EE 5: IMPROVE EFFICIENCY OF BOILERS & HEATING DISTRIBUTION SYSTEMS

ANSI/ASHRAE/IESNA 90.1 (2007) and Energy Conservation Construction Code of New York State, as incorporated in Chapter 13 of the New York City Building Code
Proposal developed by the Energy & Ventilation Committee

Summary

Issue:
The energy code permits the use of inefficient boilers and heat-distribution systems.

Recommendation:
Establish higher efficiency standards for heating systems. Also, prohibit the installation of new one-pipe steam systems and other inefficient systems.

Proposed Legislation, Rule or Study

Amendments to ANSI/ASHRAE/IESNA 90.1 (2007)

1. Amend Section 6.3.2(d) as follows:

d. Heating (if any) shall be provided by (i) a unitary packaged or split-system heat pump that meets the applicable efficiency requirements shown in Table 6.8.1B (heat pumps) or Table 6.8.1D (packaged terminal and room air conditioners and heat pumps), (ii) a fuel fired furnace (x) with a capacity less than 225,000 Btu/hour that meets the applicable efficiency requirements shown in Table 6.8.1E (furnaces, duct furnaces, and unit heaters); or, (y) with a capacity of 225,000 Btu/hour or more and meeting the greater of the applicable efficiency requirements shown in Table 6.8.1E (furnaces, duct furnaces, and unit heaters) or 81% in either case using the test procedures specified in Table 6.8.1E; or (iii) an electric resistance heater, or a baseboard system connected to a boiler (x) with a capacity less than 300,000 Btu/hour that meets the applicable efficiency requirements shown in Table 6.8.1F (boilers); or, (y) for such units with capacity of 300,000 Btu/hour or more, meeting the greater of the applicable efficiency requirements showing in Table 6.8.1F (boilers) or 81%; in either case using the test procedures specified in Table 6.8.1F. Atmospheric boilers shall not be permitted. The capacity of any auxiliary electric resistance space heater(s) shall be limited to a maximum of 5% of the peak heating load of the building.

2. Add a new Section 6.3.2(p) as follows:

p. One-pipe steam distribution is prohibited. No steam terminal units shall be permitted with capacity less than 500,000 Btu/hour. All hydronic distribution shall utilize radiation sized to permit a heating design point water supply temperature not to exceed 190°F.

Exception: Steam radiators may be replaced by equivalent units of similar or greater capacity and thermal mass if fewer than 10% of the radiators in the building are being replaced in one calendar year.

3. Amend Section 6.4.1.1 as follows:

6.4.1.1 Minimum Equipment Efficiencies - Listed Equipment-Standard Rating and Operating Conditions. Equipment shown in Tables 6.8.1A through [6.8.1G] 6.8.1D and 6.8.1G shall have a minimum performance at the specified rating conditions when tested in accordance with the specified test procedure except that furnaces with capacity of less than 225,000 Btu/hour shall have a minimum performance at the specified rating conditions in Table 6.8.1E when tested in accordance with the specified test procedure. Furnaces with capacity of 225,000 Btu/hour or greater shall have a minimum performance at the greater of the specified rating conditions in Table 6.8.1E or 81% when tested in accordance with the specified test procedure. Boilers with capacity less than 300,000 Btu/hour shall have a minimum performance at the specified rating conditions in Table 6.8.1F when tested in accordance with the specified test procedure. Boilers with capacity of 300,000 Btu/hour or greater shall have a minimum performance at the greater of the specified rating conditions in Table 6.8.1F or 81% when tested in accordance with the specified test procedure. The capacity of any auxiliary electric resistance space heat shall be restricted to 5% of the peak heating load of the building. Where multiple rating conditions or performance requirements....(remainder of 6.4.1.1 is unchanged.)

4. Add Section 6.4.4.3:
6.4.4.3 Heating Distribution Efficiency

6.4.4.3.1 Hydronic Distribution. For hydronic distribution, the heating design point water supply temperature shall not exceed 190°F, and associated radiation shall be sized to permit operation at such temperature.

6.4.4.3.2 One-Pipe Steam. One-pipe steam distribution shall be prohibited in all construction required to conform with this standard.

6.4.4.3.3 Minimum Size of Steam Terminal Units. No steam terminal unit shall be permitted with capacity less than 500,000 Btu/h.

Exception: Steam radiators may be replaced by equivalent units of similar or greater capacity and thermal mass if fewer than 10% of the radiators in the building are being replaced in one calendar year.

Amendments to the Energy Conservation Construction Code of New York State, as incorporated in Chapter 13 of the New York City Building Code:

1. Delete Section 403.7 and replace as follows:

403.7 Mechanical Equipment Efficiency. [The building thermal envelope shall be permitted to meet the requirements of Table 402.1(2) where the building mechanical system conforms with the requirements of Table 403.7.] (Delete Table 403.7.) Equipment, including furnaces having a capacity of less than 225,000 Btu/hour and boilers having a capacity of less than 300,000 Btu/hour, shall meet the minimum efficiency requirements of Tables 803.2.2(1), 803.2.2(2), 803.2.2(3), 803.2.2(4), and 803.2.2(5) when tested and rated in accordance with the applicable test procedure. Furnaces having a capacity of 225,000 Btu/hour or more shall meet the minimum efficiency standards of Table 803.2.2(4) or 81%, whichever is greater, when tested and rated in accordance with the applicable test procedure. Boilers having a capacity of 300,000 Btu/hour or more shall meet the minimum efficiency standards of Table 803.2.2(5) or 81%, whichever is greater, when tested and rated in accordance with the applicable test procedure. The efficiency shall be verified through data furnished by the manufacturer or through certification under an approved certification program. Where multiple rating conditions or performance requirements are provided, the equipment shall satisfy all stated requirements.

403.8 One-pipe steam distribution. One-pipe steam distribution is prohibited in all construction subject to this chapter.

403.9 Steam terminal units. No steam terminal units shall be permitted with a capacity less than 500,000 Btu/hour.

Exception: Steam radiators may be replaced by equivalent units of similar or greater capacity and thermal mass if fewer than 10% of the radiators in the building are being replaced in one calendar year.

403.10 Auxiliary electric resistance space heat. The capacity of any auxiliary electric resistance space heat shall be limited to a maximum of 5% of the peak heating load of the building.

403.11 Atmospheric boilers. Atmospheric boilers are prohibited in all construction subject to the requirements of this code.

Supporting Information

Issues – Expanded

Boilers and heating distribution systems are available with a wide variety of efficiencies, including some inexpensive but totally outdated technologies. This proposal will raise the floor on boiler efficiency, removing some of the least efficient options (such as atmospheric gas boilers) from consideration and raising minimum efficiencies slightly on larger boilers and furnaces. For smaller boilers and furnaces, federal standards preempt New York City from establishing more rigorous local standards.

One-pipe steam distribution systems are notoriously wasteful of both energy and water, and this measure will prohibit their use in new construction and whenever a renovation is sufficiently extensive to trigger this portion of the code. Electric resistance heat has two or three times the carbon footprint of good gas-fired heating, and it too would be prohibited except as a minor trim capability or for peak loads in heat pump systems (PTHPs).

Hydronic (water) distribution of heat is widely accepted as the most efficient system when fired by gas, oil, or ground-source heat pumps. For oil or gas fired systems, condensing boilers have substantially higher efficiencies, in the 92 to 97% range rather than in the high 80% range, when operating in condensing mode. However, they can only operate in
this mode if return water from the distribution system has been cooled to 140°F and the efficiency increases as the return water temperature is lowered. Although it is not reasonable to expect a heating system to operate in condensing mode at design point (peak) conditions, the larger the radiating surfaces in the heated space, the lower the system water temperature can be, and the more often the boilers can operate in this efficient mode. By requiring that radiation be sized for a design point temperature of 190°F, this proposal moves in the direction of promoting the effective use of condensing technology.

It should be noted that the Committee was not unanimous on what design point temperature was optimal. Some members thought 190°F would be sufficient, others wanted 150 or 160°F (mirroring practice in much of Europe), and the value 190°F is certainly the highest value that would be acceptable. An alternative would be to call for a gradual decline in the temperature, coinciding with the code review cycle.

Environmental & Health Benefits
All of these improvements will lower fuel use and attendant emissions of CO₂ and Clean Air Act pollutants. Energy-related carbon dioxide emissions, resulting from the combustion of petroleum, coal, and natural gas, represented 82% of total U.S. anthropogenic greenhouse gas emissions in 2006.2 Pollutants produced by combustion of standard fossil fuels in boilers that are known to have harmful effects on humans and the environment include carbon monoxide, nitrogen oxide, sulfur oxides, volatile organic compounds, and particulate matter. By controlling NOₓ levels, along with the other pollutants, the levels of acid rain and ozone can be reduced.

This proposal was found to have a high, positive environmental impact per building and to impact a small number of buildings. It was thus given an environmental score of 2.

This proposal was found to have a positive, indirect health impact.

Cost & Savings
As described in the Executive Summary, Bovis Lend Lease prepared cost estimates for each Task Force proposal in the context of well-defined construction projects in specific buildings. Where possible, members of the Technical Committees prepared savings estimates for some of these projects and buildings. These cost and savings estimates are presented in the February 1st draft version of Appendix A. The innate uncertainty in how construction and operation will vary from one building to another, the complexity of the Task Force proposals, and the wide range of applications in which the proposals may be realized mean these figures are truly estimates.

This proposal was estimated to increase first capital costs by 0.5% to 5.6%, depending on building type. It was thus categorized as incurring a higher capital cost increment. This proposal was also estimated to generate financial savings that will pay for the capital costs in three to ten years depending on the building type.

Precedents
This proposal is a straightforward tightening of existing efficiency standards. The proposal does not address boilers and furnaces under 300,000 Btu/hour, which are regulated by AFUE and for which NYS and NYC are therefore preempted.

LEED
Current LEED prerequisites for Minimum Energy Performance under the Energy & Atmosphere sections of almost all of the rating systems require that the scope of work complies with ANSI/ASHRAE/IESNA standard 90.1-2004. This proposed code requires compliance with measures exceeding ASHRAE 90.1-2007. Since LEED 2009 prerequisites for Minimum Energy Performance also reference ASHRAE 90.1-2007, the measures outlined in this proposal will be correlated with the next generation of LEED.

However, LEED qualifies that a more stringent local code requirement becomes the LEED prerequisite requirement as well. Therefore, this proposal will change the baseline criteria that registered projects must meet for LEED certification.

Code revisions under this proposal do not apply to the LEED for Homes or the LEED for Existing Buildings rating systems, which reference Energy Star criteria. For existing buildings, LEED EB provides an alternate calculation method.

Implementation & Market Availability
There are no known implementation issues for this proposal. All the technologies are readily available.

Notes
The committee considered explicit limits on oversizing boilers, but found that various code sections already prohibit it, so the current tendency to oversize is primarily an enforcement problem.
ENDNOTES:

1 R.W. Leigh and E.Guerra presentation at the Multifamily Building Conference, Tales from the AMP Database (2006) (For copy of presentation please email R.W. Leigh at rwl@urbangreencouncil.org).