The 16th National Conference on Building Commissioning

"PFTs: Useful Tool or A Complete Waste of My Time?"

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“PFTs: Useful Tool or A Complete Waste of My Time?”

Definition

A prefunctional test checklist is a detailed list of Installation, Operational, and Documentation requirements that need to occur or be submitted before a piece of equipment or system can be functionally tested.

New Industry Standard Term

Construction Checklists

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Purpose of the PFT

The commissioning prefunctional test checklist has many purposes. It is the responsibility of the contractors to provide operating building systems within the guidelines of the contract. The PFTs are one tool that helps the contractors fulfill that responsibility.

- Indicates that systems are ready for functional testing. Answers the question "what does complete mean?"
- Reduces the amount of time the CxA spends functionally testing.
- Allows the information reported by the DDC system to be used for testing purposes.
- Delineates for the contractor what is required in the specifications.
- Reduces the chance of contractor backcharges due to systems not being ready when CxA arrives to conduct functional testing.
- Saves money for everyone!

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How are they supposed to be used?

Each subcontractor, mechanical, electrical, test and balance, controls has a part to play in any HVAC system. One way to use them is to provide a checklist for each subcontractor. The idea is for each subcontractor to use the list as they are installing and starting up the piece of equipment to assure themselves that they have not forgotten a task.

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Examples of Problems that PFTs are designed to Eliminate

- Vibration isolation components in the shipping position instead of the operating position
- Fans running backwards
- Overcurrent protection devices the wrong size
- Missing gauges
- Valves stroking the wrong direction or slipping on the actuator rods
- Setpoints not input.

The PFT will help the contractor eliminate issues such as these, which is their responsibility, instead of relying on the CxA team to develop a punchlist for them.

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How can the PFT process be improved?

- Stronger specification language, include sample PFTs in the specifications, reference Cx in all pertinent sections.
- Put in the specifications that back charges will apply if the CA arrives on site and the equipment is not ready (eliminate coffee shop PFTs)
- Put submission of PFT documentation as a milestone on the CPM schedule.
- Easier to use forms.
- Forms for each individual piece of equipment instead of for each type of equipment.
- Adhering the PFT on the piece of equipment and let each contractor sign off as he completes his tasks – one PFT for each unit, probably multiple pages

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How can PFT documentation be Improved?

Lets look at some samples:

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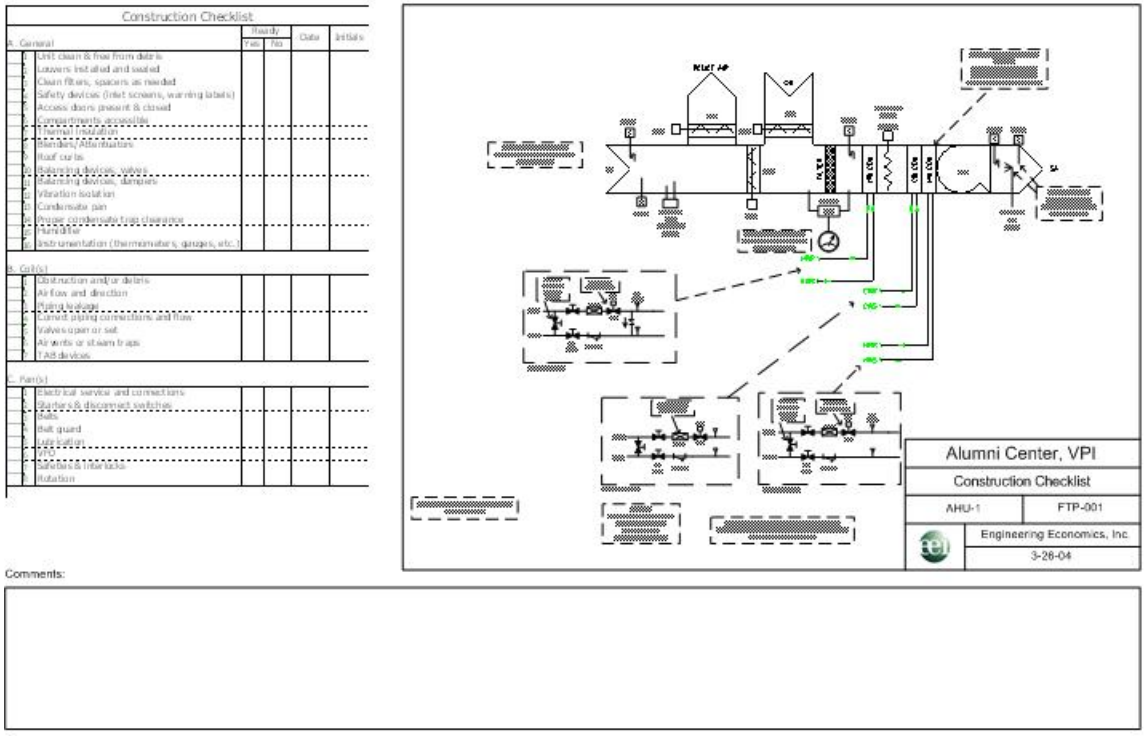

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PROJECT NAME M-PFT-XXX

Mechanical Contractor Pre-functional Test Checklist

Equipment: Rooftop Unit
Location:
Serves:

Mark:
Date:
Company:
Technician::

v	*Check when complete*	*Notes, completion data:*

Components and installation per project documents and approved submittals:

	Fans	
	Motors	
	Belts	
	Safety devices (inlet screens, belt guards)	
	Cabinet or built-up plenum	
	Coils	
	Condensate drain pan and piping	
	Filter bank (w/clean operational filters)	
	Humidifier	
	Volume control devices (variable frequency drive, inlet vanes, inlet cones)	
	Control dampers (outside air, return air, exhaust, relief, isolation, barometric)	
	Control valves	
	Balancing devices (valves and dampers)	
	Vibration isolation (in operating position)	
	Instrumentation (thermometers, pressure gauges, magnahelics, P/Ts)	
	Thermal insulation	
	Equipment/device tags and labels	
	Access panels, doors and lights	
	Blenders	
	Roof curb	

Operational checks complete:

	Fan/motor alignment	
	Fan/motor lubrication	
	Fan rotation	
	No unusual vibrations or noises	
	Acceptable air leakage	
	Debris removed and surfaces clean	
	Manufacturer's start-up test complete	

Documentation complete:

	Operation and maintenance information	
	Manufacturer's test report submitted (attach copy)	
	Contractor's start-up report submitted (attach copy)	
	As-built drawings current	

Checklist Complete

Signature Date

File: PFT Checklist-RTU

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PROJECT NAME E-PFT-XXX

Electrical Contractor Pre-functional Test Checklist

Equipment: Rooftop Unit
Location:
Serves:

Mark:
Date:
Company:
Technician::

v	*Check when complete*	*Notes, completion data:*

Components and installation per project documents and approved submittals:

	Conduit	
	Wiring	
	Variable frequency drive	
	Motors	
	Starters	
	Disconnects	
	Over-current protection devices	
	Switches (HOA, push-button, selector, safety)	
	Hardwire interlocks	
	Control transformers	
	Convenience outlets	
	Lighting	
	Grounding	
	Wiring tags and equipment labels	

Operational checks complete:

	Motor amps/volts	
	Motor rotation	
	VFD enclosure fan and filter	
	Circuits tested	

Documentation complete:

	Operation and maintenance information	
	Contractor's test report submitted	
	As-built drawings current	

Checklist Complete

Signature Date

File: PFT Checklist-RTU

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PROJECT NAME — **TAB-PFT-XXX**

Test and Balance Contractor Pre-functional Test Checklist

Equipment: Rooftop Unit
Location: _____
Serves: _____

Mark: _____
Date: _____
Company: _____
Technician:: _____

	Check when complete	Notes, completion data:

Components and installation per project documents and approved submittals:

☐	Fans	
☐	Safety devices (inlet screens, belt guards)	
☐	Coils	
☐	Filter bank (w/clean operational filters)	
☐	Humidifier	
☐	Volume control devices (variable frequency drive, inlet vanes, inlet cones)	
☐	Control dampers (outside air, return air, exhaust, relief, isolation, barometric)	
☐	Control valves	
☐	Balancing devices (valves, dampers, P/Ts)	
☐	Blenders	
☐	Instrumentation (thermometers, pressure gauges, magnahelics, manometers, P/Ts)	
☐	Overloads matched to motor	

Operational checks complete:

☐	Mechanical and electrical pre-functional checks	
☐	Fans (rpm, belts, sheaves)	
☐	Motors (amps, volts, bhp)	
☐	Volume flowrates and velocities (OA, RA, SA, water)	
☐	Pressure relationships (inlet, discharge, differential across components)	
☐	Damper positions	
☐	Overloads checked	
☐	Simulated filter loading	
☐	Manual bypass valves set, marked, and locked	
☐	Balancing devices set, marked, and locked	
☐	Test holes plugged	
☐	Sound levels per design criteria	

Documentation complete:

☐	Preliminary balancing report submitted	
☐	As-built drawings current	

Checklist Complete

_____ Signature _____ Date

PROJECT NAME — **CC-PFT-XXX**

Controls Contractor Pre-functional Test Checklist

Equipment: Rooftop Unit
Location: _____
Serves: _____

Mark: _____
Date: _____
Company: _____
Technician:: _____

	Check when complete	Notes, completion data:

Components and installation per project documents and approved submittals:

☐	Control panels (enclosure rating, ambient temperatures, accessibility)	
☐	Control valves (location, type, piping)	
☐	Control dampers (location, type, pressure class, linkage adjustment)	
☐	Control actuators (type, size, normal position)	
☐	Control sensors (type, location, range, accessibility)	
☐	Control wiring (size, type, insulation, shielding, terminations, coding, conduit)	
☐	Pneumatic tubing (material, support, filter/drier, pressure range, gauges, conduit)	
☐	Identification labels/tags (equipment, panels, devices, wiring)	

Operational checks complete:

Point-to-point:

☐	Attach point to point checklist PP-XXX with items checked off for proper location and connection (verify with open circuit or other suitable test)	
☐	For starters with HOAs, verify proper selector function in all positions	

Calibration:

	Attach Control Calibration Checklist CC-XXX with:	
☐	Analog input points indicating actual device readings and readings taken with a standard calibration instrument	
☐	For pneumatic devices, a list of analog output points indicating zero and span values for each point	
☐	Freezestat calibration	
☐	Calibration of all stand-alone control devices (thermostats, pressure switches, etc.)	
☐	Calibration and set-up of current switches	

Setpoints:

☐	Space Static Pressure	Setpoint =
☐	Mixed Air Temperature	Setpoint =
☐	Discharge Air Temperature	Setpoint =
☐	Preheat Air Temperature	Setpoint =
☐	Economizer Lockout Temperature	Setpoint =
☐	Minimum Outside Air CFM	Setpoint =
☐	Timed Override	Setpoint =
☐	Unit Operating Schedule	Setpoint =
☐	Compressor Minimum On/Off Time	Setpoint =
☐	Compressor Staging Deadbands	Setpoint =
☐	High Discharge Temperature Alarm	Setpoint =
☐	High Discharge Static Pressure Alarm	Setpoint =
☐	Manual High Discharge Static Pressure Alarm	Setpoint =
☐	Dirty Filter Alarm	Setpoint =

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PROJECT NAME — PP-XXX

Controls Point to Point Checklist

Equipment: Rooftop Unit
Location:
Serves:

Mark:
Date:
Company:
Technician:

v — *Check when complete*

Temperature Sensors:

	Point Name	Point Type	Open Circuit Reading	Notes:
Discharge Air				
Mixed Air				
Outside Air				
Return Air				
Preheat Air				

Humidity Sensors:

	Point Name	Point Type	Open Circuit Reading	
Outside Air				
Return Air				

Pressure Sensors:

	Point Name	Point Type	Open Circuit Reading	
Discharge				
Space				

Airflow Stations:

	Point Name	Point Type	Open Circuit Reading	
Supply				
Return				

Current Sensors:

	Point Name	Point Type	Open Circuit Reading	
Supply Fan				
Return Fan				

Stand Alone Devices:

	Point Name	Point Type	Open Circuit Reading	
Freezestat				
Discharge Pressure				
Filter				

File: PP Checklist-RTU

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PROJECT NAME — CC-XXX

Controls Calibration Checklist

Equipment: Rooftop Unit
Location:
Serves:

Mark:
Date:
Company:
Technician:

v — *Check when complete*

Temperature Sensors:

	Point Name	BMS	Measured	Correction Factor	Notes:
Discharge Air					
Mixed Air					
Outside Air					
Return Air					
Preheat Air					

Humidity Sensors:

	Point Name	BMS	Measured	Correction Factor	
Outside Air					
Return Air					

Pressure Sensors:

	Point Name	BMS	Measured	Correction Factor	
Discharge					
Space					

Airflow Stations:

	Point Name	BMS	Measured	Correction Factor	
Supply					
Return					

Current Sensors:

	Point Name	Amp Reading	Fan Speed	Correction Factor	
Supply Fan					
Return Fan					

Stand Alone Devices:

	Point Name	Design	Measured	Adjustment Made	
Freezestat					
Discharge Pressure					
Filter					

Dampers:

	Point Name	Milliamp, Voltage, or Pressure		Correction Factor	
		Full Closed	Full Open		
Outside Air					
Min Outside Air					
Return Air					
Exhaust Air					

File: CC Checklist-RTU

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How can PFT documentation be Improved?

One idea is to have 3 "Pre-Functional Test" forms per contractor.

- The first would be an installation checklist with a one-line diagram.
- The second would cover startup information and include submission of manufacturer's startup sheets.
- The third would cover information required before the CxA comes out to start functional testing and would include:
  - O&M Manuals
  - Control Point to Point and Control Calibration sheets
  - Preliminary TAB reports
  - Duct Pressure Tests
  - Piping Pressure Tests
  - Acknowledgement that all resources and tools will be available when the CxA reaches the job (the right contractors with the right tools).

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3 “Pre-Functional Test” forms (con’t)

Submission of the first would signal start-up activities are ready to commence. Submission of the second and third would signal functional testing is ready to commence.

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- Is this an improvement?
- Would it make life easier for owners and the contractors?
- Is it cost effective?
- Different ideas?

"PFTs: Useful Tool or A Complete Waste of My Time?"

- Contractor's Opinion – are CxA provided PFTs of any use? Are they viewed as just more paperwork? Do they aid in keeping a project on schedule? Is there a better way to format them?
- Owner's Opinion - are the PFTs cost affective? Do you see them as a benefit? Are you willing to pay the CxA to more closely monitor their use in the field?
- Provider's Opinion – are you successful in getting real PFTs with meaningful information? Do you find that even though the PFTs are meticulously filled out they are not a good representation of field conditions?
- Final questions – are they worth it? If so, how can the process and documentation be improved?