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Purpose

Procedure to standardize the testing of the Direct Digital Control (DDC) systems for construction projects.

Scope/Applicability

The DDC system for each project must be thoroughly checked out to ensure functionality.

Responsibilities

FEMC

Project Engineer or Desigee

- Coordinates the Final Inspection with appropriate parties.
- Oversees/Participates in the Start-up, Test, and Inspection Process to ensure the Specifications and Procedures are followed.

Certified Technician

Performs any testing, start-up, or inspection as dictated to ensure the warranty maintains its integrity; codes are followed; and procedures are followed as required.
NSF

_Title II Inspector_

Independent Inspector for the NSF, who witnesses the testing, start-up, and conducts his required inspections for the NSF.

**DDC System Check Out**

Since each system for every project varies, the DDC contractor will need to develop his or her own format to test the system. Below is the basic process, which needs to be detailed by the contractor.

**Hardware Control Panel Check**

Each control panel has a fixed number of digital inputs/outputs and analog inputs/outputs. Every condition should be checked against its intended functionality.

First, check the wiring. Perform all loop checks. Confirm all circuits terminate at the device shown on the drawings using wire type specified. Confirm shields are properly terminated and loop resistance is within proper limits.

Second, check each input and verify the desired output occurs. This includes verifying the control valves, actuators, dampers, and other devices function as intended for the desired resolution as a reaction to the input from the level sensors, flow sensors, and other input devices. The Sequence of Operation shall be verified, as well.

For example, if the Inside Air Temperature sensor sends an input signal of a temperature two (2) degrees lower than the setpoint or the desired temperature range, then the appropriate heating functions should occur to increase the inside air temperature.
See the following samples of checklists:

### Control Panel

<table>
<thead>
<tr>
<th>Location/Name:</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input/Output</th>
<th>Wiring</th>
<th>Functions</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input A#</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input D#</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output A#</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output D#</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Device Instance

<table>
<thead>
<tr>
<th>Device Instance</th>
<th>Device Address</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Temperature Control Panel #</th>
<th>Card #</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Object</th>
<th>Object Descr.</th>
<th>System Reading</th>
<th>Tested Reading</th>
<th>Units</th>
<th>Verify Wiring / Installation</th>
<th>Tech Initials</th>
<th>Comments</th>
</tr>
</thead>
</table>

|          |               |                  |                  |       |                               |               |          |
|          |               |                  |                  |       |                               |               |          |

### Software Check

The software operation confirmation is required as well. The software shall be loaded into the equipment, and tests shall be run. For instance, change the set point, and confirm the reactions denoted occur. The signal is sent out through the software, and the information on the screen reflects what is actually happening with the equipment. This must be documented. The vendor (or RPSC, if self performing) shall supply the form to document the test results, and prove the software functions.
Systems Check

Below is a list of systems and equipment point check out, which must be completed in order to confirm the DDC system operates as intended. These systems may not apply to all projects, and some projects could have additional systems. The vendor (or RPSC, if self-performing) will submit a project specific systems checklist.

Engine Jacket Water Heat Recovery and Cooling System

The commissioning technician will verify the normal operating conditions while a generator engine is running and verify the functionality of each component and it respective inputs and outputs to the DDC system to include the following:

- Engine Run Status
- Engine Jacket Leaving Temperature
- Engine Jacket Entering Temperature
- Engine Jacket Motor Operated Valve Modulation
- Engine Jacket Motor Operated Valve Position
- Heat Exchanger Entering Temperature
- Heat Exchanger Leaving Temperature
- Heat Exchanger Flow
- Radiator Entering Temperature
- Radiator Leaving Temperature
- Radiator Fan Start/Stop
- Radiator Fan Status
- Radiator Fan Variable Frequency Drive Modulation
- Radiator Fan Speed
- Radiator Room Space Temperature
- Radiator Room Outside Air Damper Operation
- Radiator Room Return Air Damper Operation
- Radiator Room Exhaust Air Damper Operation
- All Alarms Reporting

Waste Heat Hydronic System

The commissioning technician will simulate the normal operating conditions for each piece of equipment and verify the functionality of each component
and its respective inputs and outputs to the DDC system to include the following:

- Pumps Start/Stop
- Pump Status
- Pump Lead/Lag
- Pump Switch
- Differential Pressure Switch
- Variable Frequency Drives Modulation
- Variable Frequency Drives Speed
- Differential Pressure Sensor (System Loop pressure)
- End of the Line Differential Pressure
- Loop Hot Water Supply Temperature
- Loop Hot Water Return Temperature
- Loop Flow Transmitter
- Heat Exchanger Entering Temperature
- Heat Exchanger Leaving Temperature
- Heat Exchanger Flow Transmitter
- Heat Exchanger Motor Operated Valve Operation
- Heat Exchanger Motor Operated Valve Position
- All Alarms Reporting

**Exhaust Gas Heat Recovery**

The commissioning technician will simulate the normal operating conditions for each piece of equipment and verify the functionality of each component and its respective inputs and outputs to the DDC system to include the following:

- Pumps Start/Stop
- Pump Status
- Pump Lead/Lag
- Pump Switch
- Differential Pressure Switch
- Variable Frequency Drives Modulation
- Variable Frequency Drives Speed
- Differential Pressure Sensor (System Loop pressure)
- Exhaust Gas Heat Exchanger Entering Temperature
- Exhaust Gas Heat Exchanger Leaving Temperature
- Exhaust Gas Heat Exchanger Flow
- Exhaust Gas Heat Exchanger Motor Operated Valve Open/Close
- Exhaust Gas Heat Exchanger Motor Operated Valve Position
✓ Waste Heat Exchanger Entering Temperature
✓ Waste Heat Exchanger Leaving Temperature
✓ Waste Heat Exchanger Flow
✓ All Alarms Reporting

**Building Heating Hydronic System**

The commissioning technician will simulate the normal operating conditions for each piece of equipment and verify the functionality of each component and its respective inputs and outputs to the DDC system to include the following:

✓ Waste Heat HX Entering Temperature
✓ Waste Heat HX Leaving Temperature
✓ Waste Heat HX Flow
✓ Building Primary Loop WH HX Entering Temperature
✓ Building Primary Loop WH HX Leaving Temperature
✓ Building Primary Loop WH HX Flow
✓ Waste Heat Available Yes/No
✓ Primary Heating Loop Pump Start/Stop
✓ Primary Heating Loop Pump Status
✓ Primary Heating Loop Pump Lead/Lag
✓ Primary Heating Loop Pump Switch
✓ Primary Heating Loop Differential Pressure Switch
✓ Primary Loop System Differential Pressure
✓ Boiler Enable/Disable
✓ Boiler Status
✓ Boiler Heating Stage Low Fire
✓ Boiler Heating Stage High Fire
✓ Boiler Lead/Lag
✓ Boiler Switch
✓ Boiler Anti-shock
✓ Boiler Low Water Cutoff
✓ Boiler High Limit
✓ Boiler Hot Water Entering Temperature
✓ Boiler Hot Water Leaving Temperature
✓ Boiler Flow
✓ Outside Air Temperature
✓ Boiler Reset Schedule
✓ Primary/Secondary Loop Hot Water Mixing Motor Operated Valve Modulation
✓ Primary/Secondary Loop Hot Water Mixing Motor Operated Valve Position
✓ Secondary Loop (Building Loop) Heating Water Supply Temperature
✓ Secondary Loop (Building Loop) Heating Water Return Temperature
✓ Building Loop Pump Start/Stop
✓ Building Loop Pump Status
✓ Building Loop Pump Lead/ Lag
✓ Building Loop Pump Switch
✓ Building Loop Pump Differential Pressure Switch
✓ Building Loop System Differential Pressure
✓ Building Loop End of Line Differential Pressure
✓ All Alarms Reporting

**Heating Water System**

The temperature control contractor will simulate the normal operating conditions for the local heating water system and verify the functionality of each component and its respective input and output to the DDC control system to include the following items:
✓ Space Temperature
✓ Reheat Coil Valve Open/Closed
✓ Reheat Valve Position
✓ Fin tube Radiation Valve Open/Closed
✓ Fin tube Radiation Valve Position
✓ All Alarms Reporting

**Hot Water Single Zone Air Handling Units**

The commissioning technician will simulate the normal operating conditions for each air-handling unit and verify the functionality of each component and its respective input or output to the DDC control system to include the following items:
✓ Economizer Dampers
✓ Outside Air Damper
✓ Return Air Damper
✓ Relief damper
✓ Building Static Pressure
✓ Heating Coil Motor Operated Valve
✓ Supply Fan Start/Stop
✓ Supply Fan Status
✓ Variable Frequency Drive Modulation  
✓ Variable Frequency Drive Speed  
✓ Duct Static Pressure  
✓ Space Temperature  
✓ Duct Smoke Detector  
✓ Discharge Air Temperature  
✓ Filter Status  
✓ Door Switch  
✓ Mixed Air Temperature  
✓ Return Air Temperature  
✓ CO₂ Sensor  
✓ Freeze stat (Low Limit Thermostat)  
✓ All Alarms Reporting

The differential pressure switch provided for filter status will be appropriately configured so as to close a contact to the DDC system if the pressure drop across the filter bank exceeds the manufacturer’s recommended limit.

The low limit thermostat will be set at 35°F (adjustable).

**Exhaust Fans**

The commissioning technician will simulate the normal operating conditions for the exhaust fans and verify the functionality of each component and its respective input or output to the DDC control system to include the following items:
✓ Exhaust Fan Start/Stop  
✓ Exhaust Fan Status  
✓ Exhaust Fan Damper Open/Close  
✓ Exhaust Fan Damper Position  
✓ Building Static Pressure  
✓ Variable Frequency Drive Modulation  
✓ Variable Frequency Drive Speed

**Blower Coil Unit**

The commissioning technician will simulate the normal operating conditions for the blower coil unit and verify the functionality of each component and its respective input or output to the DDC control system to include the following items:
✓ Heating coil HW valve
✓ Supply Fan Start/Stop
✓ Supply Fan Status
✓ Space Temperature
✓ Discharge Air Temperature
✓ Filter Status
✓ Freeze stat (Low Limit Thermostat)
✓ All Alarms Reporting

The differential pressure switch provided for filter status will be appropriately configured so as to close a contact to the DDC system if the pressure drop across the filter bank exceeds the manufacturer’s recommended limit.

The low limit thermostat will be set at 35°F (adjustable).

References

See project plans, specifications, and submittals.

Records

Hardcopies of completed test results are maintained within FEMC Document Control in project specific files, and electronic copies are available on station.