable Power Supply (UPS) Test
16	Routers and Repeaters
17	Gateways (Building Level)
18	Gateways (Device Level)
19	Local Display Panel (LDP)
20	Open Network Point Verification

Sample Test Procedures	
Test No.	Test Title
21	Custom Test Template

APPENDIX A
  TEST NUMBER: <TEST NUMBER>
  TEST TITLE: <TEST TITLE>

  OBJECTIVE: <STATE TEST OBJECTIVE>

INITIAL REQUIREMENTS/CONDITIONS

1. Submittals: <LIST REQUIRED SUBMITTALS>

2. Equipment: <LIST EQUIPMENT REQUIRED FOR TEST>

3. Reference Documentation: <LIST REQUIRED REFERENCE DOCUMENTATION>

Date of Test: _____
Time of Test: _____
Contractor's Representative: _____
Government's Representative: _____

Specification References for this verification:
<LIST SECTIONS REFERENCED FOR THIS TEST>

TEST PROCEDURES: <USE THE FOLLOWING FORMAT FOR TEST PROCEDURES, EXPAND AS NECESSARY TO CAPTURE ALL TEST ITEMS>

Item	Action	Expected Results	Approved
1			
2			
3			
4			

Item	Action	Expected Results	Approved
Notes:			

-- End of Section --