DEPARTMENT OF ENERGY

Office of Energy Efficiency and Renewable Energy

10 CFR Part 430

[Docket No. EE–RM–93–501]

RIN 1904–AA45

Energy Conservation Program for Consumer Products: Test Procedures for Furnaces/Boilers, Vented Home Heating Equipment, and Pool Heaters

AGENCY: Office of Energy Efficiency and Renewable Energy, Department of Energy.

ACTION: Final rule.

SUMMARY: The Energy Policy and Conservation Act, as amended, requires the Department of Energy (DOE or the Department) to administer an energy conservation program for certain major household appliances and commercial equipment. Among other program elements, the Act requires that standard methods of testing be prescribed for each covered product. Today's final rule amends the test procedures for furnaces and boilers, vented home heating equipment, and pool heaters.

EFFECTIVE DATE: This rule is effective November 10, 1997. The incorporation by reference of certain publications listed in the regulations is approved by the Director of the Federal Register as of November 10, 1997.

ADDRESSES: The Department is incorporating by reference test standards from the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) and the American National Standards Institute, Inc. (ANSI). These standards are listed below:

American National Standards Institute/American Society of Heating, Refrigerating, and Air-Conditioning Engineers Standard 103–1993, ''Methods of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers,'' and American National Standards Institute Standard Z21.56–1994, ''Gas-Fired Pool Heaters.''

Copies of these standards may be viewed at the Department of Energy Freedom of Information Reading Room, Forrestal Building, Room 1E–190, 1000 Independence Avenue, SW., Washington, DC 20585, (202) 586–6020 between the hours of 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays.

Copies of the ANSI/ASHRAE Standard 103–1993 can be obtained from ASHRAE Publication Sales, 1791 Tullie Circle, NE, Atlanta, GA 30329, (1–800–5–ASHRAE). Copies of the ANSI Standard Z21.56–1994 can be obtained from the ANSI, Inc., 11 West 42nd Street, New York, N.Y. 10036, (212) 642–4936.

FOR FURTHER INFORMATION CONTACT:

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SUPPLEMENTARY INFORMATION:

I. Introduction

A. Authority

Part B of Title III of the Energy Policy and Conservation Act, Pub. L. 94–163, as amended by the National Energy Conservation Policy Act (NECPA) Pub. L. 95–619, the National Appliance Energy Conservation Act (NAECA) of 1987, Pub. L. 100–12, the National Appliance Energy Conservation Amendments of 1988 (NAECA 1988), Pub. L. 100–357 and the Energy Policy Act of 1992 (EPACT), Pub. L. 102–486, created the Energy Conservation Program for Consumer Products other than Automobiles (Program).[1] The 13 consumer household products currently subject to this Program (referred to hereinafter as ''covered products'') include furnaces/boilers, vented home heating equipment, and pool heaters, the subjects of today's notice.

Under the EPCA, the Program consists essentially of three parts: Testing, labeling, and Federal energy conservation standards. The Department, in consultation with the National Institute of Standards and Technology (NIST), is required to amend or establish new test procedures as appropriate for each of the covered products. EPCA section 323, 42 U.S.C. 6293. Test procedures appear at 10 CFR part 430, subpart B. The purpose of the test procedures is to produce test results that measure energy efficiency, energy use, or estimated annual operating cost of a covered product during a representative average use cycle or period of use. The procedures must not be unduly burdensome to conduct. EPCA section 323(b)(3), 42 U.S.C. 6293 (b)(3). A test procedure is not required if DOE determines by rule that one cannot be developed. EPCA section 323(d)(1), 42 U.S.C. 6293(d)(1).

One hundred and eighty days after a test procedure for a product is adopted, no manufacturer may represent the energy consumption of, or the cost of energy consumed by, the product, except as reflected in tests conducted according to the DOE procedure. EPCA section 323(c)(2), 42 U.S.C. 6293(c)(2). However, the 180-day period referred to in section 323(c)(2) may be extended for up to an additional 180 days if the Secretary determines that the requirements of section 323(c)(2) would impose an undue burden. EPCA section 323(c)(3), 42 U.S.C. 6293 (c)(3).

Section 323(e) of the Act requires DOE to determine to what extent, if any, a proposed test procedure would alter the measured energy efficiency or measured energy use of any covered product as determined under the existing test procedure. If DOE determines that an amended test procedure would alter the measured efficiency or measured energy use of a covered product, DOE is required to amend the related energy conservation standard accordingly. In determining the amended standard, DOE is required to measure the energy efficiency or energy use of representative samples of covered products that minimally comply with the existing standard. The average efficiency of these representative samples, tested using the amended test procedure, constitutes the

[1] Part B of Title III of the Energy Policy and Conservation Act , as amended, is referred to in this final rule as the ''Act'' or EPCA. Part B of Title III is codified at 42 U.S.C. 6291–6309.

amended standard. EPCA section 323(e)(2), 42 U.S.C. 6293(e)(2).

B. Background

On March 28, 1984, the Department published in the **Federal Register** a final rule, hereinafter referred to as the 1984 Final Rule, amending the test procedures for furnaces, vented home heating equipment, and unvented home heating equipment. 49 FR 12148. For furnaces, the 1984 Final Rule referenced the ANSI/ASHRAE Standard 103–1982 entitled ''Methods of Testing for Heating Seasonal Efficiency of Central Furnaces and Boilers.'' In addition, it prescribed furnace test procedures for systems and issues that were not adequately covered by the ANSI/ASHRAE Standard 103–1982. Those included, for example, provisions for modulating and condensing furnaces and boilers. Particularly impacted were units with thermal stack dampers. Other deviations between the 1984 Final Rule and ANSI/ASHRAE Standard 103–1982 related to oversize factors, furnaces without draft relief or direct exhaust system, hot water boiler minimum return (inlet) water temperature and minimum water temperature rise, pump delay on boiler controls, an improved method for the determination of the S/F factor (the ratio of stack gas mass flow rate to flue gas mass flow rate) for furnaces and boilers, and the option of an assigned jacket loss value instead of actual measurement.

The Department originally published a test procedure for vented home heating equipment on May 2, 1978. 43 FR 20182. The Department amended this test procedure in the 1984 Final Rule, to include a simplified vented heater test procedure for heaters with modulating controls, manually controlled vented heaters, vented heaters equipped with thermal stack dampers, and floor furnaces. 49 FR 12169.

The Department published the pool heater test procedure final rule on February 7, 1989, referencing ANSI Standard Z21.56–1986 for gas pool heaters and extending the test procedure to cover oil-fired pool heaters. 54 FR 6076.

Since 1984, through cooperative efforts with the furnace industry and through the DOE test procedure waiver process, DOE has become aware of several additional issues regarding furnace and vented home heating equipment test procedures. On August 23, 1993, DOE published in the **Federal Register** a proposed rule and notice of public hearing, hereinafter referred to as the 1993 Proposed Rule, to amend the furnace, vented home heating equipment, and pool heater test procedures to address these issues. 58 FR 44538. A public hearing was held in Washington, DC on January 5, 1994.

After reviewing the comments presented at the public hearing on January 5, 1994, and additional written comments submitted following the public hearing, the Department decided to reopen the public comment period to solicit additional comments on one subject of particular concern to commenters in the 1993 Proposed Rule—the application of a multiplication factor to the auxiliary electricity consumption of a fossil-fueled appliance. The proposed multiplication factor in the 1993 Proposed Rule consisted of the ratio of the electrical ''source energy'' (the amount of energy used in producing the electricity consumed by the appliance) to the electrical ''site energy'' (the amount of electricity consumed by the appliance). The multiplication factor was used in the two proposed new energy descriptors, named Energy Factor (EF) and Annual Efficiency (AE), proposed by the Department to include the auxiliary electrical energy consumption by fossil-fueled appliances.

On January 20, 1995, the Department published a **Federal Register** notice, reopening the comment period to seek comments on a revision of the proposed definition of the multiplication factor. The new proposed definition was the ratio of the cost of electricity to the cost of fossil fuel to the consumer. 60 FR 4348. The 30-day public comment period was extended by an additional 30 days at the request of commenters and was closed on March 21, 1995.

Today's notice amends the test procedures for furnaces and boilers, vented home heating equipment, and pool heaters as follows:

(1) DOE is amending the test procedure for furnaces and boilers first, to incorporate provisions contained in test procedure waivers granted to different manufacturers from 1985 to 1996 and secondly, to include test procedures for new product designs. To accomplish this, the ANSI/ASHRAE Standard 103–1993 is incorporated by reference into the test procedure, in the place of ANSI/ASHRAE 103–1988 that was referenced in the 1993 proposed rule. (See below at II. a. 23. ''ANSI/ASHRAE Standard 103–1993.'') This incorporation establishes revised test procedures for the following furnaces and features: Atmospheric furnaces with burner air inlet dampers or flue dampers; the jacket loss measurement for downflow furnaces; and furnaces and boilers employing electro-mechanical stack dampers with delayed opening and power vented units employing post purge during the off-cycle. In addition, however, today's notice incorporates into DOE's test procedure provisions that are modifications of certain sections of ANSI/ASHRAE Standard 103–1993. Those modifications include the limit on air circulation blower delay time at burner shut-off for furnaces with unvarying control on blower delay time, deletion of the insulation requirement on the internal vent pipe of downflow furnace during the cool-down and heat-up tests, deletion of the requirement for the sealing of cabinet ventilation openings during the jacket loss measurement, longer allowed free post purge time for power vented units employing post purge, and input requirement on interrupted ignition device. In addition, today's final rule provides procedures for the calculation of the annual fossil fuel and auxiliary electrical energy consumptions.

(2) DOE is amending the test procedure for vented home heating equipment by, first, including modified calculation procedures for the weighted average steady-state efficiency and Annual Fuel Utilization Efficiency (AFUE) for certain manually-controlled heaters, and secondly, adding a procedure for calculating the annual energy consumption of fossil fuel and auxiliary electrical energy for vented home heating equipment.

(3) DOE is amending the test procedure for pool heaters by updating the referenced ANSI standard for pool heaters from ANSI Z21.56–1986 to ANSI Z21.56–1994. DOE is also adding a procedure for calculating the annual energy consumption of fossil fuel and auxiliary electrical energy for pool heaters and a pool heater heating seasonal efficiency descriptor that takes into account the energy consumption by the pilot light during the standby period of the pool heating season.

II. Discussion of Comments

A. Furnaces

In general, the comments received were supportive of the goals of the proposed amendments to incorporate provisions contained in waivers previously granted, to include test procedures for new product designs, and to capture the electrical consumption of furnaces. However, the comments by various organizations presented disagreements with DOE's proposal on the effect of some of the amendments on the measured AFUE. Additionally, many comments were received on the proposed formulation of energy descriptors to capture electrical consumption, on both the 1993 Proposed Rule and the January 20, 1995, **Federal Register** notice.

In its testimony and written statement, the Gas Appliance Manufacturers Association (GAMA) classified the proposed revisions to the current test procedure contained in the 1993 Proposed Rule into three categories. (GAMA, No. 8, at 2).[2]

The first category comprised changes that GAMA states would not lower the measured AFUE of most existing furnace and boiler models, including changes to bring the test procedures in line with waivers previously granted. GAMA stated its support for the immediate implementation of most of the first category of changes.

The second category included changes that GAMA states would lower the measured AFUE of most existing furnace and boiler models. Such a change, GAMA claimed, would require the Department to amend the furnace and boiler efficiency standards because of the impact on existing models that marginally meet the standard. According to GAMA, this would cause confusion in the marketplace, accustomed as it is to the current standard, a minimum AFUE of 78 percent for warm air furnaces. Additionally, GAMA asserted that a reduction in the measured AFUE would result in many units no longer qualifying for utility rebate programs that require an AFUE of at least 80 percent. GAMA stated the view that these changes would place a heavy burden on manufacturers and requested a delay in the implementation of the second category of changes until any revised efficiency standards went into effect. GAMA puts the following changes in this category: Revised calculation for the effectiveness of electro-mechanical stack dampers; power vented systems employing post purge after burner shut-off; sealing of cabinet ventilation openings during jacket loss test; insulation of horizontal mounted external draft diverters; insulation of the flue collector box for power vented units; insulation of the internal flue pipe for downflow furnaces during heat-up and cool-down tests; minimum values for the draft factor D_P and D_F; measurement of water pump energy consumption; and test requirement for modulating boilers.

The third category was the addition of the proposed AE energy descriptor. GAMA suggested further study on the third category before implementation.

Consolidated Industries, Carrier Corp., and Lennox Industries supported GAMA's statement. (Consolidated, No. 21, at 1; Carrier, No. 12, at 1; and Lennox, Transcript, at 77). Inter-City Products presented the same list of revisions regarding their potential impact on AFUE as GAMA did. Many of the other commenters referred to GAMA's classification of the three categories of proposed revisions to the DOE test procedure in their oral and written statements and these categories are referred to in the discussion of comments below.

The following discussion addresses the comments received on the proposed rule.

1. Furnaces and Boilers With Small Air Passage in the Flue

In the 1993 Proposed Rule, DOE proposed to change the limiting value of 10 percent from a flow rate ratio to an area ratio. Both GAMA and Inter-City Products supported the proposed revision. (GAMA, No. 8, at 2; and Inter-City, No. 7, at 4). No other commenters offered comment on this issue. The Department is adopting the change in sections 8.2.1.2.2 and 8.3.1.2 of ANSI/ASHRAE Standard 103–1993 in today's final rule.

2. Air Circulation Blower Delay at Burner Ignition

The 1993 Proposed Rule specified a minimum blower delay time of 20 seconds during the heat-up test for furnaces designed with non-adjustable, unvarying delay time that is less than 20 seconds. The current furnace test procedure requires a 1.5-minute delay between the ignition of the burner and the starting of the blower. Manufacturers have requested and been granted waivers from this requirement because of an unvarying time delay designed into their specific models. The designed time delay granted in the waivers varied from 20 seconds to 66 seconds among the specific models with 30 seconds as the predominant time delay. The manufacturers claimed increases in the AFUE value of from 0.4 to 2.0 percentage points if the designed time delays were used in the rating test instead of the 1.5 minutes specified in the current test procedure. The Department's granting of the waivers permitted those manufacturers to test units with blowers having unvarying time delay designed into them. In the 1993 Proposed Rule, the Department proposed test procedures to allow testing with an unvarying time delay, but also proposed a minimum blower delay time of 20 seconds during the heat-up test. This is achieved by bypassing the electronic control, if the designed non-adjustable, unvarying delay time is less than 20 seconds.

Both GAMA and Inter-City Products opposed the requirement of a minimum 20-second delay during the heat-up test for furnaces with designed, unvarying blower time delay at burner start-up. Amana Refrigeration, Inc., stated that DOE's reason of avoiding a cold draft in the occupied zone is an issue of comfort, not energy efficiency, and that DOE should let the competitive marketplace design products that fulfill consumers' desires. (Amana, No. 2, at 1). Inter-City Products stated that DOE should not define what occupant comfort is, and as advances in heat exchanger technology come about, low mass heat exchanger with very short heat-up characteristics will evolve allowing short on-time delays. Inter-City Products also stated that mandating time delays as to occupant comfort is to prescribe the design of a furnace and would not necessarily reflect the true operation and efficiency of current or future furnace designs. (Inter-City, No. 7, at 2). GAMA and York International Corp. gave similar reasons as Inter-City Products for opposing the 20-second requirement, and stated that DOE is acting outside its authority in factoring occupant comfort into the efficiency test procedure. Further they stated that it is for the marketplace, not DOE, to discourage the sale of furnaces that do not provide a reasonable level of occupant comfort. In addition, the complexity of the electronic controls used in today's furnaces makes it very difficult for a field installer or repairer to modify an unvarying blower time delay. (GAMA, No. 8, at 16; and York, No. 10, at 3.) Carrier Corp. and Consolidated Industries both supported GAMA's statement. (Carrier No. 12, at 1; and Consolidated, No. 21, at 1.) Mr. Woodworth stated that comfort should not be the basis for provisions being included in a laboratory test procedure. Further, he suggested that the procedure should be changed to agree with section 9.6.1 of ANSI/ASHRAE Standard 103–1993, that does not include the 20-second requirement. (Woodworth, No. 20, at 5).

In the current test procedure for furnaces, the 1.5-minute fan delay at burner ignition was specified on the basis of obtaining a low overall cost of combined fossil fuel and auxiliary electrical energy consumption.[3] This

[2] Written comments on the 1993 Proposed Rule were assigned docket numbers and are numbered consecutively. Comments presented at the January 5, 1994, public hearing are contained in the transcript.

[3] Unpublished National Bureau of Standards report, Joseph Chi, ''A Note on Effect of HX Weights

was balanced with the historically accepted industry practice in furnace operation of providing occupant comfort. In granting the waiver requests, the Department recognized the advances made by manufacturers on lighter weight heat exchanger designs with fan-assisted combustion systems over the past decade. These advances permitted a faster heat-up of the heat exchanger and a shorter fan delay time while still achieving the desired low overall energy consumption. In the 1993 proposed rule, the Department believed that there is a limit to reducing the weight of the heat exchanger and, in turn, a limit to the achievable minimum fan delay time. This is evident from the fan delay times in the waiver requests, that were mostly greater than or equal to 30 seconds. It is possible, however, that as new material and technology evolve, an even lighter weight heat exchanger with better heat transfer performance will be developed. Such a heat exchanger could result in a faster furnace heat-up and allow a fan delay time of less than 20 seconds. The 20-second minimum fan delay time might become inappropriate for these better-designed furnaces of the future. Nevertheless, for furnaces lacking such designs, the Department believes that without the minimum fan delay requirement used during the test for furnaces with non-adjustable, unvarying fan delay control, a manufacturer could simply modify the furnace's electronic control without any resulting improvement in its heat transfer performance. Thus, the manufacturer would obtain a higher AFUE value. The Department assumes that consideration of consumer satisfaction in the long term will prevent that practice.

Based on the above reasons, the Department has decided to drop the proposed requirement of a 20-second minimum fan delay for furnaces designed with a non-adjustable, unvarying blower time delay during the heat-up test. Instead, DOE is adopting the procedure specified in section 9.6.1 of ANSI/ASHRAE Standard 103–1993 in today's final rule.

3. Air Circulation Blower Delay at Burner Shut-off

In the 1993 Proposed Rule, DOE proposed a modification to the ANSI/ASHRAE Standard 103–1988 version of the procedure now specified in section 9.5.1.2.2 of ANSI/ASHRAE Standard 103–1993. The modification requires that a furnace, if designed with an unvarying time delay that does not provide the same blower delay time that is specified for units with adjustable blower control, shall be tested with the blower control bypassed, and the blower manually controlled to give the delay time specified during the cool-down test. This delay time is three minutes for non-condensing, or 1.5 minutes for condensing furnaces, or 40°F temperature difference, whichever gives the longer time delay.

During the cool-down test, the extant test procedure allows a delay in blower shut-off of three minutes (1.5 minutes for condensing furnaces) or until the supply air temperature drops to a value of 40°F above the inlet air temperature, whichever gives the longer time delay. ANSI/ASHRAE Standard 103–1993 provided an additional exception (section 9.5.1.2.2) that for a furnace without adjustable fan control, the delay shall be as designed.

Both GAMA and Inter-City Products, as well as other commenters, expressed opposition to the specified maximum time delays for blowers with unvarying time delay in the proposed test procedure during the cool-down test. Inter-City Products stated that older or heavier mass heat exchangers may require more than three minutes of cool-down time. They gave the same reasons as given in Inter-City Products' comments against blower time delay at burner ignition in opposing the use of occupant comfort as the criterion in determining the maximum allowable time delay. (Inter-City, No. 7, at 2). GAMA gave similar reasons as Inter-City Products in opposing the requirement with respect to high mass heat exchangers. Further, they gave the same reasons as given in GAMA's comments against blower time delay at burner ignition in opposing the use of occupant comfort as a criterion in the test procedure. GAMA also pointed out the difficulty of adjusting an unvarying electronic time delay control in the field. (GAMA, No. 8, at 16). York International gave similar reasons as GAMA. (York International, No. 10, at 3). Carrier Corp. and Consolidated Industries both supported GAMA's statement. (Carrier, No. 12, at 1; and Consolidated, No. 21, at 1). The California Energy Commission (CEC) pointed out that the wording in section 8.4 of appendix N in the 1993 Proposed Rule is misleading. It stated that the time delay criterion of 40°F temperature difference between supply air and return air for units with adjustable fan control can be interpreted as not applying to condensing furnaces. Also, the time to reach the 40°F differential after burner shut-off may be shorter than three minutes, resulting in both a cold draft and a higher rating that fail to achieve a reasonable level of occupant comfort. (CEC, No. 25, at 1).

In the current test procedure for furnaces, the requirement for maximum fan delay time after burner shut-off was specified on the basis of obtaining an overall low cost of combined fossil fuel and auxiliary electrical energy consumption balanced with the historically accepted industry practice in furnace operation to provide occupant comfort. The after burner shut-off is defined as three minutes, or 1.5 minutes for condensing furnaces, after the burner shuts off, or until the supply air temperature drops to a value of 40°F above the inlet air temperature, whichever gives a longer fan-on time. The Department recognized the heat capacity of a heavier mass heat exchanger in retaining a greater amount of heat energy. This is evidenced by the specification in the existing test procedure of either three minutes (1.5 minutes for condensing furnaces) or 40°F differential in plenum to return air temperature, whichever gives a longer fan-on time. The removal of the maximum fan-on time requirement could encourage some manufacturers to lengthen the fan-on time after burner shut off without an accompanying improvement in furnace design. The manufacturers could do this by simply changing the electronics in the controller. Those furnaces would be able to obtain a slightly higher calculated AFUE by using a lower flue gas temperature measured at nine minutes after burner shut-off when the fan runs longer. Those furnaces however, would actually be consuming greater electrical energy than the savings in fossil fuel. This would be contrary to the intent of EPCA to reduce the nation's overall energy consumption.

Based on the reasons given above, and the fact that the proposed provision does not affect the rating of any existing furnaces, today's final rule prescribes the maximum blower delay time criterion specified in the 1993 Proposed Rule. This specification is for a furnace designed with an unvarying blower time delay during the cool-down test in today's final rule.

With respect to the comment by the CEC, the Department agrees that the wording in the 1993 Proposed Rule is misleading. In today's rule, therefore, the wording of ANSI/ASHRAE Standard 103–1993, section 9.5.1.2.1, which includes the 40°F temperature difference for condensing furnaces, is adopted instead. CEC also commented that for certain furnaces the 40°F temperature differential could be reached in less than three minutes and

on annual performance and cost of Operation of a furnace,'' February, 1978.

thus creating a possible cold draft. The blower time delay criterion is prescribed for blowers with adjustable time delay control in the current furnace test procedure. Changing the criterion would require the retesting of many existing furnaces. Also, the criterion was agreed to by consensus of the ASHRAE Standard Project Committee (SPC) 103 and specified in ANSI/ASHRAE Standard 103–1993. The Department sees no reason to change that criterion presently.

In the 1993 Proposed Rule, the Department also specified an exception to the delay time requirement for furnaces that employ a single motor to drive a power burner and the air circulation blower. In that case, the power burner and the blower would be stopped together. The current test procedure includes this exception of simultaneous start/stop operations during both the heat-up and the cool-down tests. ANSI/ASHRAE Standard 103–1993 specifically includes this exception in the heat-up test but it is not specified in the section for the cool-down test. The Department considered it to be only an inadvertent omission in ANSI/ASHRAE Standard 103–1993. There was no comment received on this issue, and the Department is specifying, in today's final rule, the modification to ANSI/ASHRAE Standard 103–1993. The Department specifies that if a single motor drives a power burner and the air circulating blower, the power burner and the blower shall be stopped together during the cool-down test.

4. Burner Box Inlet Damper and Flue Damper

Both GAMA and Inter-City Products supported the proposal to include a tracer gas test method for atmospheric furnaces with inlet or flue dampers. (GAMA, No. 8, at 2; and Inter-City, No. 7, at 4). There were no other comments on this issue. The Department has included this provision in today's final rule.

5. Jacket Loss Test for Downflow Furnaces

The proposal in the 1993 Proposed Rule to include a jacket loss test for downflow furnaces was supported by both GAMA and Inter-City Products. (GAMA, No. 8, at 2; and Inter-City, No. 7, at 4). These were the only comments on this issue. The Department is adopting the proposed jacket loss test procedure for downflow furnaces as specified in ANSI/ASHRAE Standard 103–1993 referenced in today's final rule.

6. Blower Compartment Heat Loss During Jacket Loss Test

Both GAMA and Inter-City Products supported the proposal in the 1993 Proposed Rule to exclude the surface area of the blower compartment in the jacket loss test. The CEC believed that the blower compartment should not be considered as part of the duct system and that the heat loss through the blower compartment should be measured in the jacket loss test. It stated that if the blower compartment is considered as the duct system, then the insulation requirement for duct systems in building codes will apply to the compartment. The CEC believed that this is not presently done to the furnace cabinet in the field and, in addition, manufacturers and others may recommend against the insulation of the cabinet. (CEC, No. 25, at 2).

The Department believes that for most furnaces, the blower compartment is in the return air side of the cabinet. The surface temperature of the blower compartment will be nearly the same as the air temperature around the compartment, and the heat loss from that surface to the test room air will be negligible. The added burden of instrumenting the blower compartment surface with thermocouples is not justified. The Department is therefore not adopting the CEC's suggestion of requiring some mechanism for measuring the heat loss from the blower compartment. The Department is adopting the provision of excluding the surface area of the blower compartment in the jacket loss test as specified in the ANSI/ASHRAE Standard 103–1993 referenced in today's final rule.

7. Revised Piping Arrangement for Hot Water Boilers

Both GAMA and Inter-City Products supported the proposal in the 1993 Proposed Rule for a revised piping arrangement for hot water boilers. (GAMA, No. 8, at 2; and Inter-City, No. 7, at 4). This was the only comment on this issue. The Department has adopted this provision as specified in ANSI/ASHRAE Standard 103–1993, which is referenced in today's final rule.

8. Maintaining of Draft During Off-Cycle

Both GAMA and Inter-City Products supported the proposal to maintain draft during off-cycle for only those oil-fueled or power gas burner furnaces that employ barometric dampers for draft control. (GAMA, No. 8, at 2; and Inter-City, No. 7, at 4). This was the only comment on this issue. The Department has adopted this provision as specified in ANSI/ASHRAE Standard 103–1993, which is referenced in today's final rule.

9. Tests Requirement for Modulating Units

In the 1993 Proposed Rule, DOE proposed to correct the following discrepancy between the current DOE test procedure and ANSI/ASHRAE Standard 103–1988, which DOE proposed to reference. The current DOE test procedure requires that for step modulating units, the steady-state efficiency test shall be conducted at both the maximum and the reduced input rates. The ANSI/ASHRAE Standard 103–1988 required the above tests at the reduced rate only. The 1993 Proposed Rule made clear that DOE would continue to require testing at both rates.

Both GAMA and Inter-City Products supported the proposal for testing modulating furnaces. GAMA put the proposed correction to ANSI/ASHRAE Standard 103–1988 for testing modulating boilers into the category of proposals on which it asked for delay in implementation until revised efficiency standards are adopted. (GAMA, No. 8, at 4; and Inter-City, No. 7, at 4). Carrier Corp. and Consolidated Industries both supported GAMA's position. (Carrier, No. 12, at 1; and Consolidated, No. 21, at 1). The Department does not agree with the comments that the correction is a revision to the existing DOE test procedure for modulating boilers. Such a test is already included. Specifically, the conditions (at rated input or reduced input) under which heat-up and cool-down tests are to be conducted are already specified in the current DOE test procedure. (See sections 3.1, 3.2, 3.4, and 4.5 of appendix N to subpart B of part 430.) The proposed clarification for the optional tracer gas test at rated input or at a reduced input rate is to make certain that the resulting measured draft factor D_P value(s) would be consistent with the other measured quantities when they are combined in the calculation procedure for the off-cycle losses. The Department believes that this clarification will have either no effect, or negligible effect on an insignificant number of units.

Such a requirement was not clearly stated in ANSI/ASHRAE Standard 103–1988, but in DOE's view it was implicit in that standard. The Department proposed this provision in the 1993 Proposed Rule only to clarify the language in the then-referenced ANSI/ASHRAE Standard 103-1988. The Department has therefore adopted this provision as specified in ANSI/ASHRAE Standard 103–1993, which is referenced in today's final rule.

10. On-Cycle Time Constant and Off-Cycle Time Constant

Both GAMA and Inter-City Products supported the proposal for the on-cycle time constant and off-cycle time constant. (GAMA, No. 8, at 2; and Inter-City, No. 7, at 4). The Department has adopted this provision as specified in ANSI/ASHRAE Standard 103–1993, which is referenced in today's final rule.

11. Multiplication Factor for Jacket Loss for Finned Tube Boilers for Isolated Combustion System (ICS)

In the 1993 Proposed Rule, DOE proposed to use the multiplication factor of Cj=0.50. Both GAMA and Inter-City Products supported the proposal for the value of the multiplication factor for jacket loss for finned tube boilers. (GAMA, No. 8, at 3; and Inter-City, No. 7, at 4). The Department has adopted this provision as specified in ANSI/ASHRAE Standard 103–1993, which is referenced in today's final rule.

12. Calculation Procedure for Electro-Mechanical Stack Dampers

GAMA commented that the proposed calculation procedure for evaluating the effectiveness of a stack damper would reduce the measured AFUE of both furnaces and boilers. (GAMA, No. 8, at 3). GAMA believes that the proposed changes would affect the efficiency rating of existing warm air furnaces.

In the case of warm air furnaces, the Department has considered the comment and disagrees with the statement that the proposed changes would affect the efficiency rating of existing warm air furnaces. Referring to Table 6, System Numbers, and sections 11.2.9.18, 11.2.10.3 and 11.2.10.4 of ANSI/ASHRAE 103–1993, a stack damper's operation has no effect on a warm air furnace installed as an Isolated Combustion System (ICS) No. 9 or 10. Because the existing non-weatherized warm air furnaces are rated as ICS systems, the problems cited by GAMA do not apply to existing furnaces. Also, because any direct vent system is defined as system No. 9 or 10, the problems likewise would not apply to direct vent systems such as those used for most mobile home furnaces.

In the case of boilers, which are installed indoors and rated as indoor systems, the effect of the revisions on the measured AFUE would be very small. For most existing boilers the stack damper closes within 30 seconds after the main burner is shut off, and the effect will be on the order of 0.1 percentage-point change in AFUE. The effect is therefore negligible for any stack damper that is completely closed within the 30-second interval. The effect, however, could be large if the damper closing time delay were to be extended for a long period. Such an extension would take advantage of the deficiency in the current procedure, where the damper is assumed to close instantaneously after the burner shut-off. The Department has therefore, adopted the revision as proposed in the 1993 Proposed Rule (and as included in ANSI/ASHRAE Standard 103–1993) in today's final rule.

13. Power Vented Systems Employing Post Purge After Burner Shut-Off

In the 1993 Proposed Rule, the maximum free post purge time was specified to be five seconds for both gas- and oil-fired furnaces and boilers. There were seven comments on this proposal. GAMA stated that the proposed maximum free post purge time would significantly reduce the measured AFUE of most existing models, and require DOE to amend the NAECA furnace and boiler efficiency standards for existing models that marginally meet the current minimum standard of 78 percent AFUE for furnaces and 80 percent for boilers. (GAMA, No. 8, at 4). Carrier Corp., Consolidated Industries, and Lennox Industries all supported GAMA's position. (Carrier, No. 12, at 1; Consolidated, No. 21, at 1; and Lennox, Transcript, at 77).

Inter-City Products requested that the implementation of this and other category 2 revisions be postponed to a future rulemaking, coordinated with implementation of amendments to furnace minimum efficiency standards. To support its request, Inter-City Products commented that DOE needs to lower the minimum standard on marginal units to correspond to changes in test procedure measurements, and address the problem associated with the utility rebate program. Inter-City Products further stated that for the manufacturers to modify these models, such that they attain the 80 percent AFUE value, the redesigned equipment may operate in the condensing region that can affect performance, reliability, and life of both the equipment and the associated vent system. (Inter-City, No. 7, at 3).

Energy Kinetics, Inc. commented that the proposed revision does not cover systems equipped with a power burner and a draft inducer. Energy Kinetics stated that the off-cycle flue gas flow rate with only the inducer on, but not the power burner, is significantly reduced from the on-cycle flow rate. According to Energy Kinetics, since the proposed revision in the 1993 Proposed Rule uses the on-cycle flue gas volume flow rate as a base to compute the flue loss during the post purge period, the loss will be higher than it should be. Energy Kinetics suggests that a tracer gas option be allowed for this type of system. (Energy Kinetics, No. 16, at 6).

The independent commenter, Mr. John Woodworth asserted that, based on research conducted at Brookhaven National Laboratory, the post-purge provisions are not accurate for oil-fired furnaces and boilers with relatively long post purge-periods. He reasons that, to reduce the test burden on manufacturers, the provisions assume a linearly decreasing flue gas temperature between the beginning and the end of the post purge period. Thus, measurements at only two points are required in the calculation. According to Mr. Woodworth, this assumption of a linearly varying temperature is valid only for a limited interval, since the temperature will eventually level off to nearly ambient conditions over a long purge period. Mr. Woodworth recommends that DOE adopt the provisions of ANSI/ASHRAE Standard 103–1993 which limit the post purge period during the test to 180 seconds. (Woodworth, No. 20, at 4).

The Department believes that the use of a post purge in power vented units during the off-cycle, when longer than necessary, is a waste of energy because a forced purge increases the loss of the residue heat in the furnace or boiler through the vent system. A forced purge is the forced combustion air flow through the heat exchanger. Given the deficiencies in the existing test procedure described in the 1993 Proposed Rule, DOE is aware that the current procedure could encourage a manufacturer to use a long post purge period to obtain a higher calculated AFUE rating while actually wasting more energy through the vent system. Tests conducted at NIST on a gas furnace with an induced draft combustion blower showed that increasing the post purge interval increased the flue loss, but the calculated AFUE based on current test procedure showed an increase in value. The discrepancy between the AFUE based on the current calculation procedure, and on the proposed calculation procedure, becomes progressively greater with an increasing post purge period. The difference was 0.9 percentage points with 30 seconds post purge and increased to 4.5 percentage points with 180 seconds post purge. Yet the calculated AFUE based on the current test procedure showed a gain (from the condition of no post purge) of about 0.2 percentage points at 30 seconds post purge to nearly 1.0

percentage point at 180 seconds post purge.

Data gathered indicated that the six major control manufacturers surveyed all have post purge timing of 30 seconds or less on their post purge control equipment. The data was gathered by the Lawrence Berkeley National Laboratory (LBNL) for DOE regarding the current practice of the furnace industry. The survey showed that if the free post purge time is extended from five seconds, as proposed in the 1993 Proposed Rule, to 30 seconds before the post purge calculation method is required, most of the existing furnace and boiler models that employ post purge will be treated as if there is no post purge. With post purge timing of 30 seconds, no retesting or re-rating will be required and no reduction in AFUE will result for those existing furnaces and boiler models.

Based on the above reasons, DOE is changing the maximum free post purge time of five seconds in the 1993 Proposed Rule to 30 seconds. That is, only units with post purge time longer than 30 seconds shall be tested by the prescribed post purge test procedure. Further, units with post purge periods of less than or equal to 30 seconds shall be tested without the post purge test procedure. The Department agrees with the commenters that if the maximum free post purge time is limited to the proposed five seconds, some existing furnace and boiler models that employ post purge time between five and thirty seconds would have to be retested. The Department acts today to limit the burden on the manufacturers of retesting those models and the possibility of lower AFUE ratings. The Department is prescribing, in today's final rule, the modified free post purge period of 30 seconds as the criterion for applying the revised test and calculation procedures for units that employ post purge after burner shut off.

DOE believes, however, that with this exception, where the maximum free post purge time is thirty seconds, additional energy is being lost through the venting system by the combustion blower. The Department will continue to examine this subject and may consider later implementation of the original five second criterion, which is based on the technical judgement of the ASHRAE Standard Project Committee (SPC) that developed ANSI/ASHRAE Standard 103–1993.

Secondly, on the issue of oil-fired furnaces and boilers that have purge periods greater than three minutes, the Department acts to limit the post purge time to 180 seconds during the rating test as suggested by commenter Mr. John Woodworth. If the designed post purge time is longer than 180 seconds, the blower control is to be bypassed and the blower manually turned off during the cool-down test. This provision is specified in ANSI/ASHRAE Standard 103–1993, which is referenced in today's final rule.

The comment by Energy Kinetics on the difference in the flue gas flow rate between the on-cycle (power burner and inducer on) and off-cycle (only inducer on during post purge) on oil-fired boilers, if the draft inducer is an integral part of the boiler supplied by the manufacturer, would require additional study. Therefore, this type of boiler is not covered by today's final rule. The Department will continue to solicit additional data on the on-cycle and off-cycle operations of this type of boilers, and will issue a revision to the test procedure at a future time.

14. Sealing of Ventilation Openings During Jacket Loss Test

The 1993 Proposed Rule would require conducting the jacket loss test with the ventilation openings sealed. There were six comments on this issue. GAMA provided data from tests recently conducted at the ETL Testing Laboratories of the Inchcape Testing Services (ETL). This data showed that for four furnace models tested for sealing the ventilation openings in jacket loss test, the percentage point reductions in AFUE were 1.0, 0.5, 0.7 and 0.1 for models currently rated at AFUE of 78.7 percent, 80.0 percent, 80.0 percent and 78.0 percent, respectively. Thus, two models would be below the 78 percent minimum and two models would be below the 80 percent rebate criteria if tested pursuant to the proposed revision. (GAMA, No. 8, at 4 and A–1). Carrier Corp., Consolidated Industries, and Lennox Industries all supported GAMA's position (Carrier, No. 12, at 1; Consolidated, No. 21, at 1; and Lennox, Transcript, at 77). Inter-City Products made several assertions on this issue. First, it stated that sealing ventilation openings could potentially reduce AFUE by 0.3–0.5 percent. Second, it stated that an attempt to determine which louver openings are for ventilation air egress and which are for intake cooling air would be a time-consuming and subjective test procedure. Third, the company claimed that a louver acting as ventilation air intake in one operating mode may be an exhaust louver in another. Fourth, it asserted that additional test time in development, agency certification, and independent efficiency audits (by ETL) would increase manufacturers' costs substantially. Finally, according to Inter-City, the revised procedure would lower the baseline efficiencies of equipment currently at 78 percent. (Inter-City, No.7, at 2). The CEC suggested that air leakage during the jacket loss test from any part of the furnace cabinet should represent the performance of the product as installed in the field. Any joints, holes, or other openings should remain as shipped by the manufacturer and should not be taped or sealed for the test. (CEC, No. 25, at 2).

Today's final rule does not include the sealing of furnace cabinet ventilation openings during the jacket loss test, and the sealing requirement specified in section 8.6.1.1 of the referenced ANSI/ASHRAE Standard 103–1993 has not been included in today's rule. Upon review, the Department considers that sealing of the ventilation openings will result in a more accurate measure of the combined effects of conduction and radiation heat loss. This is the heat loss from the cabinet surface to the test room surroundings and the convective cooling of the airflow into and out of the spaces adjacent to the inside surfaces of the jacket. The Department, however, has decided not to incorporate this provision into today's final rule. This is because the Department sees some merit in the objections offered by commenters with respect to test time, retesting and re-rating all the currently rated furnace units and the associated costs, reduction in currently marginal AFUE ratings, and the difficulty in objectively determining the most effective openings to seal. DOE will continue to examine this subject and may consider implementation of the provision at a later date.

15. Insulation Requirement for Units With Draft Diverter

The 1993 Proposed Rule would require insulation for units with a draft diverter, when testing furnaces with exposed diverters. There were three comments on this issue. GAMA objected to its immediate implementation. In addition, GAMA provided data from tests recently conducted at ETL. This data showed that, for two furnace models with integral draft diverters tested with insulation added to the draft diverter, the percentage point reductions in AFUE were 0.3 and 0.4 for the two models currently rated at AFUE of 78.0 percent. They would be below the 78 percent minimum standard if tested in accordance with the proposed revision. (GAMA, No. 8, at 4 and A–2). Carrier Corp. and Consolidated Industries both supported GAMA's position. (Carrier, No. 12, at 1; Consolidated, No. 21, at 1).

As described in the 1993 Proposed Rule on this issue, the ETL stated that it insulates the exposed diverters (in horizontal furnaces) when testing furnaces with exposed diverters. (April 30, 1991, letter from ETL to NIST). Therefore, the rated AFUE values for horizontal furnaces with exposed integral draft diverters in GAMA's Efficiency Certification Directory were tested with the proposed insulation in place. This means that the existing furnaces have already been tested according to the proposed provision and found to meet the minimum efficiency standard. Thus, no retesting or re-rating is required.

The Department therefore is not accepting GAMA's request that this provision be omitted from the final rule, and instead has adopted this provision as specified in ANSI/ASHRAE Standard 103–1993, which is referenced in today's final rule.

16. Insulation Requirement for Flue Collector Box

In the 1993 Proposed Rule, DOE called for the insulation of the flue collector box. Numerous comments were received on this issue. Specifically, Inter-City Products requested that the implementation of this provision be postponed to a later date. Inter-City Products cited the reduced AFUE of existing marginal units, that would require DOE to reduce the minimum standard, and the criterion of the 80 percent AFUE by the utility rebate program in support of the request. (Inter-City, No.7, at 1). Inter-City Products suggested that the flue collector box on equipment with draft inducers is significantly smaller in area than the sheet metal involved in an integral draft diverter, so losses are consequently less. Inter-City Products estimated that this provision would have an impact of lowering the efficiency by 0.3–0.4 percent in AFUE. Inter-City Products also believed that the requirement of insulating the collector box during the cool-down and heat-up tests, but not during the jacket loss test, constitutes ''double dipping.'' This is because any loss in heat from the collector box would be accounted for twice—first, as a reduced efficiency from a higher flue gas temperature during the cool-down and heat-up tests (cyclic test) due to the insulation requirement, and second, as a larger measured jacket loss because the insulation is not applied during the steady-state jacket loss test.

GAMA put this issue in its second category of proposed changes in the 1993 Proposed Rule and objected to its immediate implementation. In addition, GAMA provided data from tests recently conducted at ETL to show that for eleven furnace models tested for insulation of the exposed flue collector box, the percentage point reductions in AFUE ranged from 0.5 to 2.8 for models currently rated at AFUE of 78.0 percent to 80.2 percent. Seven models will be below the 78 percent minimum and five models will be below the 80 percent rebate criterion, if tested in accordance with the proposed revision. (GAMA, No. 8, at 4 and A–2). Carrier Corp., Consolidated Industries, and Lennox Industries all supported GAMA's position (Carrier, No. 12, at 1; Consolidated, No. 21, at 1; and Lennox, Transcript, at 77).

Energy Kinetics, Inc. commented that in addition to the cool-down and heat-up tests, the flue collector box should be insulated for the steady-state portion of the test also. It believed that without the insulation, the measured steady state efficiency is higher due to a lower measured flue gas temperature than that measured with the insulation. (Energy Kinetics, No. 16, at 6).

The commenters are not correct in classifying the proposed requirement of insulating the flue collector box on induced draft or forced draft units as a revision of the furnace test procedure. This requirement is already specified in the current test procedure, and has been in the DOE test procedure since 1980. Compliance with this requirement is demonstrated by a waiver request that was denied by DOE. This request was from the Carrier Corporation in 1980 for an exemption from the requirement of insulating the ''flue collector and inducer housing'' on its induced draft gas furnace. 76 FR 22799, April 21, 1981. The current test procedure cited at section 3.0—Test procedure, of appendix N to subpart B of part 430, 56 FR 12159, March 28, 1984 references section 9 of ANSI/ASHRAE Standard 103–1982 as the pertinent test procedure. In ANSI/ASHRAE Standard 103–1982, the requirement of section 9.1.1.6 specifies ''* * * cover the draft diverter and flue gas collector box (on a power vented unit) with insulation having an R value no less than 7. * * *'' Therefore, the provision is not a new requirement and should require no retesting or re-rating of any existing gas-fired, power vented units. The specification in the 1993 Proposed Rule was to: (1) Combine the requirement with the language in section 9.1.4 of ANSI/ASHRAE Standard 103–1988 that does not specifically include the language for a power vented unit in the insulation requirement, as was done in ANSI/ASHRAE Standard 103–1982, and (2) include any units that employ a power burner. The requirement is now specifically included in sections 7.2.2.2, 7.3.2.2, and 9.1.4, ANSI/ASHRAE Standard 103–1993.

DOE has reviewed the comments by Inter-City Products on ''double dipping,'' and by Energy Kinetics on the steady state efficiency being overstated due to an un-insulated flue gas collector box. The jacket loss and the steady state efficiency are measured without the insulation on the flue gas collector box because these conditions exist in practice. The reason for insulating the flue gas collector box during the transient cool-down and heat-up tests is to obtain a measured flue gas temperature as close as possible to its true value when the flue gas first exits from the heat exchanger. This allows a better calculation of the off-cycle flow through the heat exchanger. In the original development of the flue loss methodology, an assumption was made on the flue gas temperature variation during the transient condition of cool-down and heat-up. This assumption was based on the value of a flue gas temperature exiting the heat exchanger, not on a lowered value measured some distance away. This transient gas temperature variation has never been used in the calculation for jacket loss and steady state efficiency.

DOE has adopted this provision as specified in ANSI/ASHRAE Standard 103–1993, which is referenced in today's final rule. This action is taken for the reasons described above, and because this is not a new requirement for gas-fired units and no comments were received opposing the requirement for insulation of the flue gas collector box on oil-fired units.

17. Insulation Requirement for Downflow Furnaces

DOE proposed an insulation provision that specifies that during the cool-down and heat-up tests, the internal section of the vent pipe is to be insulated to an R value of not less than 7 ft^2–h–°F/Btu. GAMA and Inter-City Products both expressed their opposition to the insulation requirement. They claim that the insulation requirement will reduce the AFUE value of currently rated units, requiring the possible lowering of the minimum standard on marginal units and affecting the utility rebate program. GAMA provided data from tests recently conducted at ETL to show that for twelve furnace models tested with insulation of the internal vent pipe on downflow furnaces, the percentage point reductions in AFUE range from 0.2 to 1.1 for models currently rated at AFUE of from 78 percent to 80.2 percent. Eight of the models will be below the 78 percent minimum, and three will be below the 80 percent rebate criterion, if tested pursuant to the proposed revision. (GAMA, No. 8, at 2,4 and A–1; and Inter-City, No. 7, at 4). Carrier Corp., Consolidated Industries, and Lennox Industries all supported GAMA's position. (Carrier, No. 12, at 1; Consolidated, No. 21, at 1; and Lennox, Transcript, at 77).

The purpose of the proposal to require insulation of the flue pipe is to obtain as nearly as possible the true flue gas temperature required in the calculation of the flue loss. The assumption made in the calculation procedure is that the flue gas temperature is the temperature at the exit plane from the heat exchanger. Since this is sometimes impossible to measure in practice, provisions are made in the test procedure to measure the flue gas temperature in a more convenient and accessible location such as in the flue pipe or stack. Insulation of the sections of the flue gas passage between the heat exchanger exit plane and the flue gas temperature measuring plane in the stack is not for the purpose of reducing the heat loss through the jacket but to obtain a more accurate flue gas temperature.

Today's final rule does not include the insulation of the internal flue pipe during the cool-down and heat-up tests. Also, the insulation requirement specified in section 7.2.2.5 of the referenced ANSI/ASHRAE Standard 103–1993 has not been included in today's final rule. This action is justified by the fact that for the downflow furnace, there is no existing specification in the current DOE test procedure that covers the internal flue pipe. The Department considers the insulation of the internal flue pipe during the heat-up and cool-down tests as a desirable procedure in obtaining a more accurate measure of the flue gas temperatures. Commenters objected to immediate implementation, however, because of the test time, retesting and re-rating of all the currently rated downflow furnace units with the associated costs, and the reduction in AFUE. The Department decided that the objections offered by commenters warrant a delay in the implementation of this provision. DOE will continue to examine this subject and may consider the implementation of the insulation requirement at a later date.

18. Revised Minimum Value for the Draft Factor D_P and D_F

DOE proposed that a value of 0.05 for the draft factor D_P be assigned for any units whose D_P value, when measured by the optional tracer gas method, is less than 0.10. This action was based on the following circumstances. The current test procedure allows the minimum value for the draft factor D_P and D_F to equal 0.0 on units where absolutely no air flows through the combustion chamber and heat exchanger when the burner is off (section 9.4.4 of ANSI/ASHRAE Standard 103–1982 as referenced in section 3.0 of appendix N to subpart B of part 430, 56 FR 12159, March 28, 1984). However, it is very difficult to verify an ''absolutely no air-flow'' condition by current flow measurement technology.

Only two comments were received. GAMA objected to the immediate implementation of these changes. (GAMA, No. 8, at 4). Carrier Corp. and Consolidated Industries both supported GAMA's position. (Carrier, No. 12, at 1; and Consolidated, No. 21, at 1). Energy Kinetics, Inc. commented that the values are too small to have any significant effect. (Energy Kinetics, No. 16, at 6).

The Department does not agree with GAMA's position and has adopted this provision as specified in ANSI/ASHRAE Standard 103–1993, which is referenced in today's final rule. This action is founded upon the following observations. The measurement of very low flow rates of flue gas is very difficult, and replicating the measurement would be a problem at the low flow rate encountered. The Department considers the value of 0.05 to be reasonable. The Department believes that only pulse combustion furnaces meet the requirement of no air flow during the off-cycle. The effect of this change will be that more units can use a lower draft factor D_F (with a very slight increase in AFUE), but it will not result in a lower AFUE for the set of units that are minimally compliant with this provision, and will negate the necessity of repeatedly conducting the tracer gas test to confirm the accuracy of a measured value varying below the 0.1 range.

19. Water Pump Energy Consumption

DOE proposed the measurement of the electrical energy consumption of the water pump for hot water boilers in the 1993 Proposed Rule. GAMA put this requirement in its second category (GAMA, No. 8, at 4). Carrier Corp. and Consolidated both supported GAMA's position. (Carrier, No. 12, at 1; and Consolidated, No. 21, at 1). Hydronics Institute (HI) stated that not all boilers are supplied with pumps. Instead of measuring the pump power, HI suggested adopting the requirement in ANSI/ASHRAE Standard 103–1993. This requirement specifies the use of the nameplate wattage if the pump is supplied by the manufacturers and a default value of 0.13 kW if no pump is supplied. (HI, No. 15, at 3). Energy Kinetics stated that the value of 0.13 kW is too high and that the standard pumps shipped with residential systems today consume no more than 60 watts (W). (Energy Kinetics, No. 16, at 7). Mr. John Woodworth, independent commenter, stated that the requirement would create a hardship and the results would have an insignificant effect on the annual efficiency descriptor. He stated that boilers are seldom tested with the ''standard pump'' in the laboratory. Instead, test rigs in most laboratories include pumps and mixing valves to test all sizes of boilers. When sold, a model boiler may be equipped with as many as three different brands of pumps, or shipped without a pump. Mr. Woodworth recommended that DOE adopt the requirement of ANSI/ASHRAE Standard 103–1993 instead of the proposed measurement requirement. (J. Woodworth, No. 20, at 3).

The Department, in today's final rule, adopts the requirement of ANSI/ASHRAE Standard 103–1993 for pump power consumption. The requirement states that if a pump is supplied with the boiler (as cited by Energy Kinetics), then BE (electrical power to water pump) is the nameplate wattage rating, and if no pump is supplied, then the current default value of BE is 0.13 kW in calculation of annual electrical energy consumption. By referencing the revised ANSI/ASHRAE Standard 103–1993, this is included in today's final rule. The Department does not agree with GAMA's inclusion of this issue in its second category, since pump power consumption is not involved with the calculation of AFUE. DOE does agree that the 1993 Proposed Rule, by requiring an additional measurement of pump power consumption, would impose a burden that does not significantly improve the calculation of annual electrical energy consumption. Hence, DOE adopts instead the ANSI/ASHRAE provision.

20. Energy Factor and Annual Efficiency Descriptors

In the 1993 Proposed Rule, the Department proposed two energy descriptors, the energy factor and annual efficiency, for both fossil-fueled furnaces and boilers. The proposed energy factor includes the auxiliary electrical energy consumption of the appliance, and is identical to the energy factor term as defined in appendix B of ANSI/ASHRAE Standard 103–1993, except that DOE proposed a different ''F-factor.'' Appendix B defined ''energy factor'' as the ratio of the annual output of heat energy provided to the space to the total annual energy input required to operate the appliance. The annual output of heat energy includes the contribution from a portion of the auxiliary electrical energy that is recovered as useful heat. The total annual energy input required includes both the fossil fuel and the auxiliary electric energy. The F-factor, however, equal to 3.0 in ANSI/ASHRAE Standard 103–1993, was 3.37 in the DOE proposal. The modified F-factor then approximated the ratio of the energy required to generate and transmit the auxiliary electricity consumed by the appliance to the amount of such electrical energy. The F-factor was applied to the auxiliary electrical consumption to reflect the efficiency in the use of all energy used to run the appliance.

The purpose of the Department's proposal to establish the new efficiency descriptor and the energy factor was to account for the auxiliary electric energy in the operation of fossil-fueled furnaces and boilers. The proposed descriptors would combine the consumption of fossil fuel and auxiliary electricity into a single value that would reflect the overall energy cost of a fossil-fueled appliance. The current energy descriptor, AFUE, deals only with the primary type of energy consumed by an appliance. Therefore, it does not give the consumer a complete account of the overall energy and cost performance of the appliance. On the basis of AFUE alone, a consumer would not be able to compare the overall cost of operation of two or more different models of fossil-fueled furnaces or boilers of comparable output capacity with blowers of different motor efficiencies or on/off controller timings. The proposed energy descriptors were intended to give the consumer the necessary information for a more informed decision. Another purpose for the proposed energy descriptors was to provide an evaluation procedure for different design options for fossil-fueled furnaces and boilers that involves auxiliary electric energy consumption. This information would be considered in the determination of energy efficiency standard levels.

At the public hearing and during the public comment period following the publication of the 1993 Proposed Rule, twenty-one commenters offered views on this issue. The comments ranged from support for an energy descriptor that included both the fossil fuel and the auxiliary electric energy consumption, to complete disagreement with that concept. Nearly all commenters however, expressed reservations on the source-based multiplication factor (the F-factor to be applied to the auxiliary electrical energy consumption of fossil-fueled appliances). A summary of the commenters' reasons for objection include: (1) The use of source energy in determining the energy efficiency, through the proposed F-factor, is not permitted by EPCA and NAECA, which specify that efficiency must be determined by energy consumption at the point of use (site) of the covered products; (2) the application of the F-factor to the auxiliary electrical energy consumed by fossil-fueled appliances, but not to all-electric furnaces, is biased against fossil-fueled appliances; (3) a national average source to site energy ratio ignores the variation in the value of the F-factor due to different methods of power generation; (4) the value of the proposed energy descriptor would be lower than the AFUE, creating confusion for AFUE based rebate/incentive programs by utility companies; (5) combination furnace/air-conditioning systems with a single heating capacity may require different size blowers depending on cooling load requirements; and (6) fuel switching and marketplace distortion could result. A detailed summary of comments on the F-factor and the proposed energy descriptor is found in the **Federal Register** notice. 60 FR 4348 (January 20, 1995).

In 1995 the Department reopened the comment period on the 1993 Proposed Rule, solely to address this issue, and the Department proposed a revision of its 1993 proposal. In place of the 1993 Proposed Rule's definition of the F-factor as a source-to-site based energy ratio, the Department proposed a cost-based electricity-to-fossil fuel price ratio with a value of 3.36 at the point of use. The proposed revision was published in the **Federal Register** on January 20, 1995. 60 FR 4348.

Seventy comments were received concerning this proposed revision to the F-factor. Many comments were similar to those received in response to the original 1993 proposal, and disregarded the change to an F-factor based on cost of energy. Most commenters considered the proposal as violating the intent and language of EPCA and NAECA, asserting that these statutes define energy efficiency with reference to energy consumption at the point of use (site energy). Because comments were similar or identical to those submitted following the 1993 proposal, a commenter-by-commenter description of the comments is not presented here. Virtually all of the commenters urged DOE to either withdraw or modify the F-factor proposal.

One of the principal issues raised by the commenters is the authority of DOE to establish an energy efficiency standard for furnaces on the basis of either energy cost or source energy, as opposed to site energy consumption in units of energy. Upon further examination, it is the view of the Department of Energy that EPCA requires the energy efficiency of a furnace to be based on consumption of energy at the site of the furnace, and that the statute does not permit the promulgation of an energy efficiency standard that is expressed in terms of annual operating costs of the furnace.

EPCA defines the energy conservation standard of a covered appliance as ''a performance standard which prescribes a minimum level of energy efficiency or a maximum quantity of energy use.'' EPCA section 321(6), 42 U.S.C. 6291(6). EPCA defines ''energy efficiency'' as the ratio of a product's useful output of services to its ''energy use.'' EPCA section 321(5), 42 U.S.C. 6291(5). Thus, ''energy use'' is a basis for any standard for furnaces and boilers. ''Energy use'' in turn is defined in section 321(4), 42 U.S.C. 6291(4), as ''the quantity of energy directly consumed by a consumer product at point of use.'' Therefore, furnace energy conservation standards must be based on consumption of energy at the site of the appliance. The Department believes that this conclusion is further supported by terminology used in section 325(f) of EPCA, 42 U.S.C. 6295(f), which concerns standards for furnaces. Section 325(f)(1)(B), for example, requires the promulgation of an ''energy conservation standard'' for small furnaces, and, as just discussed, such a standard must be based on energy consumption at the site of the application.

Based on the above analysis, the Department is withdrawing the proposed energy descriptor and energy factor in today's final rule. The current procedures of determining AFUE from the energy efficiency descriptor, and of calculating of the annual energy consumption of fossil fuel and electrical energy for furnaces/boilers, therefore will remain unchanged. In the meantime, the Department will continue to explore and to solicit input from interested parties on various options for the development of a descriptor that would take into account separately both a new energy factor for fossil fueled furnaces and the auxiliary electrical energy consumption of an appliance.

21. Measurement of Electric Energy Consumption for Interrupted Ignition Device

The 1993 Proposed Rule required measurement of the energy consumption by the interrupted ignition device. Both GAMA and Inter-City Products argued that the electrical energy consumption of the interrupted ignition device constitutes an extremely small amount of all electrical consumption of a furnace. To include the measurement of the energy consumption of the device is burdensome in time and effort. Carrier Corp. and Consolidated Industries both supported GAMA's position. (Inter-City, No. 7, at 3; GAMA, No. 8, at 18; Carrier, No. 12, at 1; and Consolidated, No. 21, at 1). HI and independent commenter Mr. John Woodworth both stated that the energy consumption of these ignition devices is small and will not affect the energy descriptors. Additionally, according to HI and Mr. Woodworth, a separate test would be required since the ignition devices are off during the steady state test, and they are difficult to measure because the time duration and power draw are not constant during ignition. Therefore, HI recommended the deletion of the device in the proposed measurement requirement and the calculation procedures. (HI, No. 15, at 3; and J. Woodworth, No. 20, at 4).

To assess the merits of these comments, and to determine the amount of energy consumption of an interrupted ignition device, NIST measured the power input, on-time duration and energy consumption of an electric hot surface ignition device on a 90,000 Btu/h input gas-fired furnace. It was found that the power input varied from 515 W to 470 W during the 40 seconds the device was on. Except for the first few seconds, the power draw was approximately 470 W. This translated into an energy consumption of approximately 18 Btu per burner on-cycle, or 63 Btu/h for the assumed average 3.5 burner on-cycles per hour (3.87 minutes on and 13.3 minutes off) for a single stage furnace. While this compares favorably with the average 400 Btu/h energy consumption of a pilot light, DOE does not agree that the energy consumption of the interrupted ignition device should be completely ignored. DOE agrees, however, that the energy consumption is small enough to justify the deletion of the measurement requirement in the proposed test procedure. Therefore, DOE is specifying in today's final rule that the on-time of an interrupted ignition device, as specified in a furnace's nameplate, should be used as the actual on-time. Further, the nameplate power input rating, or 0.4 kW if none is specified on the nameplate, should be used as the average power draw in the electrical energy calculation. The device on-time will be measured with a stop watch if not specified on the nameplate. The device on-time will be set to equal zero if the nameplate or measured value is less than or equal to five seconds.

22. Measurement of Energy Consumption of Combustion Blower During Post Purge

The test procedure of the proposed rule and ASHRAE 103–93 requires the measurement of the energy consumption of combustion blowers during a post purge. Commenters GAMA and Inter-City Products both argued that the electrical energy consumption of the combustion blower during post purge constitutes an extremely small amount of all electrical consumption of a furnace, and that to include the measurement of the energy consumption of the combustion blower is overly burdensome in time and effort. Carrier Corp. and Consolidated Industries both supported GAMA's position. (Inter-City, No. 7, at 3; GAMA, No. 8, at 18; Carrier, No. 12, at 1; and Consolidated, No. 21, at 1). Energy Kinetics, while not commenting on the power consumption of the draft inducer during post purge, pointed out that the power burner is off for some oil-fired units during post purge and thus, only the draft inducer is on. As a result, the auxiliary electrical energy consumption measured during steady state may not be equal to the electrical energy consumption during the post purge period. (Energy Kinetics, No. 16, at 6).

The 1989 ASHRAE Handbook of Fundamentals states that the power consumption of motors with rated horsepowers of $\frac{1}{20}$ hp and $\frac{1}{12}$ hp, which would be typical for combustion blowers, are approximately 360 Btu/h and 580 Btu/h, respectively. For a post purge period of 30 seconds, the energy consumptions would be 3–5 Btu per off-cycle for the two sizes of motors, and for a post purge period of 180 seconds, the motor energy consumptions would be 18–29 Btu per off-cycle. For an average 3.5 on-cycles per hour of furnace operation, the energy consumption would be 10 Btu/h to 17 Btu/h for the 30-second post purge and 60 Btu/h to 100 Btu/h for the 180-second post purge. For boilers with an average of 1.3 on-cycles per hour, the values would be approximately $\frac{1}{3}$ the above.

DOE does not agree that the energy consumption should be completely ignored. Therefore, DOE is specifying in today's final rule that the nameplate power rating of the combustion blower be used as the power consumption in the calculation for the electrical energy consumption. DOE agrees that the energy consumption is small enough to justify the deletion of the electric power measurement requirement for the combustion blower. But measurement of the full length of the post purge period, easily determined with a stop watch, is still required as set forth in the proposed rule.

23. ANSI/ASHRAE Standard 103–1993

The 1993 Proposed Rule referenced ANSI/ASHRAE Standard 103–1988 and added additional amendments to cover the changes, revisions and advances in technology between the years when the Standard was published (1988) and the Proposed Rule was published (1993). Those additional amendments included a revised calculation procedure for units with stack dampers; revised test procedures for atmospheric burner units with a burner inlet damper or flue damper; revised test procedures for power burner units employing post purge during the off-cycle; insulation requirements during heat-up and cool-down tests for downflow furnaces; a jacket loss test for units with ventilation openings on their cabinets; and other technical corrections.

Subsequent to the publication of the 1993 Proposed Rule, ASHRAE published in October 1993 ANSI/ASHRAE Standard 103–1993 which supersedes ANSI/ASHRAE Standard 103–1988. The revised ANSI/ASHRAE Standard 103–1993 incorporated most of the revisions and additions to ANSI/ASHRAE Standard 103–1988 that were included in the 1993 Proposed Rule, with the following exceptions: (1) The requirement of a minimum on-time delay for the blower at burner ignition and a maximum off-time delay after burner shut-off for units with an unvarying blower timing control; (2) the actual measurement of power input to hot water boiler pumps; (3) the measurement of ignition energy input to interrupted ignition devices; and (4) the measurement of combustion blower time delay during post purge after burner shut-off in power vented units. With the above exceptions, the revised ANSI/ASHRAE Standard 103–1993 and the 1993 Proposed Rule are nearly identical in content.

Commenters including GAMA stated that ANSI/ASHRAE Standard 103–1993 should be incorporated in the Department's test procedure rather than ANSI/ASHRAE 103–1988 as proposed in the 1993 Proposed Rule. (GAMA, Transcript, at 8). HI stated that since

ANSI/ASHRAE 103–1988 is no longer the current standard and will no longer be published by ASHRAE, it would be difficult for manufacturers to obtain additional copies for reference; therefore, the 1993 version should be referenced. (HI, Transcript, at 74). Mr. John Woodworth, who was Chairman of the SPC that developed ANSI/ASHRAE 103–1993, Secretary of the SPC for ANSI/ASHRAE 103–1988 and Vice-Chairman of the SPC for ANSI/ASHRAE 103–1982, suggested that DOE should reference the ANSI/ASHRAE 103–1993 rather than ANSI/ASHRAE 103–1988. He asserts that, with few exceptions, the requirements in ANSI/ASHRAE 103–1993 are the same as the requirements in the 1993 Proposed Rule. In addition, ANSI/ASHRAE 103-1988 will no longer be available from ASHRAE. (John Woodworth, No. 20, at 2). The CEC stated that it supports the use of ANSI/ASHRAE Standard 103–1993 with DOE-specified changes. (CEC, No. 25, at 3). It was suggested by Lennox (Lennox Transcript, at 78) that the test procedure be published in its entirety.

The Department agrees with the commenters on this issue and is referencing the ANSI/ASHRAE Standard 103–1993 instead of the 1988 version in today's final rule. DOE decided not to publish the above standard in its entirety, since it is the practice of the Department to incorporate by reference any industry consensus standards, and the test procedures adopted in today's final rule are nearly identical to ANSI/ASHRAE Standard 103–1993.

24. Other Minor Modifications to ANSI/ASHRAE Standards 103–1988 and 103–1993

In the 1993 Proposed Rule, DOE also proposed to adopt corrections and clarifications of several typographical errors and inconsistencies identified by ASHRAE SPC 103 following publication of ASHRAE Standard 103–1988.

No commenter expressed objection to those specific revisions with the exception of Mr. Woodworth on revision to section 9.7.3 of the Standard. Therein, Mr. Woodworth stated that, since $T_{F,OFF}$ is not needed in the calculation of off-period flue gas mass flow rate if the draft is maintained during cool-down, the $T_{F,OFF}$ reading is not necessary. The draft is maintained during cool-down for units with barometric draft regulators. Therefore, the phrase ''if draft is not maintained during cool-down'' should not be deleted. (J. Woodworth, No. 20, at 4). DOE agrees with Mr. Woodworth's comment, and the proposed revision is dropped from today's final rule.

DOE, by referencing ANSI/ASHRAE Standard 103–1993 today, has included all the other minor revisions and corrections to ANSI/ASHRAE Standard 103–1988 in today's final rule. With the exception of the item commented on by Mr. Woodworth above, the revised ANSI/ASHRAE Standard 103–1993 incorporated all the other minor revisions and corrections to ANSI/ASHRAE Standard 103–1988 described in the 1993 Proposed Rule.

After the publication of ANSI/ASHRAE Standard 103–1993, a few typographical errors were identified. On October 24, 1996, ASHRAE issued an Errata Sheet for ASHRAE Standard 103–1993, that listed the typographical errors to be corrected in ANSI/ASHRAE 103–1993. This ASHRAE Errata is incorporated by reference in today's final rule.

25. Other Issues

The following is a discussion of comments DOE received on issues not raised by the proposed test procedure for furnaces and boilers. As discussed below, however, in the 1993 Proposed Rule DOE had requested comments on certain of these issues.

(1) Distribution System Efficiency.—First, commenters including Dr. M. A. Habegger of Boulder, Colorado, remarked that in the field installation, the air flow rate through the distribution system has a large effect on the overall system efficiency. Further, the value of AFUE obtained through the current test procedure is usually much higher than the overall system efficiency. (M. A. Habegger, No. 22 at 1). The Department agrees that a reduced air flow rate will reduce the overall efficiency of the heating system due to a higher flue gas temperature and duct air leakage.

Dr. Habegger further comments that the circulation air flow rate is not considered in the current test procedure and that testing the efficiency of equipment without considering the overall installed system effect is meaningless. The Department disagrees. The rate of circulation air flow is addressed in the test procedure by the limits set on both the minimum external static pressure and the air temperature rise between the supply and return air. This assures that the circulation air blower will deliver the appropriate amount of air flow at the required design conditions.

As the Department specifically pointed out in the preamble to the 1984 Final Rule for furnaces, boilers, and vented and unvented home heaters, the test procedures cannot predict the energy performance of a furnace in every installation. 49 FR 12153 (March 28, 1984). Rather, their use is for comparison purposes and thus installation variables are only representatively accounted for. That preamble continues to state the Department's position on this issue.

(2) Input/Output Method.—Two commenters, Energy Kinetics and the CEC, responded to the Department's request to comment on the appropriateness of a test procedure for furnaces and boilers based on an input/output method. Both suggested the development or adoption of the input/output method as a more accurate method for rating furnaces and boilers in place of the present flue loss method. (Energy Kinetics, No. 16, at 7; and CEC, No. 25, at 3). GAMA, in response to questions during the public hearing, stated that ETL researchers working on an input/output method for GAMA experienced a great deal of difficulty in repeating the test results and in correlating the resulting efficiency rating with the current method. GAMA felt that more time is needed for work in the input/output method. (GAMA, Transcript, at 35).

An analysis by Dr. D. R. Tree of Purdue University with data supplied by NIST on the errors associated with the input/output method showed that for warm air furnaces, the uncertainties in duct air flow measurement and non-uniform temperature distribution in the duct, during steady state and cyclic conditions, would result in an error estimate of ±12 percent for the AFUE value. This made the input/output method unacceptable as a test procedure for warm air furnaces.[4] The problem of flow and temperature measurements for hot water boilers would not be as severe. A detailed method, however, on the transient performance of hot water boilers, both during the on-cycle (energy delivered) and the off-cycle (heat loss) needs to be developed and a consensus on the procedure agreed upon. The problems of testing according to two different test procedures, one for warm air furnaces and one for hydronic heating systems, also require further discussion. The Department is, therefore, reserving action on the possible adoption of an input/output method for hydronic heating systems to a future rulemaking.

(3) Test Procedure for Combined Space/Water Heating Appliances.—Only Energy Kinetics raised this issue, and questioned the appropriateness of the current ASHRAE Standard 124–

[4] David R. Tree, ''Error Analysis of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnace Boilers, Report Number 4, Executive Summary,'' Ray W. Herrick Laboratories, Purdue University.

1991 that covers the testing and rating of combination appliances. (Energy Kinetics, No. 16, at 8).

The Department is preparing to propose a test procedure for combined space/water heating appliances in the future. DOE welcomes any comments and input from industry and interested individuals and organizations.

(4) Off-Cycle Draft Setting.—Only Energy Kinetics commented that the operation and off-cycle draft conditions at the flue connection to a unit affect the ratings of the unit, and suggested that the draft value should not be left to be at the manufacturer's recommendation. Energy Kinetics suggested a standard draft level of 0.05″ water column to be maintained at both the on-cycle and off-cycle periods during the test. (Energy Kinetics, No. 16, at 5).

DOE believes that this specification is not necessary as the draft produced during the operation of the unit cannot be arbitrarily set by the manufacturer if proper operation, such as smoke number, CO_2 concentration, and flame stability, of the unit is to be maintained. DOE reasons that if the manufacturers do not require or recommend the maintenance of a specific draft level during the off-cycle for the normal operation of their unit, it should not be required during the off-period test.

(5) Supply and Return Water Temperature Settings for Hot Water Boilers.—Energy Kinetics stated that the hot water boiler temperature settings of 120°F return water temperature and 140°F supply water temperature during the tests, as prescribed in the current test procedure, are too low. They are not the normal temperatures of 160°F and 180°F encountered in a home installation. (Energy Kinetics, No. 16, at 4).

The Department prescribed the test conditions for hot water boilers (boiler return water of at least 120°F and a 20°F temperature rise) during the 1983 proposed rulemaking (48 FR 28014, June 17, 1983) before the publication of the final rule for the current furnace test procedure (49 FR 12148, March 24, 1984). In so doing, the Department stated its belief that all non-condensing hot water boilers, including finned tube boilers and low thermal mass boilers, generally operated at these conditions, and the specifications would eliminate the need for future test procedure waivers for specific types of hot water boilers from a uniform test condition. At that time the boiler industry had also indicated its desire to have these test conditions included. The Department sees no fundamental change in the application of hot water boilers to warrant revision to the current test procedure. In addition, changing the test conditions to those suggested by Energy Kinetics would result in a reduction of the AFUE for existing hot water boilers as the flue loss would be slightly higher due to a higher flue gas temperature. This would require the retesting and re-rating of most existing hot water boilers.

For the reasons discussed above, today's final rule does not include any changes to the test conditions with respect to the boiler water return temperature and temperature rise for hot water boilers as specified in the current test procedure.

(6) Energy Lost at Appliance Location (Boilers in Unheated Space).—Energy Kinetics disagreed with the requirement that boilers be tested as indoor installation. It claimed that most boilers are installed in un-conditioned space. (Energy Kinetics, No. 16, at 4).

Since the minimum standard for boilers is based on a statutory definition of AFUE which explicitly assumes that non-weatherized boilers are located indoors, DOE will not consider any change in the installation location for boilers at the present time.

(7) Setting Throughput Air Temperature Rise for Furnaces.—In the current DOE test procedure and ANSI/ASHRAE Standard 103–1988, the adjustment to the air throughput for warm air furnaces at steady state operation is specified under the following conditions: a temperature rise, across the heat exchanger, shall be the higher of (1) 15°F below the maximum temperature rise, or (2) 15°F above the minimum temperature rise, as specified by the manufacturer.

In the 1993 Proposed Rule and in the 1993 revision of ANSI/ASHRAE Standard 103 (as 103–1993), a provision was added to the test setting of the air temperature rise. The provision requires that, for furnaces whose design does not permit a temperature rise range of 30°F, the furnace shall be tested at the midpoint of the rise range specified by the manufacturer if the rise is less than 30°F. Commenters GAMA and Inter-City mentioned this provision for condensing furnaces whose temperature rise range may be less than 30°F, and listed this provision in GAMA's first category of revisions for immediate implementation. (GAMA, No. 8 at 3; Inter-City, No. 7 at 4).

DOE has adopted this provision as specified in ANSI/ASHRAE Standard 103–1993 referenced in today's final rule.

B. Vented Home Heating Equipment

The Department originally published the test procedure for vented home heating equipment on May 2, 1978. 43 FR 20182. The Department amended this test procedure on March 28, 1984, to include a simplified vented heater test procedure for heaters with modulating controls, manually controlled vented heaters, vented heaters equipped with thermal stack dampers, and floor furnaces. 49 FR 12169.

In the 1993 Proposed Rule, DOE proposed the following amendments to the vented home heating equipment test procedure: (1) To establish an annual efficiency descriptor to account for the auxiliary electrical energy consumed by the fan or blowers in addition to the fossil fuel consumed; (2) to revise the calculation procedure for AFUE for manually controlled heaters; and (3) to revise the calculation procedure for weighted average steady-state efficiency for manually controlled heaters with various input rates.

The following discussion addresses the comments received on the proposed rule.

1. Annual Efficiency Descriptor

The Department proposed in the 1993 Proposed Rule to adopt the energy factor as defined in appendix B of ANSI/ASHRAE Standard 103–1993 as the new energy descriptor for vented home heating equipment, and renamed it the annual efficiency descriptor.

The Department's current test procedure for vented home heating equipment prescribes the calculation of AFUE based on the energy consumption of fossil fuel only. Since auxiliary electrical energy can be consumed by these appliances such as for the operation of a blower, DOE considered that a more appropriate energy descriptor was needed to account for both fossil fuel and auxiliary electrical energy consumption of the appliances. This energy descriptor would also be used to address the electrical energy used by some of the design options considered for energy standard level evaluation.

Seventeen commenters, directly or in support of another commenter, have commented on this issue. The comments from each individual or organization were discussed in the **Federal Register** notice of January 20, 1995. 60 FR 4348. This was described previously in the section for the proposed energy factor and annual efficiency descriptors for central furnaces and boilers. (See II.A. 20 above, ''Annual Efficiency Descriptor and Energy Factor.'')

As concluded in the discussion above, DOE has decided to withdraw the proposed energy descriptor from today's final rule. Since the commenters combined their comments on this proposed energy descriptor with those for the central furnaces/boilers, readers are referred to that section for a discussion of this issue. Therefore, the current procedures of determining AFUE as the energy efficiency descriptor will remain unchanged. However, the proposed procedure for the calculation of the annual energy consumption of fossil fuel and electrical energy for the vented home heating equipment is included in today's final rule. This added procedure does not involve any additional testing beyond that required by the current test procedure. The added calculation procedure is intended to allow for the adequate and fair cost ranking of the different design options that may be considered in future evaluations of possible revisions of energy standard levels.

2. Pilot Light Energy Consumption for Manually Controlled Heaters

In the 1993 Proposed Rule, for manually controlled heaters, under certain conditions, the measurement of pilot light energy is not needed. Two comments on this issue were received. GAMA supported the provision of not requiring the measurement of the pilot energy consumption for manually controlled heaters equipped with a piezo igniter. (GAMA, No. 8, at 20). The CEC stated that the language in the provision should be more explicit in defining what is meant by the phrase ''when the heater is not in use and instruction to do so is given,'' in section 3.5.2 of appendix O to subpart B of part 430. The CEC further stated that the manufacturer should only be allowed to ignore the pilot energy use if the pilot extinguishes whenever the burner is off. (CEC, No. 25, at 3).

The Department agrees with the suggestion of the CEC to clarify when the proposed provision is applicable. This provision applies to a heater that provides manually controlled settings for the control knob in the operation of the appliance, and a clearly marked knob setting such as the ''OFF'' knob setting shuts off the appliance completely including the pilot light. DOE is today revising the section in question to read as follows:

''3.5.2 For manually controlled heaters where the pilot light is designed to be turned off by the user when the heater is not in use, that is, turning the control to the OFF position will shut off the gas supply to the burner(s) and to the pilot light, the measurement of Q_P is not needed. This provision applies only if an instruction to turn off the unit is provided on the heater near the gas control valve (e.g., by label) by the manufacturer.''

3. Weighted Average Steady-State Efficiency

In the 1993 Proposed Rule, DOE proposed that for manually controlled vented home heaters with multiple input rates whose design is such that the specified minimum firing rate cannot be set at 50±5 percent of the unit's maximum firing rate, the test will be conducted at the unit's minimum fuel input rate, provided that the minimum input shall be no higher than ⅔ of the maximum fuel input rate of the heater.

GAMA supported this provision. (GAMA, No. 8, at 20). DOE is adopting the provision in today's final rule.

C. Pool Heaters

The Department published the pool heater test procedure on February 7, 1989, referencing ANSI Standard Z21.56–1986 for gas-fired pool heaters. 54 FR 6076. In the 1993 Proposed Rule, DOE proposed to amend the pool heater test procedure, first, to include an annual efficiency descriptor that accounts for the fossil fuel and the auxiliary electrical energy consumed by any fan or pump and, second, to replace the reference to ANSI Standard Z21.56–1986 with references to the then updated version of ANSI Standard Z21.56.

Standard Z21.56 was updated again in 1994. But no substantive changes were made in the portions of that Standard which DOE had proposed, in the 1993 Proposed Rule, to incorporate into its pool heater test procedure. DOE is therefore referencing ANSI Standard Z21.56–1994 in the pool heater test procedure it adopts today.

All of the comments received on the proposed amendment to this test procedure concerned the proposed annual efficiency descriptor. The following discussion addresses those comments.

1. Annual Efficiency Descriptor

The Department proposed in the 1993 Proposed Rule a new energy descriptor, the Annual Efficiency (AE), for pool heaters. The proposed AE descriptor, was defined as the ratio of the annual output of energy delivered to the heated pool water by fossil fuel to the total annual energy input to the heater including auxiliary electrical energy. The latter term, auxiliary electrical energy, was multiplied by a factor F which represents the ratio of the heat energy required to generate and transmit the electricity to the electrical energy delivered at the pool heater. This was for the purpose of reflecting the efficiency of total energy used to run the appliance.

The Department's current test procedure for pool heaters prescribes the calculation of the thermal efficiency under steady state condition only. The thermal efficiency is defined as the ratio of the useful output of heated water to the sum of the input of fossil fuel energy and auxiliary electric energy during the steady state test period. DOE considered that a more appropriate energy descriptor was needed in order to account for the energy consumption during the burner-off periods of a pool heating season. DOE based this view on the fact that a significant quantity of energy can be consumed by a continuous pilot light and the auxiliary electrical energy consumption during the burner-off periods of the pool heating season. The proposed energy descriptor could also be used to address the energy savings by some of the design options that might be considered in future evaluation of possible revisions of energy standard levels. For example, to consider electronic ignition, the evaluation would have to account for the savings in gas consumption resulting from elimination of a continuous burning pilot.

Seventeen commenters, directly or in support of another commenter, have commented on this issue. The comments from each individual or organization concerning the proposed multiplication factor F applied to the auxiliary electric energy consumption are discussed in the **Federal Register** notice of January 20, 1995 (60 FR 4348). This was described previously in subsection 20 of section II.A of this notice, which discusses the proposed energy factor and annual efficiency descriptors for central furnaces and boilers. Readers are referred to that section for the discussion of the F-factor issue.

GAMA also commented on the proposed annual efficiency descriptor concerning pool heaters. GAMA stated that the use of a recirculating pump should be factored into the AE descriptor only if the pump is used during the thermal efficiency test under section 2.8.1 of ANSI Z21.56–1990 standard. Further, GAMA claims, the pump or the pump/filter system used in any given installation in the field that is not supplied by the manufacturer should not be considered as part of the heater's auxiliary components. GAMA commented that DOE should focus on addressing a pool heater's primary electrical energy consumption rather than auxiliary losses.

The Department believes that the above concerns expressed by GAMA are unfounded. As shown in section 4 of appendix P of the 1993 Proposed Rule, the determination of the auxiliary electrical energy consumption of the pool heater is as specified in ANSI Z21.56–1990 standard, and was not modified in the 1993 Proposed Rule. As proposed in section 4.4 of appendix P, the calculation of the annual auxiliary electrical energy consumption is based on heater on-time only.

GAMA first stated that, since DOE defined the average number of burner operating hours as 104 hours independent of pool and heater size, then ''100,000 Btu/hr and 400,000 Btu/hr pool heaters can have the same AE value, and would give the impression that a 400,000 Btu/hr pool heater is an effective choice for heating a 500 gallon hot tub.'' GAMA then stated that during pool ''off-season'' hours, the continuous pilot is usually shut off.

DOE disagrees with the first statement. If the output capacity of the pool heater is properly selected by the contractor or installer based on the size or load requirement of a particular pool, then the burner operating time would be neither excessively long nor unduly short. Moreover, although the selection of a particular pool heater among models of similar capacity for a specific pool size may be based on its energy efficiency, the selection of a correct capacity heater is based on the pool size or load requirement. As to GAMA's statement about the pilot light being off during the ''off season,'' the 1993 proposal already assumed that the continuous pilot light, if used, will be off during non-heating season hours. (See section 4.2 of appendix P to subpart B of part 430, on the definition of the average number of seasonal pool operating hours (POH).)

In its statement, GAMA also suggested that, instead of the AE descriptor, DOE should develop a methodology to calculate total annual energy consumption, based on thermal efficiency, electrical energy consumption, and continuous pilot light consumption. Thus, consumers could use this information to estimate annual energy consumption and operating costs for a specific pool size and season of operation.

DOE agrees with this suggestion. The calculation procedure in today's final rule includes the calculation of the average annual fossil fuel and auxiliary electric energy consumption.

The Department has decided to withdraw the proposed energy descriptor with the proposed F-factor multiplier from today's final rule, for the reasons discussed in subsection 20 of section II.A of this notice. The current procedure for determining the energy efficiency descriptor for pool heaters, the steady state thermal efficiency, shall remain unchanged. A procedure, however, for the calculation of the pool heater seasonal efficiency and the annual energy consumption of fossil fuel and auxiliary electricity for the pool heater is included in today's final rule. The pool heater seasonal efficiency is defined as the ratio (in percent) of the useful output of the heater in terms of heated pool water during the pool heating season to the sum of the total energy input when the burner is on and the energy consumption of the pilot light when the burner is off during the pool heating season. The total burner-on hours and the length of the pool heating season are assumed to be 104 hours and 4464 hours per year, respectively. The heater is assumed to be in steady state operation whenever the burner is on. The pilot light is assumed to be off during the non-heating season hours (4296 hours) and on during the pool heating season hours (4464 hours). The auxiliary electrical energy consumption is assumed to be negligible when the burner is off. For heaters which do not employ a continuous pilot light during the pool heating season, the seasonal efficiency will be the same as the steady state thermal efficiency. This procedure will account for the energy consumption of those pool heaters that employ a continuous pilot light during the pool heating season. As stated previously, the procedure also provides a calculation procedure for the average annual fossil fuel and auxiliary electric energy consumption. These calculations are simply arithmetic exercises with no additional testing required. Since these calculations could be used to address the energy savings by some design options that might be considered in future evaluations of energy standard levels, DOE believes it is justified to include these additional calculations.

III. Procedural Requirements

A. Review Under the National Environmental Policy Act of 1969

The Department has concluded that this final rule falls into a class of actions (categorical exclusion A5) that are categorically excluded from the National Environmental Policy Act of 1969 (NEPA) review because they would not individually or cumulatively have a significant impact on the human environment, as determined by DOE's regulations (10 CFR part 1021, appendix A to subpart D) implementing the NEPA (42 U.S.C. 4321, 4331–35, 4341–47). Therefore this final rule does not require an environmental impact statement or an environmental assessment pursuant to NEPA.

B. Review Under Executive Order 12866, ''Regulatory Planning and Review''

Today's regulatory action has been determined not to be a ''significant regulatory action'' under Executive Order 12866, ''Regulatory Planning and Review,'' 58 FR 51735, October 4, 1993. Accordingly, today's action was not subject to review under the Executive Order by the Office of Information and Regulatory Affairs.

C. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act, 5 U.S.C. 603, requires the preparation of an initial regulatory flexibility analysis for every rule which by law must be proposed for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. A regulatory flexibility analysis examines the impact of the rule on small entities and considers alternate ways of reducing negative impacts.

The Department believes the final rule will not have a significant impact on either small or large manufacturers of furnaces and boilers, vented home heating equipment, and pool heaters under the provisions of the Regulatory Flexibility Act. The final rule amends DOE's test procedures, primarily to incorporate (1) test procedures already in use by manufacturers pursuant to waivers that DOE previously granted to those manufacturers, and (2) revisions to standard industry testing methods, contained in American Society of Heating, Air-Conditioning and Refrigerating Engineers (ASHRAE) Standard 103–1993, ''Methods of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers,'' and American National Standards Institute Standard Z21.56–1994, ''Gas-Fired Pool Heaters.'' Examples of amendments are:

- The 90-second delay from burner ignition to activation of the warm air circulation fan designed with an unvarying time delay in a central furnace has been shortened to accommodate current manufacturers designs.
- There is no requirement to calculate the energy consumption of a gas pilot light on manually controlled vented home heaters provided that there is instruction for the user to turn the pilot light off and restart it.

• The test procedure for modulated, vented home heating equipment allows testing at 100 percent and sixty six percent rated input power, instead of 100 percent and fifty percent power, to accommodate new designs.

Such requirements presented in the final rule incorporate improvements in the current testing technology for furnaces and boilers, vented home heating equipment, and pool heaters utilized by industry. But they would not have a significant economic impact, since they are methods already in use by manufacturers, and will not cause manufacturers to purchase equipment, consume testing time, nor employ technical staff beyond what is required by existing DOE test procedures.

In addition, in some respects the test procedures in the final rule are less burdensome than the current procedures. For example:

• The formula to calculate the time delay and energy loss of a stack damper traversing from fully open to fully closed has been adjusted for greater accuracy. The revised formula has been incorporated into the existing computer program for the calculation of the AFUE and will require no additional hand calculations.

Therefore, DOE certifies that the final rule, if promulgated, would not have a ''significant economic impact on a substantial number of small entities'' and that the preparation of a regulatory flexibility analysis is not warranted.

D. Review Under Executive Order 12612, ''Federalism'

Executive Order 12612 (52 FR 41685, October 30, 1987) requires that regulations or rules be reviewed for any substantial direct effects on States, on the relationship between the Federal Government and the States, or on the distribution of power and responsibilities among various levels of government. If there are sufficient substantial direct effects, then Executive Order 12612 requires preparation of a Federalism assessment to be used in all decisions involved in promulgating and implementing a regulation or a rule.

The final rule published today would not alter the distribution of authority and responsibility to regulate in this area. The final rule would only revise a currently applicable DOE test procedure to improve existing testing methods, and to add provisions that DOE might use in future standard setting. Accordingly, DOE has determined that preparation of a federation assessment is unnecessary.

E. Review Under Section 32 of the Federal Energy Administration Act of 1974

The test procedures in this final rule incorporate commercial standards to measure the efficiency and capacity of furnaces and/boilers, vented home heating equipment, and pool heaters. The commercial standards are ANSI/ASHRAE Standard 103–1993, ''Method of Testing for Annual Fuel utilization Efficiency of Residential Central Furnaces and Boilers,'' and ANSI Standard Z21.56–1994, ''Gas Fired Pool Heaters.''

Pursuant to section 301 of the Department of Energy Organization Act (Pub. L. 95–91), DOE is required to comply with section 32 of the Federal Energy Administration Act of 1974, as amended by section 9 of the Federal Energy Administration Authorization Act of 1977 (FEAA) Pub. L. 95–70, which imposes certain requirements where a proposed rule contains commercial standards or authorizes or requires the use of such standards. The findings required of DOE by section 32 serve to alert the public and DOE regarding the use and background of commercial standards in a proposal and through the rulemaking process. They allow interested persons to make known their views regarding the appropriateness of the use of any particular commercial standard in a proposed rulemaking.

The Department has evaluated ANSI/ASHRAE Standard 103–1993 and ANSI Standard Z21.56–1994 with regard to compliance with section 32(b) of the FEAA. The Department is unable to conclude whether these standards fully complied with the requirements of section 32(b), i.e., that they are developed in a manner which fully provided for public participation, comment, and review.

In addition, section 32(c) of the FEAA precludes the Department from incorporating any commercial standard into a rule unless it has consulted with the Attorney General and the Chairman of the Federal Trade Commission (FTC) as to the impact of such standard on competition, and neither individual recommends against its incorporation. Pursuant to section 32(c), the Department advised these individuals of its intention to incorporate Standards 103–1993 and Z21.56–1991 into its final test procedure rules for furnaces/boilers and pool heaters, respectively. Neither recommended against such incorporation.

The Department notes that it is incorporating into today's rule the method for testing pool heaters that is set forth in ANSI Standard Z21.56–1994. Standard Z21.56–1994 was not specifically identified in the aforementioned communications with the FTC and Department of Justice. It is, however, a revised and updated version of Standard Z21.56–1991, which was mentioned in those communications, and the provisions DOE is incorporating from Z21.56–1994 are identical in substance to the corresponding provisions in Z21.56–1991.[5]

F. Review Under Executive Order 12630, ''Governmental Actions and Interference With Constitutionally Protected Property Rights''

It has been determined pursuant to Executive Order 12630 (52 FR 8859, March 18, 1988) that this final rule would not result in any takings which might require compensation under the Fifth Amendment to the United States Constitution.

The Department believes that test procedures implementing a long-established statutory mandate in a manner calculated to minimize adverse economic impacts does not constitute a ''taking'' of private property. Thus, testing under the appliance standards program does not invoke the provisions of E.O. 12630.

G. Review Under the Paperwork Reduction Act of 1980

No new information or record keeping requirements are imposed by this rulemaking. Accordingly, no OMB clearance is required under the Paperwork Reduction Act (44 U.S.C. 3501 *et seq.*).

H. Review Under Executive Order 12988, ''Civil Justice Reform''

With respect to the review of existing regulations and the promulgation of new regulations, section 3(a) of Executive Order 12988, ''Civil Justice Reform,'' 61 FR 4729 (February 7, 1996), imposes on Executive agencies the general duty to adhere to the following requirements: (1) Eliminate drafting errors and ambiguity; (2) write regulations to minimize litigation; and (3) provide a clear legal standard for affected conduct rather than a general standard and promote simplification and burden reduction. With regard to the review required by section 3(a), section 3(b) of Executive Order 12988 specifically requires that Executive agencies make every reasonable effort to ensure that the regulation: (1) Clearly

[5] The Department has informally advised the Department of Justice and the Federal Trade Commission of its intention to incorporate the updated version of Standard Z21.56 into the final rule.

specifies the preemptive effect , if any; (2) clearly specifies any effect on existing Federal law or regulation; (3) provides a clear legal standard for affected conduct while promoting simplification and burden reduction; (4) specifies the retroactive effect, if any; (5) adequately defines key terms; and (6) addresses other important issues affecting clarity and general draftsmanship under any guidelines issued by the Attorney General. Section 3(c) of Executive Order 12988 requires Executive agencies to review regulations in light of applicable standards in section 3(a) and section 3(b) to determine whether they are met or it is unreasonable to meet one or more of them. DOE has completed the required review and determined that, to the extent permitted by law, the final regulations meet the relevant standards of Executive Order 12988.

I. Review Under Unfunded Mandates Reform Act of 1995

If any proposed or final rule includes a Federal mandate that may result in expenditure by state, local, and tribal governments, in the aggregate, or by the private sector, of $100 million or more in any one year, the Unfunded Mandates Reform Act of 1995, signed into law on March 22, 1995, requires an agency (prior to promulgation) to prepare a budgetary impact statement and select the least costly, most cost effective and least burdensome alternative that achieve the objectives of the rule and is consistent with statutory requirements.

DOE has determined that the action promulgated today does not include such a Federal mandate. Therefore, the requirements of the Unfunded Mandates Act do not apply to this action.

J. Review Under Small Business Regulatory Enforcement Fairness Act of 1996

As required by 5 U.S.C. 801, DOE will report to Congress promulgation of the rule prior to its effective date. 5 U.S.C. 801. The report will state that it has been determined that the rule is not a ''major rule'' as defined by 5 U.S.C. 804(3).

List of Subjects in 10 CFR Part 430

Administrative practice and procedure, Energy conservation, Household appliances, Incorporation by reference.

Issued in Washington, DC, on February 28, 1997.

Christine A. Ervin,

Assistant Secretary, Energy Efficiency and Renewable Energy.

For the reasons set forth in the preamble, part 430 of chapter II of Title 10, Code of Federal Regulations, is amended as set forth below.

PART 430—ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

1. The authority citation for part 430 continues to read as follows:

Authority: 42 U.S.C. 6291–6309

2. Section 430.2 is amended by adding a definition for the term ''Mobile home furnace'' in alphabetical order, to read as follows:

§ 430.2 Definitions.

* * * * *

Mobile home furnace means a direct vent furnace that is designed for use only in mobile homes.

* * * * *

3. Section 430.22 is amended by adding paragraph (a)(3)(iv) and adding item numbers 13 and 14 to paragraph (a)(4) to read as follows:

§ 430.22 Reference sources.

(a) * * *

(3) * * *

(iv) American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Publication Sales, 1791 Tullie Circle, NE, Atlanta, GA 30329, (1–800–5–ASHRAE).

(4) * * *

13. American National Standards Institute/ American Society of Heating, Refrigerating, and Air-Conditioning Engineers Standard 103–1993, ''Methods of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers,'' (with Errata of October 24, 1996) except for sections 3.0, 7.2.2.5, 8.6.1.1, 9.1.2.2, 9.5.1.1, 9.5.1.2.1, 9.5.1.2.2, 9.5.2.1, 9.7.1, 10.0, 11.2.12, 11.3.12, 11.4.12, 11.5.12 and appendices B and C.

14. American National Standards Institute Standard Z21.56–1994, ''Gas-Fired Pool Heaters,'' section 2.9.

* * * * *

4. Section 430.23 is amended as follows:

A. In paragraph (n)(1)(i), the words ''section 4.8 or 4.10'' are revised to read ''section 10.2.2 or 10.3'' and in paragraph (n)(1)(ii), the words ''section 4.9'' are revised to read ''section 10.2.3'' and, in the parenthetical phase, the words ''section 4'' are revised to read ''section 10.''

B. In paragraph (n)(2), the words ''section 4.6'' are revised to read ''section 10.1'' and the words ''section 4.1 of appendix N of this subpart'' are revised to read ''section 11.1 of American National Standards Institute/ American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ANSI/ASHRAE) Standard 103–1993.''

C. In paragraph (n)(3)(i), the words ''section 4.11 or 4.13'' are revised to read ''section 10.5.1 or 10.5.3'' and in paragraph (n)(3)(ii), the words ''section 4.12'' are revised to read ''section 10.5.2.''

D. In paragraph (n)(4), the words ''section 4.14'' are revised to read ''section 10.4.''

E. Revise paragraphs (o)(2), and (p)(1) to read as follows:

§ 430.23 Test procedures for measures of energy consumption.

* * * * *

(o) *Vented home heating equipment.* * * *

(2) The estimated annual operating cost for vented home heating equipment is the sum of:

(i) The product of the average annual fuel energy consumption, in Btu's per year for natural gas, propane, or oil fueled vented home heating equipment, determined according to section 4.6.2 of appendix O of this subpart, and the representative average unit cost in dollars per Btu for natural gas, propane, or oil, as appropriate, as provided pursuant to section 323(b)(2) of the Act; plus

(ii) The product of the average annual auxiliary electric energy consumption in kilowatt-hours per year determined according to section 4.6.3 of appendix O of this subpart, and the representative average unit cost in dollars per kilowatt-hours as provided pursuant to section 323(b)(2) of the Act, the resulting sum then being rounded off to the nearest dollar per year.

* * * * *

(p) *Pool heaters.* (1) The estimated annual operating cost for pool heaters is the sum of: (i) The product of the average annual fuel energy consumption, in Btu's per year, of natural gas or oil fueled pool heaters, determined according to section 4.2 of appendix P of this subpart, and the representative average unit cost in dollars per Btu for natural gas or oil, as appropriate, as provided pursuant to section 323(b)(2) of the Act; plus (ii) the product of the average annual auxiliary electric energy consumption in kilowatt-hours per year determined according to section 4.3 of appendix P of this subpart, and the representative average unit cost in dollars per kilowatt-hours as provided pursuant to section 323(b)(2) of the Act, the resulting sum then being rounded off to the nearest dollar per year.

* * * * *

5. Appendix N to subpart B of part 430 is revised to read as follows:

Appendix N to Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers

1.0 *Scope.* The scope of this appendix is as specified in section 2.0 of ANSI/ASHRAE Standard 103–1993.

2.0 *Definitions.* Definitions include the definitions specified in section 3 of ANSI/ASHRAE Standard 103–1993 and the following additional and modified definitions:

2.1 *ANSI/ASHRAE Standard 103–1993* means the test standard published in 1993 by ASHRAE, approved by the American National Standards Institute (ANSI) on October 4, 1993, and entitled ''Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers'' (with errata of October 24, 1996).

2.2 *ASHRAE* means the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

2.3 *Thermal stack damper* means a type of stack damper which is dependent for operation exclusively upon the direct conversion of thermal energy of the stack gases to open the damper.

2.4 *Isolated combustion system.* The definition of isolation combustion system in section 3 of ANSI/ASHRAE Standard 103–1993 is incorporated with the addition of the following: ''The unit is installed in an un-conditioned indoor space isolated from the heated space.''

3.0 *Classifications.* Classifications are as specified in section 4 of ANSI/ASHRAE Standard 103–1993.

4.0 *Requirements.* Requirements are as specified in section 5 of ANSI/ASHRAE Standard 103–1993.

5.0 *Instruments.* Instruments must be as specified in section 6 of ANSI/ASHRAE Standard 103–1993.

6.0 *Apparatus.* The apparatus used in conjunction with the furnace or boiler during the testing must be as specified in section 7 of ANSI/ASHRAE Standard 103–1993 except for section 7.2.2.5; and as specified in section 6.1 of this appendix:

6.1 *Downflow furnaces.* Install the internal section of vent pipe the same size as the flue collar for connecting the flue collar to the top of the unit, if not supplied by the manufacturer. Do not insulate the internal vent pipe during the jacket loss test (if conducted) described in section 8.6 of ANSI/ASHRAE Standard 103–1993 or the steady-state test described in section 9.1 of ANSI/ASHRAE Standard 103–1993. Do not insulate the internal vent pipe before the cool-down and heat-up tests described in sections 9.5 and 9.6, respectively, of ANSI/ASHRAE Standard 103–1993. If the vent pipe is surrounded by a metal jacket, do not insulate the metal jacket. Install a 5-ft test stack of the same cross sectional area or perimeter as the vent pipe above the top of the furnace. Tape or seal around the junction connecting the vent pipe and the 5-ft test stack. Insulate the 5-ft test stack with insulation having an R-value not less than 7 and an outer layer of aluminum foil. (See Figure 3–E of ANSI/ASHRAE Standard 103–1993.)

7.0 *Testing conditions.* The testing conditions shall be as specified in section 8 of ANSI/ASHRAE Standard 103–1993 with errata of October 24, 1996, except for section 8.6.1.1; and as specified in section 7.1 of this appendix.

7.1 *Measurement of jacket surface temperature.* The jacket of the furnace or boiler shall be subdivided into 6-inch squares when practical, and otherwise into 36-square-inch regions comprising 4 in. x 9 in. or 3 in. x 12 in. sections, and the surface temperature at the center of each square or section shall be determined with a surface thermocouple. The 36-square-inch areas shall be recorded in groups where the temperature differential of the 36-square-inch area is less than 10°F for temperature up to 100°F above room temperature and less than 20°F for temperature more than 100°F above room temperature. For forced air central furnaces, the circulating air blower compartment is considered as part of the duct system and no surface temperature measurement of the blower compartment needs to be recorded for the purpose of this test. For downflow furnaces, measure all cabinet surface temperatures of the heat exchanger and combustion section, including the bottom around the outlet duct, and the burner door, using the 36 square-inch thermocouple grid. The cabinet surface temperatures around the blower section do not need to be measured (See figure 3–E of ANSI/ASHRAE Standard 103–1993.)

8.0 *Test procedure.* Testing and measurements shall be as specified in section 9 of ANSI/ASHRAE Standard 103–1993 except for sections 9.5.1.1, 9.5.1.2.1, 9.5.1.2.2, 9.5.2.1, and section 9.7.1. ; and as specified in sections 8.1, 8.2, 8.3, 8.4, and 8.5, of this appendix.

8.1 *Input to interrupted ignition device.* For burners equipped with an interrupted ignition device, record the nameplate electric power used by the ignition device, PE_{IG}, or use PE_{IG}=0.4 kW if no nameplate power input is provided. Record the nameplate ignition device on-time interval, t_{IG}, or measure the on-time period at the beginning of the test at the time the burner is turned on with a stop watch, if no nameplate value is given. Set t_{IG}=0 and PE_{IG}=0 if the device on-time is less than or equal to 5 seconds after the burner is on.

8.2 *Gas- and oil-fueled gravity and forced air central furnaces without stack dampers cool-down test.* Turn off the main burner after steady-state testing is completed, and measure the flue gas temperature by means of the thermocouple grid described in section 7.6 of ANSI/ASHRAE 103–1993 at 1.5 minutes ($T_{F,OFF}(t_3)$) and 9 minutes ($T_{F,OFF}(t_4)$) after the burner shuts off. An integral draft diverter shall remain blocked and insulated, and the stack restriction shall remain in place. On atmospheric systems with an integral draft diverter or draft hood, equipped with either an electromechanical inlet damper or an electro-mechanical flue damper that closes within 10 seconds after the burner shuts off to restrict the flow through the heat exchanger in the off-cycle, bypass or adjust the control for the electromechanical damper so that the damper remains open during the cool-down test. For furnaces that employ post purge, measure the length of the post-purge period with a stopwatch. The time from burner OFF to combustion blower OFF (electrically de-energized) shall be recorded as t_p. For the case where t_p is intended to be greater than 180 seconds, stop the combustion blower at 180 seconds and use that value for t_p. Measure the flue gas temperature by means of the thermocouple grid described in section 7.6 of ANSI/ASHRAE 103–1993 at the end of post-purge period, t_p ($T_{F,OFF}(t_p)$), and at the time (1.5 + t_p) minutes ($T_{F,OFF}(t_3)$) and (9.0 + t_p) minutes ($T_{F,OFF}(t_4)$) after the main burner shuts off. For the case where the measured tp is less than or equal to 30 seconds, it shall be tested as if there is no post purge and t_p shall be set equal to 0.

8.3 *Gas- and oil-fueled gravity and forced air central furnaces without stack dampers with adjustable fan control—cool-down test.* For a furnace with adjustable fan control, this time delay will be 3.0 minutes for non-condensing furnaces or 1.5 minutes for condensing furnaces or until the supply air temperature drops to a value of 40°F above the inlet air temperature, whichever results in the longest fan on-time. For a furnace without adjustable fan control or with the type of adjustable fan control whose range of adjustment does not allow for the delay time specified above, the control shall be bypassed and the fan manually controlled to give the delay times specified above. For a furnace which employs a single motor to drive the power burner and the indoor air circulating blower, the power burner and indoor air circulating blower shall be stopped together.

8.4 *Gas-and oil-fueled boilers without stack dampers cool-down test.* After steady-state testing has been completed, turn the main burner(s) OFF and measure the flue gas temperature at 3.75 ($T_{F,OFF}(t_3)$) and 22.5 ($T_{F,OFF}(t_4)$) minutes after the burner shut off, using the thermocouple grid described in section 7.6 of ANSI/ASHRAE 103–1993. During this off-period, for units that do not have pump delay after shutoff, no water shall be allowed to circulate through the hot water boilers. For units that have pump delay on shutoff, except those having pump controls sensing water temperature, the pump shall be stopped by the unit control and the time t^+, between burner shutoff and pump shutoff shall be measured within one-second accuracy. For units having pump delay controls that sense water temperature, the pump shall be operated for 15 minutes and t^+ shall be 15 minutes. While the pump is operating, the inlet water temperature and flow rate shall be maintained at the same values as used during the steady-state test as specified in sections 9.1 and 8.4.2.3 of ANSI/ASHRAE 103–1993.

For boilers that employ post purge, measure the length of the post-purge period with a stopwatch. The time from burner OFF to combustion blower OFF (electrically de-energized) shall be recorded as t_P. For the case where t_P is intended to be greater than

180 seconds, stop the combustion blower at 180 seconds and use that value for t_P. Measure the flue gas temperature by means of the thermocouple grid described in section 7.6 of ANSI/ASHRAE 103–1993 at the end of the post purge period $t_P(T_{F,OFF}(t_P))$ and at the time (3.75 + t_P) minutes ($T_{F,OFF}(t_3)$) and (22.5 + t_P) minutes ($T_{F,OFF}(t_4)$) after the main burner shuts off. For the case where the measured t_P is less or equal to 30 seconds, it shall be tested as if there is no post purge and t_P shall be set to equal 0.

8.5 *Direct measurement of off-cycle losses testing method.* [Reserved.]

9.0 *Nomenclature.* Nomenclature shall include the nomenclature specified in section 10 of ANSI/ASHRAE Standard 103–1993 and the following additional variables:

Eff_{motor}=Efficiency of power burner motor
PE_{IG}=Electrical power to the interrupted ignition device, kW
$R_{T,a}$=$_{RT,F}$ if flue gas is measured
=$R_{T,S}$ if stack gas is measured
$R_{T,F}$=Ratio of combustion air mass flow rate to stoichiometric air mass flow rate
$R_{T,S}$=Ratio of the sum of combustion air and relief air mass flow rate to stoichiometric air mass flow rate
t_{IG}=Electrical interrupted ignition device on-time, min.
$T_{a,SS,X}$=$T_{F,SS,X}$ if flue gas temperature is measured, °F
=$T_{S,SS,X}$ if stack gas temperature is measured, °F
y_{IG}=ratio of electrical interrupted ignition device on-time to average burner on-time
y_P=ratio of power burner combustion blower on-time to average burner on-time

10.0 *Calculation of derived results from test measurements.* Calculations shall be as specified in section 11 of ANSI/ASHRAE Standard 103–1993 and the October 24, 1996, Errata Sheet for ASHRAE Standard 103–1993, except for appendices B and C; and as specified in sections 10.1 through 10.8 and Figure 1 of this appendix.

10.1 *Annual fuel utilization efficiency.* The annual fuel utilization efficiency (AFUE) is as defined in sections 11.2.12 (non-condensing systems), 11.3.12 (condensing systems), 11.4.12 (non-condensing modulating systems) and 11.5.12 (condensing modulating systems) of ANSI/ASHRAE Standard 103–1993, except for the definition for the term $Effy_{HS}$ in the defining equation for AFUE. $Effy_{HS}$ is defined as:

$Effy_{HS}$=heating seasonal efficiency as defined in sections 11.2.11 (non-condensing systems), 11.3.11 (condensing systems), 11.4.11 (non-condensing modulating systems) and 11.5.11 (condensing modulating systems) of ANSI/ASHRAE Standard 103–1993 and is based on the assumptions that all weatherized warm air furnaces or boilers are located out-of-doors, that warm air furnaces which are not weatherized are installed as isolated combustion systems, and that boilers which are not weatherized are installed indoors.

10.2 *National average burner operating hours, average annual fuel energy consumption and average annual auxiliary electrical energy consumption for gas or oil furnaces and boilers.*

10.2.1 *National average number of burner operating hours.* For furnaces and boilers equipped with single stage controls, the national average number of burner operating hours is defined as:

BOH_{SS}=2,080 (0.77) A DHR–2,080 B

where:

2,080=national average heating load hours
0.77=adjustment factor to adjust the calculated design heating requirement and heating load hours to the actual heating load experienced by the heating system
DHR=typical design heating requirements as listed in Table 8 (in unit of kBtu/h) of ANSI/ASHRAE Standard 103–1993, using the proper value of Q_{OUT} defined in 11.2.8.1 of ANSI/ASHRAE Standard 103–1993
A=100,000 / [341,300(y_PPE+$y_{IG}$$PE_{IG}$+yBE)+($Q_{IN}$–$Q_P$)$Effy_{HS}$], for forced draft unit, indoors
=100,000 / [341,300(y_PPE Eff_{motor}+$y_{IG}$$PE_{IG}$+y BE)+($Q_{IN}$–$Q_P$)$Effy_{HS}$], for forced draft unit, ICS,
=100,000 / [341,300(y_PPE(1–Eff_{motor})+$y_{IG}$$PE_{IG}$+y BE)+($Q_{IN}$–$Q_P$)$Effy_{HS}$], for induced draft unit, indoors, and
=100,000 / [341,300($y_{IG}$$PE_{IG}$+yBE)+($Q_{IN}$–$Q_P$)$Effy_{HS}$], for induced draft unit, ICS
B=2 Q_P($Effy_{HS}$)(A) / 100,000

where:

Eff_{motor}=Power burner motor efficiency provided by manufacturer,
=0.50, an assumed default power burner efficiency if not provided by manufacturer.
100,000=factor that accounts for percent and kBtu
PE=burner electrical power input at full-load steady-state operation, including electrical ignition device if energized, as defined in 9.1.2.2 of ANSI/ASHRAE Standard 103–1993
y_P=ratio of induced or forced draft blower on-time to average burner on-time, as follows:
1 for units without post purge;
1+(t_P/3.87) for single stage furnaces with post purge;
1+(t_P/10) for two-stage and step modulating furnaces with post purge;
1+(t_P/9.68) for single stage boilers with post purge; or
1+(t_P/15) for two stage and step modulating boilers with post purge.
PE_{IG}=electrical input rate to the interrupted ignition device on burner (if employed), as defined in 8.1 of this appendix
y_{IG}=ratio of burner interrupted ignition device on-time to average burner on-time, as follows:
0 for burners not equipped with interrupted ignition device;
(t_{IG}/3.87) for single stage furnaces;
(t_{IG}/10) for two-stage and step modulating furnaces;
(t_{IG}/9.68) for single stage boilers; or
(t_{IG}/15) for two stage and step modulating boilers.
t_{IG}=on-time of the burner interrupted ignition device, as defined in 8.1 of this appendix
t_P=post purge time as defined in 8.2 (furnace) or 8.4 (boiler) of this appendix
=0 if t_P is equal to or less than 30 second.
y=ratio of blower or pump on-time to average burner on-time, as follows:
1 for furnaces without fan delay;
1 for boilers without a pump delay;
1+(t^+—t^-)/3.87 for single stage furnaces with fan delay;
1+(t^+—t^-)/10 for two-stage and step modulating furnaces with fan delay;
1+(t^+/9.68) for single stage boilers with pump delay; or
1+(t^+/15) for two stage and step modulating boilers with pump delay.
BE=circulating air fan or water pump electrical energy input rate at full load steady-state operation, as defined in ANSI/ASHRAE Standard 103–1993
Q_{IN}=as defined in 11.2.8.1 of ANSI/ASHRAE Standard 103–1993
Q_P=as defined in 11.2.11 of ANSI/ASHRAE Standard 103–1993
$Effy_{HS}$=as defined in 11.2.11 (non-condensing systems) or 11.3.11.3 (condensing systems) of ANSI/ASHRAE Standard 103–1993, percent, and calculated on the basis of:
ICS installation, for non-weatherized warm air furnaces;
indoor installation, for non-weatherized boilers; or
outdoor installation, for furnaces and boilers that are weatherized.
2=ratio of the average length of the heating season in hours to the average heating load hours
t^+=as defined in 9.5.1.2 of ANSI/ASHRAE Standard 103–1993 or 8.4 of this appendix
t^-=as defined in 9.6.1 of ANSI/ASHRAE Standard 103–1993

10.2.1.1 For furnaces and boilers equipped with two stage or step modulating controls the average annual energy used during the heating season, E_M, is defined as:

E_M=(Q_{IN} − Q_P) BOH_{SS}+(8,760 − 4,600)Q_P

where:

Q_{IN}=as defined in 11.4.8.1.1 of ANSI/ASHRAE Standard 103–1993
Q_P=as defined in 11.4.12 of ANSI/ASHRAE Standard 103–1993
BOH_{SS}=as defined in section 10.2.1 of this appendix, in which the weighted $Effy_{HS}$ as defined in 11.4.11.3 or 11.5.11.3 of ANSI/ASHRAE Standard 103–1993 is used for calculating the values of A and B, the term DHR is based on the value of Q_{OUT} defined in 11.4.8.1.1 or 11.5.8.1.1 of ANSI/ASHRAE Standard 103–1993, and the term (y_PPE+$y_{IG}$$PE_{IG}$+yBE) in the factor A is increased by the factor R, which is defined as:
R=2.3 for two stage controls
=2.3 for step modulating controls when the ratio of minimum-to-maximum output is greater than or equal to 0.5
=3.0 for step modulating controls when the ratio of minimum-to-maximum output is less than 0.5
A=100,000/[341,300(y_PPE+$y_{IG}$$PE_{IG}$+y BE) R+($Q_{IN}$ − Q_P) $Effy_{HS}$], for forced draft unit, indoors
=100,000/[341,300(y_PPE Eff_{motor}+$y_{IG}$$PE_{IG}$+y BE) R+($Q_{IN}$ − Q_P)$Effy_{HS}$], for forced draft unit, ICS,

$=100{,}000/[341{,}300(y_P PE(1-Eff_{motor})+y_{IG}PE_{IG}+y\ BE)\ R+(Q_{IN}-Q_P)\ Effy_{HS}]$, for induced draft unit, indoors, and

$=100{,}000/[341{,}300(y_{IG}PE_{IG}+y\ BE)\ R+(Q_{IN}-Q_P)\ Effy_{HS}]$, for induced draft unit, ICS

where:

Eff_{motor}=Power burner motor efficiency provided by manufacturer,

=0.50, an assumed default power burner efficiency if none provided by manufacturer.

$Effy_{HS}$=as defined in 11.4.11.3 or 11.5.11.3 of ANSI/ASHRAE Standard 103–1993, and calculated on the basis of:

—ICS installation, for non-weatherized warm air furnaces

—indoor installation, for non-weatherized boilers

—outdoor installation, for furnaces and boilers that are weatherized

8,760=total number of hours per year

4,600=as specified in 11.4.12 of ANSI/ASHRAE Standard 103–1993

10.2.1.2 For furnaces and boilers equipped with two stage or step modulating controls the national average number of burner operating hours at the reduced operating mode is defined as:

$BOH_R=X_R E_M/Q_{IN,R}$

where:

X_R=as defined in 11.4.8.7 of ANSI/ASHRAE Standard 103–1993

E_M=as defined in section 10.2.1.1 of this appendix

$Q_{IN,R}$=as defined in 11.4.8.1.2 of ANSI/ASHRAE Standard 103–1993

10.2.1.3 For furnaces and boilers equipped with two stage controls the national average number of burner operating hours at the maximum operating mode (BOH_H) is defined as:

$BOH_H=X_H E_M/Q_{IN}$

where:

X_H=as defined in 11.4.8.6 of ANSI/ASHRAE Standard 103–1993

E_M=as defined in section 10.2.1.1 of this appendix

Q_{IN}=as defined in 11.4.8.1.1 of ANSI/ASHRAE Standard 103–1993

10.2.1.4 For furnaces and boilers equipped with step modulating controls the national average number of burner operating hours at the modulating operating mode (BOH_M) is defined as:

$BOH_M=X_H E_M/Q_{IN,M}$

where:

X_H=as defined in 11.4.8.6 of ANSI/ASHRAE Standard 103–1993

E_M=as defined in section 10.2.1.1 of this appendix

$Q_{IN,M}=Q_{OUT,M}/(Effy_{SS,M}/100)$

$Q_{OUT,M}$=as defined in 11.4.8.10 or 11.5.8.10 of ANSI/ASHRAE Standard 103–1993, as appropriate

$Effy_{SS,M}$=as defined in 11.4.8.8 or 11.5.8.8 of ANSI/ASHRAE Standard 103–1993, as appropriate, in percent

100=factor that accounts for percent

10.2.2 *Average annual fuel energy consumption for gas or oil fueled furnaces or boilers.* For furnaces or boilers equipped with single stage controls the average annual fuel energy consumption (E_F) is expressed in Btu per year and defined as:

$E_F=BOH_{SS}(Q_{IN}-Q_P)+8{,}760\ Q_P$

where:

BOH_{SS}=as defined in 10.2.1 of this appendix

Q_{IN}=as defined in 11.2.8.1 of ANSI/ASHRAE Standard 103–1993

Q_P=as defined in 11.2.11 of ANSI/ASHRAE Standard 103–1993

8,760=as specified in 10.2.1 of this appendix

10.2.2.1 For furnaces or boilers equipped with either two stage or step modulating controls E_F is defined as:

$E_F=E_M+4{,}600Q_P$

where:

E_M=as defined in 10.2.1.1 of this appendix

4,600=as specified in 11.4.12 of ANSI/ASHRAE Standard 103–1993

Q_P=as defined in 11.2.11 of ANSI/ASHRAE Standard 103–1993

10.2.3 *Average annual auxiliary electrical energy consumption for gas or oil fueled furnaces or boilers.* For furnaces or boilers equipped with single stage controls the average annual auxiliary electrical consumption (E_{AE}) is expressed in kilowatt-hours and defined as:

$E_{AE}=BOH_{SS}(y_P PE+y_{IG}PE_{IG}+yBE)$

where:

BOH_{SS}=as defined in 10.2.1 of this appendix

PE=as defined in 10.2.1 of this appendix

y_P=as defined in 10.2.1 of this appendix

y_{IG}=as defined in 10.2.1 of this appendix

PE_{IG}=as defined in 10.2.1 of this appendix

y=as defined in 10.2.1 of this appendix

BE=as defined in 10.2.1 of this appendix

10.2.3.1 For furnaces or boilers equipped with two stage controls E_{AE} is defined as:

$E_{AE}=BOH_R(y_P PE_R+y_{IG}PE_{IG}+yBE_R)+BOH_H(y_P PE_H+y_{IG}PE_{IG}+y\ BE_H)$

where:

BOH_R=as defined in 10.2.1.2 of this appendix

y_P=as defined in 10.2.1 of this appendix

PE_R=as defined in 9.1.2.2 and measured at the reduced fuel input rate, of ANSI/ASHRAE Standard 103–1993

y_{IG}=as defined in 10.2.1 of this appendix

PE_{IG}=as defined in 10.2.1 of this appendix

y=as defined in 10.2.1 of this appendix

BE_R=as defined in 9.1.2.2 of ANSI/ASHRAE Standard 103–1993, measured at the reduced fuel input rate

BOH_H=as defined in 10.2.1.3 of this appendix

PE_H=as defined in 9.1.2.2 of ANSI/ASHRAE Standard 103–1993, measured at the maximum fuel input rate

BE_H=as defined in 9.1.2.2 of ANSI/ASHRAE Standard 103–1993, measured at the maximum fuel input rate

10.2.3.2 For furnaces or boilers equipped with step modulating controls E_{AE} is defined as:

$E_{AE}=BOH_R(y_P\ PE_R+y_{IG}PE_{IG}+y\ BE_R)+BOH_M(y_P PE_H+y_{IG}PE_{IG}+y\ BE_H)$

where:

BOH_R=as defined in 10.2.1.2 of this appendix

y_P=as defined in 10.2.1 of this appendix

PE_R=as defined in 9.1.2.2 of ANSI/ASHRAE Standard 103–1993, measured at the reduced fuel input rate

y_{IG}=as defined in 10.2.1 of this appendix

PE_{IG}=as defined in 10.2.1 of this appendix

y=as defined in 10.2.1. of this appendix

BE_R=as defined in 9.1.2.2 of ANSI/ASHRAE Standard 103–1993, measured at the reduced fuel input rate

BOH_M=as defined in 10.2.1.4 of this appendix

PE_H=as defined in 9.1.2.2 of ANSI/ASHRAE Standard 103–1993, measured at the maximum fuel input rate

BE_H=as defined in 9.1.2.2 of ANSI/ASHRAE Standard 103–1993, measured at the maximum fuel inputs rate

10.3 *Average annual electric energy consumption for electric furnaces or boilers.* For electric furnaces and boilers the average annual energy consumption (E_E) is expressed in kilowatt-hours and defined as:

$E_E=100(2{,}080)(0.77)DHR/(3.412\ AFUE)$

where:

100=to express a percent as a decimal

2,080=as specified in 10.2.1 of this appendix

0.77=as specified in 10.2.1 of this appendix

DHR=as defined in 10.2.1 of this appendix

3.412=conversion to express energy in terms of watt-hours instead of Btu

AFUE=as defined in 11.1 of ANSI/ASHRAE Standard 103–1993, in percent, and calculated on the basis of:

ICS installation, for non-weatherized warm air furnaces;

indoor installation, for non-weatherized boilers; or

outdoor installation, for furnaces and boilers that are weatherized.

10.4 *Energy factor.*

10.4.1 *Energy factor for gas or oil furnaces and boilers.* Calculate the energy factor, EF, for gas or oil furnaces and boilers defined as, in percent:

$$EF=\frac{\left(E_F-4{,}600\ Q_P\right)Effy_{HS}}{E_F+3{,}412\ E_{AE}}$$

where:

E_F=average annual fuel consumption as defined in 10.2.2 of this appendix.

E_{AE}=as defined in 10.2.3 of this appendix.

$Effy_{HS}$=Annual Fuel Utilization Efficiency as defined in 11.2.11, 11.3.11, 11.4.11 or 11.5.11 of ANSI/ASHRAE Standard 103–1993, in percent, and calculated on the basis of:

ICS installation, for non-weatherized warm air furnaces;

indoor installation, for non-weatherized boilers; or

outdoor installation, for furnaces and boilers that are weatherized.

3,412=conversion factor from kilowatt to Btu/h

10.4.2 *Energy factor for electric furnaces and boilers.* The energy factor, EF, for electric furnaces and boilers is defined as:

EF=AFUE

where:

AFUE=Annual Fuel Utilization Efficiency as defined in section 10.3 of this appendix, in percent

10.5 *Average annual energy consumption for furnaces and boilers located in a different geographic region of the United States and in* *buildings with different design heating requirements.*

10.5.1 *Average annual fuel energy consumption for gas or oil-fueled furnaces and boilers located in a different geographic region of the United States and in buildings with different design heating requirements.* For gas or oil-fueled furnaces and boilers the average annual fuel energy consumption for a specific geographic region and a specific typical design heating requirement (E_{FR}) is expressed in Btu per year and defined as:

$E_{FR}=(E_F-8,760\ Q_P)(HLH/2,080)+8,760\ Q_P$

where:

E_F=as defined in 10.2.2 of this appendix
8,760=as specified in 10.2.1 of this appendix
Q_P=as defined in 11.2.11 of ANSI/ASHRAE Standard 103–1993
HLH=heating load hours for a specific geographic region determined from the heating load hour map in Figure 1 of this appendix
2,080=as defined in 10.2.1 of this appendix

10.5.2 *Average annual auxiliary electrical energy consumption for gas or oil-fueled furnaces and boilers located in a different geographic region of the United States and in buildings with different design heating requirements.* For gas or oil-fueled furnaces and boilers the average annual auxiliary electrical energy consumption for a specific geographic region and a specific typical design heating requirement (E_{AER}) is expressed in kilowatt-hours and defined as:

$E_{AER}=E_{AE}\ (HLH/2,080)$

where:

E_{AE}=as defined in 10.2.3 of this appendix
HLH=as defined in 10.5.1 of this appendix
2,080=as specified in 10.2.1 of this appendix

10.5.3 *Average annual electric energy consumption for electric furnaces and boilers located in a different geographic region of the United States and in buildings with different design heating requirements.* For electric furnaces and boilers the average annual electric energy consumption for a specific geographic region and a specific typical design heating requirement (E_{ER}) is expressed in kilowatt-hours and defined as:

$E_{ER}=100\ (0.77)\ DHR\ HLH/(3.412\ AFUE)$

where:

100=as specified in 10.3 of this appendix
0.77=as specified in 10.2.1 of this appendix
DHR=as defined in 10.2.1 of this appendix
HLH=as defined in 10.5.1 of this appendix
3.412=as specified in 10.3 of this appendix
AFUE=as defined in 10.3 of this appendix, in percent

10.6 *Annual energy consumption for mobile home furnaces*

10.6.1 *National average number of burner operating hours for mobile home furnaces (BOH_{SS}).* BOH_{SS} is the same as in 10.2.1 of this appendix, except that the value of $Effy_{HS}$ in the calculation of the burner operating hours, BOH_{SS}, is calculated on the basis of a direct vent unit with system number 9 or 10.

10.6.2 *Average annual fuel energy for mobile home furnaces (E_F).* E_F is same as in 10.2.2 of this appendix except that the burner operating hours, BOH_{SS}, is calculated as specified in 10.6.1 of this appendix.

10.6.3 *Average annual auxiliary electrical energy consumption for mobile home furnaces (E_{AE}).* E_{AE} is the same as in 10.2.3 of this appendix, except that the burner operating hours, BOH_{SS}, is calculated as specified in 10.6.1 of this appendix.

10.7 *Calculation of sales weighted average annual energy consumption for mobile home furnaces.* In order to reflect the distribution of mobile homes to geographical regions with average HLH_{MHF} value different from 2,080, adjust the annual fossil fuel and auxiliary electrical energy consumption values for mobile home furnaces using the following adjustment calculations.

10.7.1 For mobile home furnaces the sales weighted average annual fossil fuel energy consumption is expressed in Btu per year and defined as:

$E_{F,MHF}=(E_F-8,760\ Q_P)HLH_{MHF}/2,080+8,760\ Q_P$

where:

E_F=as defined in 10.6.2 of this appendix
8,760=as specified in 10.2.1 of this appendix
Q_P=as defined in 11.2.11 of ANSI/ASHRAE Standard 103–1993
HLH_{MHF}=1880, sales weighted average heating load hours for mobile home furnaces
2,080=as specified in 10.2.1 of this appendix

10.7.2 For mobile home furnaces the sales weighted average annual auxiliary electrical energy consumption is expressed in kilowatt-hours and defined as:

$E_{AE,MHF}=E_{AE}HLH_{MHF}/2,080$

where:

E_{AE}=as defined in 10.6.3 of this appendix
HLH_{MHF}=as defined in 10.7.1 of this appendix
2,080=as specified in 10.2.1 of this appendix

10.8 *Direct determination of off-cycle losses for furnaces and boilers equipped with thermal stack dampers.* [Reserved.]

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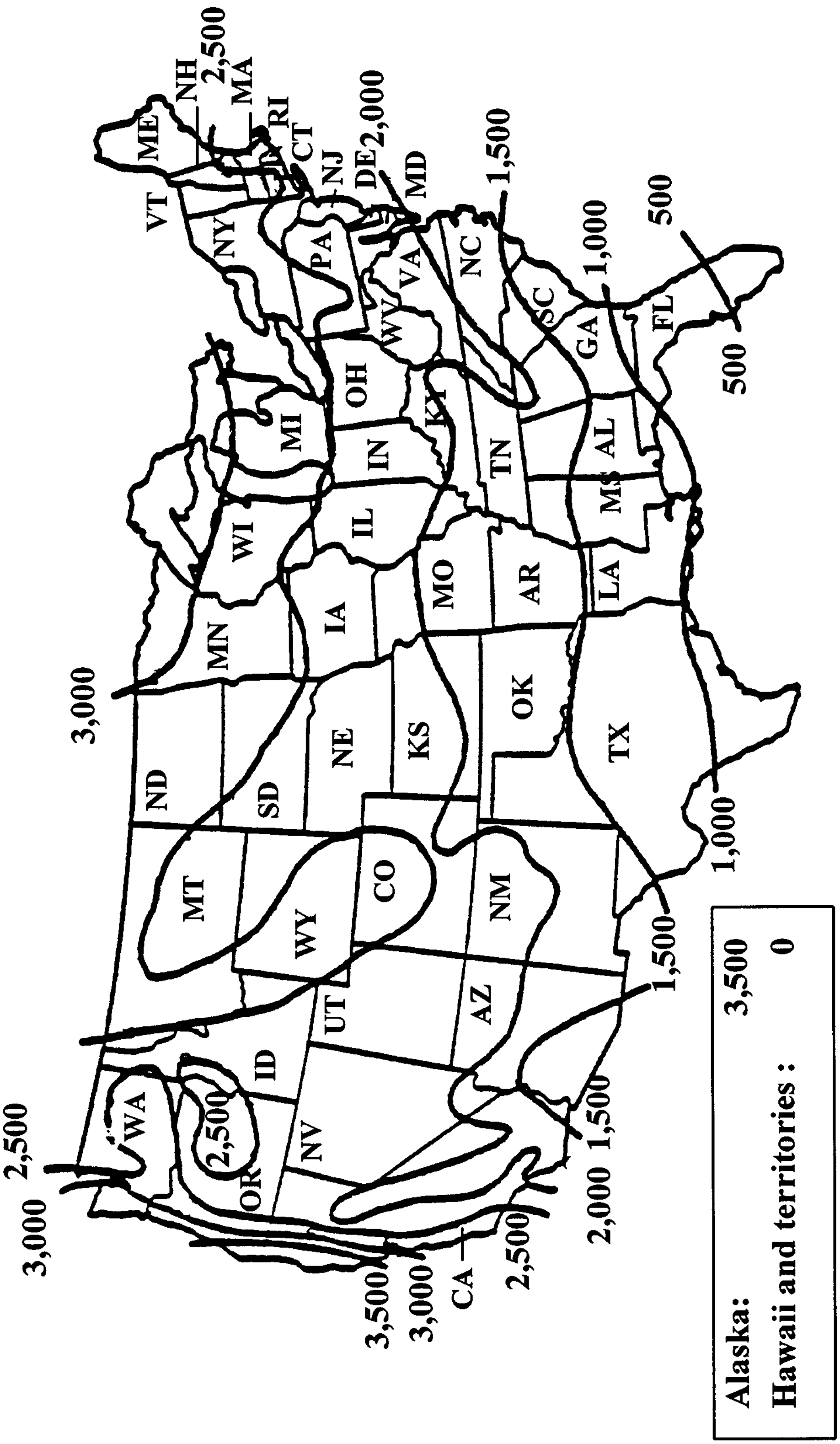

This map is reasonably accurate for most parts of the United States but is necessarily generalized, and consequently not too accurate in mountainous regions, particularly in the rockies.

FIGURE 1- HEATING LOAD HOURS (HLH) FOR THE UNITED STATES

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6. Appendix O to subpart B of part 430 is amended as follows:

Appendix O to Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Vented Home Heating Equipment

a. Section 3.5 is revised to read as follows:

3.5 *Pilot light measurement.*

3.5.1 Measure the energy input rate to the pilot light (Q_P) with an error no greater than 3 percent for vented heaters so equipped.

3.5.2 For manually controlled heaters where the pilot light is designed to be turned off by the user when the heater is not in use, that is, turning the control to the OFF position will shut off the gas supply to the burner(s) and to the pilot light, the measurement of Q_P is not needed. This provision applies only if an instruction to turn off the unit is provided on the heater near the gas control valve (e.g. by label) by the manufacturer.

b. Section 4.2.4 is revised to read as follows:

4.2.4 *Weighted-average steady-state efficiency.*

4.2.4.1 For manually controlled heaters with various input rates the weighted average steady-state efficiency (η_{SS-WT}), is determined as follows:

(1) at 50 percent of the maximum fuel input rate as measured in either section 3.1.1 of this appendix for manually controlled gas vented heaters or section 3.1.2 of this appendix for manually controlled oil vented heaters, or

(2) at the minimum fuel input rate as measured in either section 3.1.1 to this appendix for manually controlled gas vented heaters or section 3.1.2 to this appendix for manually controlled oil vented heaters if the design of the heater is such that the ± 5 percent of 50 percent of the maximum fuel input rate cannot be set, provided this minimum rate is no greater than ⅔ of maximum input rate of the heater.

4.2.4.2 For manually controlled heater with one single firing rate the weighted average steady-state efficiency is the steady-state efficiency measured at the single firing rate.

c. Section 4.2.6 is revised to read as follows:

4.2.6 *Annual Fuel Utilization Efficiency.*

4.2.6.1 For manually controlled vented heaters, calculate the AFUE expressed as a percent and defined as:

$$AFUE = \frac{2{,}950\ \eta_{SS}\ \eta_u\ Q_{in-max}}{2{,}950\ \eta_{SS}\ Q_{in-max} + 2.083(4{,}600)\eta_u\ Q_P}$$

where:

2,950=average number of heating degree days
η_{SS}=as defined as η_{SS-WT} in 4.2.4 of this appendix
η_u=as defined in 4.2.5 of this appendix
Q_{in-max}=as defined as Q_{in} at the maximum fuel input rate, as defined in 3.1 of this appendix
4,600=average number of non-heating season hours per year
Q_P=as defined in 3.5 of this appendix
2.083=(65–15)/24=50/24
65=degree day base temperature, °F
15=national average outdoor design temperature for vented heaters as defined in section 4.1.10 of this appendix
24=number of hours in a day

4.2.6.2 For manually controlled vented heaters where the pilot light can be turned off by the user when the heater is not in use as described in section 3.5.2, calculate the AFUE expressed as a percent and defined as:

$AFUE=\eta_u$

where:

η_u=as defined in section 4.2.5 of this appendix

d. Section 4.3.7 is revised to read as follows:

4.3.7 Annual Fuel Utilization Efficiency.

Calculate the AFUE expressed as a percent and defined as:

$$AFUE = \frac{2{,}950\ \eta_{SS-WT}\ \eta_u\ Q_{in-max}}{2{,}950\ \eta_{SS-WT}\ Q_{in-max} + 2.083(4{,}600)\eta_u\ Q_P}$$

where:

2,950=average number of heating degree days
η_{SS-WT}=as defined in 4.1.16 of this appendix
η_u=as defined in 4.3.6 of this appendix
Q_{in-max}=as defined in 4.2.6 of this appendix
4,600=as specified in 4.2.6 of this appendix
Q_P=as defined in 3.5 of this appendix
2.083=as specified in 4.2.6 of this appendix

e. Add section 4.6 after section 4.5.3 and before the table 1 to read as follows:

4.6 *Annual energy consumption.*

4.6.1 *National average number of burner operating hours.* For vented heaters equipped with single stage controls or manual controls, the national average number of burner operating hours (BOH) is defined as:

$BOH_{SS}=1{,}416A_FA\ DHR-1{,}416\ B$

where:

1,416=national average heating load hours for vented heaters based on 2,950 degree days and 15°F outdoor design temperature
A_F=0.7067, adjustment factor to adjust the calculated design heating requirement and heating load hours to the actual heating load experienced by the heating system
DHR=typical design heating requirements based on Q_{OUT}, from Table 4 of this appendix.
$Q_{OUT}=[(\eta_{SS}/100)-C_j\ (L_j/100)]\ Q_{in}$
L_j=jacket loss as defined in 4.1.5 of this appendix
C_j=2.8, adjustment factor as defined in 4.3.6 of this appendix
η_{SS}=steady-state efficiency as defined in 4.1.10 of this appendix, percent
Q_{in}=as defined in 3.1 of this appendix at the maximum fuel input rate
$A=100{,}000/[341{,}300P_E+(Q_{in}-Q_P)\eta_u]$
$B=2.938(Q_P)\ \eta_u\ A/100{,}000$
100,000=factor that accounts for percent and kBtu
P_E=as defined in 3.1.3 of this appendix
Q_P=as defined in 3.5 of this appendix
η_u=as defined in 4.3.6 of this appendix for vented heaters using the tracer gas method, percent
=as defined in 4.2.5 of this appendix for manually controlled vented heaters, percent
$=2{,}950\ AFUE\eta_{SS}\ Q_{in}/[2{,}950\ \eta_{SS}\ Q_{in}—AFUE(2.083)(4{,}600)Q_P]$, for vented heaters equipped without manual controls and without thermal stack dampers and not using the optional tracer gas method, where:
AFUE=as defined in 4.1.17 of this appendix, percent
2,950=average number of heating degree days as defined in 4.2.6 of this appendix
4,600=average number of non-heating season hours per year as defined in 4.2.6 of this appendix

2.938=(4,160/1,416)=ratio of the average length of the heating season in hours to the average heating load hours
2.083=as specified in 4.2.6 of this appendix

4.6.1.1 For vented heaters equipped with two stage or step modulating controls the national average number of burner operating hours at the reduced operating mode is defined as:

$BOH_R=X_1E_M/Q_{red\text{-}in}$

where:

X_1=as defined in 4.1.14 of this appendix
$Q_{red\text{-}in}$=as defined in 4.1.11 of this appendix
E_M=average annual energy used during the heating season
$=(Q_{in}-Q_P)BOH_{SS}+(8{,}760-4{,}600)Q_P$
Q_{in}=as defined in 3.1 of this appendix at the maximum fuel input rate
Q_P=as defined in 3.5 of this appendix
BOH_{SS}=as defined in 4.6.1 of this appendix, in which the term P_E in the factor A is increased by the factor R, which is defined in 3.1.3 of this appendix as:
R=1.3 for two stage controls
=1.4 for step modulating controls when the ratio of minimum-to-maximum fuel input is greater than or equal to 0.7
=1.7 for step modulating controls when the ratio of minimum-to-maximum fuel input is less than 0.7 and greater than or equal to 0.5
=2.2 for step modulating controls when the ratio of minimum-to-maximum fuel input is less than 0.5
$A=100{,}000/[341{,}300\ PE\ R+(Q_{in}-Q_P)\eta_u]$
8,760=total number of hours per year
4,600=as specified in 4.2.6 of this appendix

4.6.1.2 For vented heaters equipped with two stage or step modulating controls the national average number of burner operating hours at the maximum operating mode (BOH_H) is defined as:

$BOH_H=X_2E_M/Q_{in}$

where:

X_2=as defined in 4.1.15 of this appendix
E_M=average annual energy used during the heating season
$=(Q_{in}-Q_P)BOH_{SS}+(8{,}760-4{,}600)Q_P$
Q_{in}=as defined in 3.1 of this appendix at the maximum fuel input rate

4.6.2 *Average annual fuel energy for gas or oil fueled vented heaters.* For vented heaters equipped with single stage controls or manual controls, the average annual fuel energy consumption (E_F) is expressed in Btu per year and defined as:

$E_F=BOH_{SS}\ (Q_{in}-Q_P)+8{,}760\ Q_P$

where:

BOH_{SS}=as defined in 4.6.1 of this appendix
Q_{in}=as defined in 3.1 of this appendix
Q_P=as defined in 3.5 of this appendix
8,760=as specified in 4.6.1 of this appendix

4.6.2.1 For vented heaters equipped with either two stage or step modulating controls E_F is defined as:

$E_F=E_M+4{,}600Q_P$

where:

E_M=as defined in 4.6.1.2 of this appendix
4,600=as specified 4.2.6 of this appendix
Q_P=as defined in 3.5 of this appendix

4.6.3 *Average annual auxiliary electrical energy consumption for vented heaters.* For vented heaters with single stage controls or manual controls the average annual auxiliary electrical consumption (E_{AE}) is expressed in kilowatt-hours and defined as:

$E_{AE}=BOH_{SS}P_E$

where:

BOH_{SS}=as defined in 4.6.1 of this appendix
P_E=as defined in 3.1.3 of this appendix

4.6.3.1 For vented heaters equipped with two stage or modulating controls E_{AE} is defined as:

$E_{AE}=(BOH_R+BOH_H)P_E$

where:

BOH_R=as defined in 4.6.1 of this appendix
BOH_H=as defined in 4.6.1 of this appendix
P_E=as defined in 3.1.3 of this appendix

4.6.4 *Average annual energy consumption for vented heaters located in a different geographic region of the United States and in buildings with different design heating requirements.*

4.6.4.1 *Average annual fuel energy consumption for gas or oil fueled vented home heaters located in a different geographic region of the United States and in buildings with different design heating requirements.* For gas or oil fueled vented heaters the average annual fuel energy consumption for a specific geographic region and a specific typical design heating requirement (E_{FR}) is expressed in Btu per year and defined as:

$E_{FR}=(E_F-8{,}760\ Q_P)(HLH/1{,}416)+8{,}760Q_P$

where:

E_F=as defined in 4.6.2 of this appendix
8,760=as specified in 4.6.1 of this appendix
Q_P=as defined in 3.5 of this appendix
HLH=heating load hours for a specific geographic region determined from the heating load hour map in Figure 3 of this appendix
1,416=as specified in 4.6.1 of this appendix

4.6.4.2 *Average annual auxiliary electrical energy consumption for gas or oil fueled vented home heaters located in a different geographic region of the United States and in buildings with different design heating requirements.* For gas or oil fueled vented home heaters the average annual auxiliary electrical energy consumption for a specific geographic region and a specific typical design heating requirement (E_{AER}) is expressed in kilowatt-hours and defined as:

$E_{AER}=E_{AE}\ HLH/1{,}416$

where:

E_{AE}=as defined in 4.6.3 of this appendix
HLH=as defined in 4.6.4.1 of this appendix
1,416=as specified in 4.6.1 of this appendix

f. Table 4 and Figure 3 are added to the end of appendix O to subpart B of 10 CFR part 430 to read as follows:

TABLE 4.—AVERAGE DESIGN HEATING REQUIREMENTS FOR VENTED HEATERS WITH DIFFERENT OUTPUT CAPACITIES

Vented heaters output capacity Q_{out}—(Btu/hr)	Average design heating requirements (kBtu/hr)
5,000–7,499	5.0
7,500–10,499	7.5
10,500–13,499	10.0
13,500–16,499	12.5
16,500–19,499	15.0
19,500–22,499	17.5
22,500–26,499	20.5
26,500–30,499	23.5
30,500–34,499	26.5
34,500–38,499	30.0
38,500–42,499	33.5
42,500–46,499	36.5
46,500–51,499	40.0
51,500–56,499	44.0
56,500–61,499	48.0
61,500–66,499	52.0
66,500–71,499	56.0
71,500–76,500	60.0

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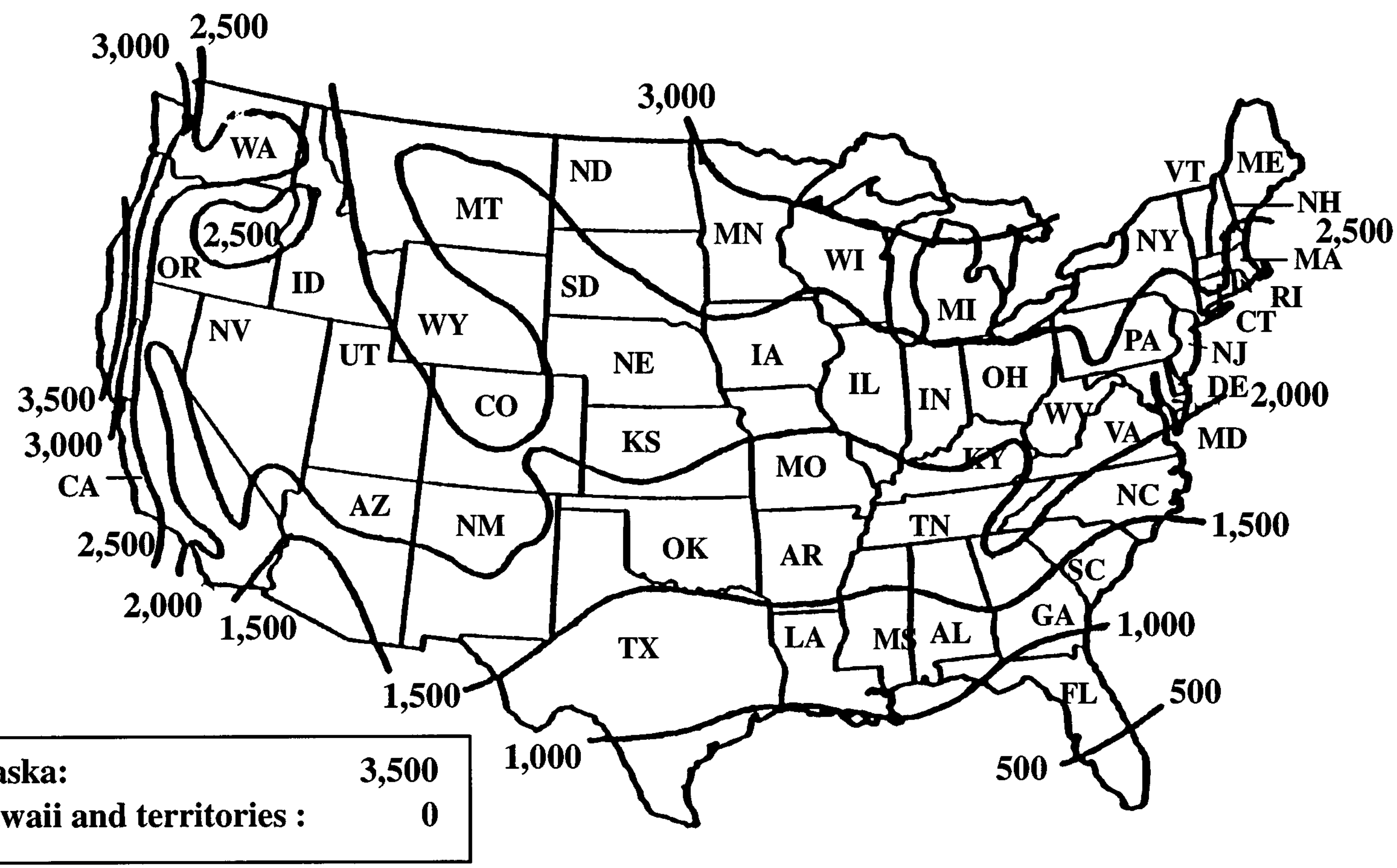

This map is reasonably accurate for most parts of the United States but is necessarily generalized, and consequently not too accurate in mountainous regions, particularly in the rockies.

FIGURE 3- HEATING LOAD HOURS (HLH) FOR THE UNITED STATES

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7. Appendix P to Subpart B of Part 430 is revised to read as follows:

Appendix P to Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Pool Heaters

1. Test method. The test method for testing pool heaters is as specified in American National Standards Institute Standard for Gas-Fired Pool Heaters, Z21.56–1994.

2. Test conditions. Establish the test conditions specified in section 2.9 of ANSI Z21.56–1994.

3. Measurements. Measure the quantities delineated in section 2.9 of ANSI Z21.56–1994. The measurement of energy consumption for oil-fired pool heaters in Btu is to be carried out in appropriate units, e.g., gallons.

4. Calculations.

4.1 *Thermal efficiency.* Calculate the thermal efficiency, E_t (expressed as a percent), as specified in section 2.9 of ANSI Z21.56–1994. The expression of fuel consumption for oil-fired pool heaters shall be in Btu.

4.2 *Average annual fossil fuel energy for pool heaters.* The average annual fuel energy for pool heater, E_F, is defined as:

$$E_F = BOH\ Q_{IN} + (POH - BOH) Q_P$$

where:

BOH=average number of burner operating hours=104 h

POH=average number of pool operating hours=4464 h

Q_{IN}=rated fuel energy input as defined according to 2.9.1 or 2.9.2 of ANSI Z21.56–1994, as appropriate

Q_P=energy consumption of continuously operating pilot light if employed, in Btu/h.

4.3 *Average annual auxiliary electrical energy consumption for pool heaters.* The average annual auxiliary electrical energy consumption for pool heaters, E_{AE}, is expressed in Btu and defined as:

$$E_{AE} = BOH\ PE$$

where:

PE=$2E_c$ if heater tested according to 2.9.1 of ANSI Z21.56–1994

=3.412 PE_{rated} if heater tested according to 2.9.2 of ANSI Z21.56–1994, in Btu/h

E_c=Electrical consumption of the heater (converted to equivalent unit of Btu), including the electrical energy to the recirculating pump if used, during the 30-minute thermal efficiency test, as defined in 2.9.1 of ANSI Z21.56–1994, in Btu per 30 min.

2=Conversion factor to convert unit from per 30 min. to per h.

PE_{rated}=nameplate rating of auxiliary electrical equipment of heater, in Watts

BOH=as defined in 4.2 of this appendix

4.4 *Heating seasonal efficiency.*

4.4.1 Calculate the seasonal useful output of the pool heater as:

$$E_{OUT} = BOH\ [(E_t/100)(Q_{IN} + PE)]$$

where:

BOH=as defined in 4.2 of this appendix

E_t=thermal efficiency as defined in 4.1 of this appendix

Q_{IN}=as defined in 4.2 of this appendix

PE=as defined in 4.3 of this appendix

100=conversion factor, from percent to fraction

4.4.2 Calculate the seasonal input to the pool heater as:

$$E_{IN} = BOH\ (Q_{IN} + PE) + (POH - BOH)\ Q_P$$

where:

BOH=as defined in 4.2 of this appendix

Q_{IN}=as defined in 4.2 of this appendix

PE=as defined in 4.3 of this appendix

POH=as defined in 4.2 of this appendix

Q_P=as defined in 4.2 of this appendix

4.4.3 *Calculate the pool heater heating seasonal efficiency (in percent).*

4.4.3.1 For pool heaters employing a continuous pilot light:

$$EFFY_{HS} = 100(E_{OUT}/E_{IN})$$

where:

E_{OUT}=as defined in 4.4.1 of this appendix

E_{IN}=as defined in 4.4.2 of this appendix

100=to convert a fraction to percent

4.4.3.2 For pool heaters without a continuous pilot light:

$$EFFY_{HS} = E_t$$

where:

E_t=as defined in 4.1 of this appendix.

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