BUILDING PERFORMANCE INSTITUTE, INC.

TECHNICAL STANDARDS
FOR THE
MULTIFAMILY HYDRONIC HEATING PROFESSIONAL

	Module	Category	Standard	Method or Technique	Special Materials or Equipment
1	**General**				
1.1	General		Design and specify the highest efficiency system, system enhancements, and equipment that are cost effective, while being an advocate for the interests of both the owner and the occupants.	Energy Star, Motor Master, BPI Best Practices	
1.2	General		All design specifications, performance parameters, and testing procedures shall meet or exceed current energy codes and standards.	ASHRAE 90.1, IEC 2003	

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2 Initial Evaluation and Analysis					
2.1	Initial Evaluation and Analysis	Interview / Preliminary Review	Request and review in detail any previous energy audit or other building assessment reports, check for their validity and accuracy including assumptions and results, and incorporate into your overall building analysis and review		
2.2	Initial Evaluation and Analysis	Interview / Preliminary Review	Determine if other energy improvements are planned and evaluate what their impact could be on the system		
2.3	Initial Evaluation and Analysis	Interview / Preliminary Review	Document the owner's requirements and help to clarify the owner's expectations		
2.4	Initial Evaluation and Analysis	Interview / Preliminary Review	Identify enhancements to the owner's planned scope of work to improve the overall performance of the system after installation and make appropriate recommendations		
2.5	Initial Evaluation and Analysis	Interview / Preliminary Review	Collect available energy usage of building and perform benchmarking of current usage. Designer shall input current building information into benchmarking database, if developed.	Utility bills; Heating: Btu/sq.ft./hdd; DHW: fuel use per occupant/year; DHW baseload as % of total load	
2.6	Initial Evaluation and Analysis	Interview/ Preliminary Review	Interview owner, maintenance staff and occupants to determine existing system inadequacies and potential solutions	Face to face interviews;	
2.7	Initial Evaluation and Analysis	Site Assessment	Conduct a physical site inspection that includes but is not limited to: ◆ evaluation of existing conditions/problems and equipment	Written documentation and/or pictures; temperature measurement and	

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			◆ inspection of existing distribution systems and documentation of conditions; ◆ inspection of all physical building characteristics that would have an impact on the building load analysis ◆ measurement of equipment room and evaluation of potential alternatives	documentation; observation of open windows	
2.8	Initial Evaluation and Analysis	Site Assessment	When combustion efficiency tests are conducted, they shall NOT be used as a sole determinant to replace a heating plant, but to indicate possible problem areas or as part of a comprehensive diagnostic procedure.		Access to a Combustion Analyzer
2.9	Initial Evaluation and Analysis	Site Assessment	During the site inspection, the designer shall measure the ambient CO level in the equipment room with the boiler operating. Stop work and evacuate if ambient levels reach or exceed 35ppm as measured. Determine and fix source when safe to re-enter	CO detector with digital readout	
2.10	Initial Evaluation and Analysis	Site Assessment	Identify and diagnose alternatives or remedies to poor installation techniques that need to be addressed from the old system to the new	Visual inspection; IBR standards and manufacturers recommendations	
2.11	Initial Evaluation and Analysis	Site Assessment	Assess areas of overheating and inadequate heating for both heat and hot water and identify potential solutions		
2.12	Initial Evaluation and Analysis	Site Assessment	Assess the adequacy of the combustion air supply and evaluate the effectiveness of the venting system	Visual inspection; Uniform Mechanical Code, NFPA, IBR	

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				standards and manufacturers recommendations	
2.13	Initial Evaluation and Analysis	Load Analysis	Identify heating and hot water system zones and the loads associated with those zones; determine modifications to existing zones in order to better serve owner, occupants, and overall efficiency of the system and building		
2.14	Initial Evaluation and Analysis	Load Analysis	Gather all information from the site to perform a detailed load analysis of heating, radiation, and DHW loads of the building, including planned or potential changes to building and determine each load. The designer shall document all assumptions and obtain the owner's sign-off for all assumed data inputs.	IBR, ASHRAE, ACCA: Manual J, Dan Hallohan	
2.15	Initial Evaluation and Analysis	Design Analysis	Complete a life cycle cost analysis on all proposed options that includes: first cost, utility costs, O&M costs, replacement costs, and the time value of money. The base case shall include all costs to create a properly operating, minimally code compliant system that reflects the owner's expectations. At least on option shall be a combined heat and DHW system. Additional O& M costs associated with keeping fully modulating burners properly tuned shall be included in the LCC analysis	Performance and effectivenes values for combined vs. separate systems will be researched. In the absence of data, the EP will determine default values. BPI will use existing data to create LCC database: equipment lifetimes, discount rate, etc.	
2.16	Initial Evaluation and Analysis	Design Analysis	When evaluating options, distribution measures shall be prioritized over central		

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		plant replacement or modification measures whenever the central plant does not pose an immediate health and safety risk.		

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3 System Design					
3.1	System Design	Design Load	When sizing steam systems, the equipment sizing shall be dependent on the radiation load, the building load, a pick-up factor, and the DHW load (in combined systems).	Reference BPI Best Practices	Manufacturer's computer programs, ACCA, ASHRAE, IBR
3.2	System Design	Design Load	When sizing hot water heating systems, the equipment sizing shall be dependent on the building load, the existing radiation, and the DHW load (in combined systems).		1997 ASHRAE Fundamentals Table 1A 99 Percentile
3.3	System Design	Design Load	When sizing stand-alone DHW systems, the equipment sizing shall be dependent on the DHW load.		Manufacturer's computer programs, ACCA, ASHRAE, IBR
3.4	System Design	All Systems	Specify the installation of a water meter to determine possible leakage on the water feed line where automatic water feeders are installed.		
3.5	System Design	All Systems	Specify a working pressure gauge and supply and return thermometers (if applicable).		
3.6	System Design	All Systems	Specify a permanently installed but serviceable stack temperature gauge.		
3.7	System Design	All Systems	In oil systems, specify liquid-filled vacuum gauges on both sides of the oil filter.		
3.8	System Design	All Systems	Where oil tanks are present, the designer shall insure that measurement of the oil level is possible. The designer shall insure that the measurement device is properly calibrated for the size of the tank.		
3.9	System Design	All Systems	Confirm local service and maintenance availability by at least two providers for any		

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			equipment specified.		
3.10	System Design	All Systems	Guideline strategies for addressing existing distribution systems.		
3.11	System Design	All Systems	Specify an outdoor lock-out sensor. Lock-out sensors must be located in the shade.		
3.12	System Design	All Systems	Specify controlled access to the operating and safety control systems.		
3.13	System Design	All Systems	Install pop safety valves as required by ASME standards or more stringent local codes, including piping the discharge to the floor.	ASME standards	
3.14	System Design	All Systems	Atmospheric gas boilers are not allowable except in steam heating distribution systems below 500,000 BTU. If specified, they shall be equipped with motorized vent dampers and no standing pilot.		
3.15	System Design	DHW	End use water saving devices like low flow showerheads and aerators shall be considered for all DHW retrofits where such devices do not already exist.		
3.16	System Design	DHW	The maximum specified DHW temperature may not exceed 130°F at the faucet.		
3.17	System Design	DHW	Specify pipe insulation on all heating & DHW supply pipes in unconditioned space. All copper piping shall be insulated. All cold water piping shall be insulated.	½" on cold water; 1" on DHW supply	
3.18	System Design	DHW	When designing DHW storage, specify a minimum storage temperature of 115°F - 120°F or as specified by local codes. Delivery cannot exceed 120°F or as specified by local	Local or National Code	

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			codes		
3.19	System Design	Pumps	Pump specifications shall ensure the shut-off head does not exceed 80% of the pressure at which the thermostatic radiator valves or zone valves crack open.		
3.20	System Design	Pumps	Specify pumps and piping that have the flow capacity to meet the manufacturer's recommendation for the radiation.	ASHRAE or Moody Chart. Manufacturer's pump design programs	
3.21	System Design	Hot Water	The design fill pressure shall be adequate to maintain 15 psi at the top of the system as determined based on the following formula: ((Height(ft) from point of fill to top of the system ÷ 2.31) + 15) = Fill Pressure (psi). This safety factor will ensure that the pressure remain positive at the top of the system. Reference exceptions document.		
3.22	System Design	Hot Water	Specify that expansion tanks shall be pumped up with compressed air to the calculated fill pressure while there is zero pressure in the system. Verify the expansion tank pressure with a tire pressure gauge. Specify diaphragm tanks ONLY.	Tire pressure gauge; Manufacturer Specifications	
3.23	System Design	Hot Water	Specify that the make up water pressure regulator shall be set to match the calculated system fill pressure.		
3.24	System Design	Hot Water	Include the system fill detail provided for all hot water systems.	Reference system fill diagram.	
3.25	System Design	Hot Water	When designing a new hot water distribution		

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			system, make each room a separate zone with its own temperature control. All terminal units shall be equipped with thermostatic radiator valves. Zone control for a room shall respond to the temperature in that room.		
3.26	System Design	Hot Water	Specify outdoor reset and lock-out controls in all hot water systems.		
3.27	System Design	Steam	Float-type air vents shall be specified at each high point in the distribution piping. Pipe all returns for new installations together to a common pipe at the top of the building where a single centrifugal vent is located, then a single express return runs back to the boiler room. For one or two story buildings, specify scoop type or centrifugal type air separator downstream of the boiler and upstream of the heating water distribution pump. For buildings taller than two stories, air separator is not needed at the bottom.		
3.28	System Design	Steam	The near boiler piping shall be designed to eliminate water hammer.		
3.29	System Design	Steam	The radiator shall not be reversed pitched whether one or two pipe system. Level radiators are acceptable.		
3.30	System Design	Steam	The specified thermostat shall be capable of		

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			adjustment to avoid short cycling. When specifying use of an indoor thermostat to control the burner, ensure the span is adjustable. Outdoor reset control cycling settings shall be adjustable long enough to be appropriate for steam.		
3.31	System Design	Steam	Buried return lines are not allowable in the system design. If buried return lines are present in the existing systems, recommend that they are relocated above grade.		
3.32	System Design	Steam	Specify both a primary and secondary low-water cut-off.		
3.33	System Design	Steam	Specify operating pressure control devices with ranges no higher than 5 psi, or as specified by local codes, properly piped with perpendicular pigtails.		
3.34	System Design	Steam	Specify a high limit pressure safety control device with manual reset properly piped with perpendicular pigtails.		
3.35	System Design	Steam	Specify a modulating pressure control device when specifying a modulating burner.		
3.36	System Design	Steam	Condensate return/pump units shall not be used to control boiler water level.		
3.37	System Design	One-Pipe Steam	When retrofitting one-pipe steam systems, specify master venting. Riser venting shall also be included on all risers where accessible and where all the risers go to the top floor. Otherwise install properly sized and located high capacity vents on the horizontal main		

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			lines.		
3.38	System Design	One-Pipe Steam	Properly size radiator vents when required to balance the system. Ensure that the radiator vent is properly operating. All radiator valves shall be capable of 100% closure.		
3.39	System Design	Two-Pipe Steam	Develop a master venting strategy for the system design.		
3.40	System Design	Two-Pipe Steam	Specify one or a combination of energy saving control systems including, but not limited to multipoint thermostats, TRVs, and a steam cycle reset controller.		

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4 Document Preparation and Presentation					
4.1	Document Preparation and Presentation	Specifications	Prepare written specifications to include, at a minimum, the following: (1) Piping Layout showing pipe sizes and insulation requirements (2) System Wiring Diagram (3) Equipment specifications (4) Initial control and safety settings with sequence of operation		
4.2	Document Preparation and Presentation	Specifications	The specification shall include delivery of the as-built drawings of the system by the contractor/installer at the end of the project.		
4.3	Document Preparation and Presentation	Specifications	The specification shall define the training requirements for maintenance personnel/operator and end user.		
4.4	Document Preparation and Presentation	Specifications	The specification shall include a detailed system cleaning regimen to include as appropriate: system flushing, skimming, addition of temporary filter, etc.		
4.5	Document Preparation and Presentation	Specifications	The specification shall indicate specific markings such as flow indicators, equipment labeling, valve labels referenced by a valve schedule, etc.		
4.6	Document Preparation and Presentation	Specifications	The specification shall indicate all required permits and attainment responsibilities.		
4.7	Document Preparation and Presentation	Bid Documents	The specification/bid documents shall specifically indicate responsibility for each aspect of the scope of work.		

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4.8	Document Preparation and Presentation	Bid Documents	The specification/bid documents shall include language to specify change order procedures and approval responsibility.		
4.9	Document Preparation and Presentation	Bid Documents	The specification/bid document shall include an indication of controlled inspections based on milestones and ties to payments.		

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5 Quality Assurance and Verification					
5.1	Quality Assurance and Verification	Pre-construction	Review the design and specifications with the owner to ensure the system as designed is consistent with the owner's expectations and verify proposed equipment meets design specifications.		
5.2	Quality Assurance and Verification	Pre-construction	Conduct a site tour with all relevant parties to ensure uniformity of bids; ensure that all contractors are aware that they must follow all codes and file all permits with governmental entities.		
5.3	Quality Assurance and Verification	Pre-construction	Conduct a pre-construction conference to provide scheduling and eliminate potential conflicts during the construction process. Prepare addenda as required and prior to 5 days before the bid date (or as specified); verify that all bidding contractors receive addenda by noting on the bid form. Post addenda in the specification book so they are not forgotten.		
5.4	Quality Assurance and Verification	Pre-construction	Confirm all submitted equipment meets design guidelines & service clearances; provide standardized documentation for reporting, results, and testing during construction, and determine schedule for testing and balancing milestones.		
5.5	Quality Assurance and Verification	Construction Phase	Ensure that all necessary permits and insurance documents are posted and filed prior to any start of work on the job.		

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5.6	Quality Assurance and Verification	Construction Phase	Through continuing inspections, verify that: ◆ all equipment meets specifications; ◆ all equipment, piping, and insulation are installed to design specifications, manufacturer's specifications, and with appropriate clearances; ◆ all temperature sensors and controls are properly located, calibrated, and operating; and ◆ all safety controls are operating according to specifications.	Standardized written reports following up verbal communication in field; manufacturer's specifications	
5.7	Quality Assurance and Verification	Construction Phase	Document the results of in process inspections to the owner and contractor for payment and/or correction as per contract & milestones.	Standardized written reports following up verbal communication in field	
5.8	Quality Assurance and Verification	Construction Phase	Continuously review all contractor and subcontractor performance to ensure that work meets standards and best practices, and document any anomalies and problems in writing to owner and contractor.	Standardized written reports following up verbal communication in field	
5.9	Quality Assurance and Verification	Construction Phase	Assure that contractor shall follow all codes and manufacturers instructions, and that all persons on the site (contractors, subcontractors, designer & associated staff) wear protective equipment as required by OSHA or other governing body.	Manufacturer's specifications, OSHA	
5.10	Quality Assurance and Verification	Post-construction	Review all balancing procedures and evaluate T&B report results for consistency with design specifications.		

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5.11	Quality Assurance and Verification	Post-construction	Review and verify the performance of all equipment for code compliance, combustion efficiency and firing rates.		
5.12	Quality Assurance and Verification	Post-construction	Verify all system components have been installed in compliance with the design specifications including: ◆ all sensor and thermostat locations and operation ◆ verify equipment, piping, insulation, controls, and sensors. ◆ Run all equipment; cycle all controls to ensure proper operation, ensure that all safeties and sensors are installed and performing to manufacturers' and design specifications; ◆ check supply and return temperatures ◆ Verify that steam vents, valves, risers, and lines do not leak.	Verify test and balance parameters and have T&B contractor to demonstrate selected test(s) in your presence.	
5.13	Quality Assurance and Verification	Post-construction	Review and insure delivery of: ◆ as-built drawings (with additional copies as required by contract); ◆ O & M manuals from manufacturers ◆ any specially prepared customized O&M procedures that are job-specific; and ◆ oversee and verify customer training.		
5.14	Quality Assurance and Verification	Post-construction	Document QA and verification results for contractor performance evaluation.		
5.15	Quality	Post-construction	Facilitate turnover of system from contractor to		

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Assurance and Verification		owner and verify start of warranty period, including all warranty records; check for filing of all necessary permits, regulatory filings, and other forms to ensure final governmental approvals.		