APPENDIX L. DETERMINATION OF FURNACE AND BOILER ENERGY USE IN THE LCC ANALYSIS

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APPENDIX L. DETERMINATION OF FURNACE AND BOILER ENERGY USE IN THE LCC ANALYSIS

L.1 INTRODUCTION

The energy consumption in the LCC analysis is determined using the proposed BSR/ASHRAE SPC 103R "Method of Testing for Annual Fuel Efficiency of Residential Central Furnaces and Boilers".[1] Department of Energy used this test procedure instead of the current DOE test procedure, because of the anomaly with the DHR parameter as described in Appendix D section D.2.3. This approach requires the calculation of the average annual fuel energy consumption (E_F), the average annual electrical energy consumption (E_{AE}), and the national average number of burner operating hours (BOH) of furnaces and boilers.

The following calculations and summary tables describe the determination of E_F, E_{AE}, and BOH for gas- and oil-fired furnaces and boilers.

L.2 CALCULATIONS

L.2.1 Determination of Average Annual Fuel Energy Consumption (E_F)

The average annual fuel consumption is calculated in Appendix C section 2 of the BSR/ASHRAE 103/1993R test procedure:[1]

$E_F = BOH_{SS} * (Q_{IN} - Q_P) + 8{,}760 * Q_P$, for single-stage furnaces and boilers, **Eq. 1**

$E_F = (BOH_H * Q_{IN}) + (BOH_R * Q_{IN,R}) + [8{,}760 - (BOH_H + BOH_R)] * Q_P$, for two-stage furnaces and boilers, and **Eq. 2**

$E_F = (BOH_M * Q_{IN,M}) + (BOH_R * Q_{IN,R}) + [8{,}760 - (BOH_M + BOH_R)] * Q_P$, for step modulating furnaces and boilers **Eq. 3**

where,

BOH_{SS} = national average number of burner operating hours (see derivation in section L.2.3),
BOH_H = national average number of burner operating hours at the maximum operating mode for two-stage furnaces and boilers (see derivation in section L.2.3),
BOH_R = national average number of burner operating hours at the reduced operating mode for two-stage or step modulating furnaces and boilers (see derivation in section L.2.3),
BOH_M = national average number of burner operating hours at the modulating operating mode for step modulating furnaces and boilers (see derivation in section L.2.3),

Q_{IN} = steady-state nameplate input rate in Btu/h for single-stage furnaces and boilers or steady-state nameplate maximum input rate in Btu/h for two-stage and step modulating furnaces and boilers,
$Q_{IN,R}$ = steady-state reduced fuel input rate,
$Q_{IN,M}$ = steady-state modulating fuel input rate, and
Q_P = pilot flame fuel input rate in Btu/h.

Q_{IN} is based on the baseline value for each product class. We set $Q_{IN,R}$ to be 69% of Q_{IN} for non-condensing two-stage equipment, 67% for condensing two-stage equipment, and 40% for step modulation equipment, where this value represents the average ratio $Q_{IN}/Q_{IN,R}$ as derived using manufacturer product literature and Gas Appliance Manufacturers Association (GAMA) March 2005 Directory data for all listed two-stage furnace models.[2]

From Appendix C Section 1,[1] $Q_{IN,M}$ is calculated using $Q_{OUT,M}$ and $Effy_{SS,M}$ (as defined in section 11.4.8.10 or 11.5.8.8).[1] Q_P is zero for all product classes, except for the baseline manufactured-home gas furnace and gas boiler.

L.2.2 Determination of Average Annual Electrical Energy Consumption (E_{AE})

Using the BSR/ASHRAE SPC 103 test procedure,[1] the average annual auxiliary electrical energy consumption is calculated in Appendix C section 3:

$$E_{AE} = BOH_{SS}\,(y_P * PE + y_{IG} * PE_{IG} + y * BE), \text{ for single-stage furnaces and boilers,} \quad \textbf{Eq. 4}$$

and

$$E_{AE} = BOH_R\,(y_{P,R} * PE_R + y_{IG,R} * PE_{IG,R} + y_R * BE_R) + BOH_{H\ or\ M}\,(y_P * PE_H + y_{IG} * PE_{IG,H} + y * BE_H)^1, \text{ for two-stage and step modulating furnaces and boilers,} \quad \textbf{Eq. 5}$$

where

$BOHss$ = as defined in section L.2.3,
BOH_H = as defined in section L.2.3,
BOH_M = as defined in section L.2.3,
BOH_R = as defined in section L.2.3,
y_P = ratio of induced or forced draft blower on-time to average burner on-time,
$y_{P,R}$ = ratio of induced or forced draft blower on-time to average burner on-time, measured at the reduced fuel input rate,
PE = burner (or draft inducer) electrical power input at full-load steady-state operation in kW,

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[1] The BSR/ASHRAE test procedure does not deal with ignitor energy consumption. The ratio of ignitor on-time to burner on-time and the ignitor power consumption variables come from the DOE test procedure.[3]

PE_R = burner (or draft inducer) electrical power input at full-load steady-state operation in kW, measured at the reduced fuel input rate,

PE_H = burner (or draft inducer) electrical power input at full-load steady-state operation in kW, measured at the maximum fuel input rate,

y_{IG} = ratio of burner interrupted-ignition device on-time to average burner on-time,

$y_{IG,R}$ = ratio of burner interrupted-ignition device on-time to average burner on-time, measured at the reduced fuel input rate,

PE_{IG} = electrical input rate to the interrupted ignition device on the burner,

$PE_{IG,R}$ = electrical input rate to the interrupted ignition device on the burner, measured at the reduced fuel input rate,

$PE_{IG,H}$ = electrical input rate to the interrupted ignition device on the burner, measured at the maximum fuel input rate,

y = ratio of blower or pump on-time to burner on-time,

y_R = ratio of blower or pump on-time to burner on-time, measured at the reduced fuel input rate,

BE = circulating-air fan or water pump electrical energy input rate in kW,

BE_R = circulating-air fan or water pump electrical energy input rate in kW, measured at the reduced fuel input rate, and

BE_H = circulating-air fan or water pump electrical energy input rate in kW, measured at the maximum fuel input rate.

The values y_P and $y_{P,R}$ are calculated using t_P (post-purge time). For this calculation, DOE took t_P to be 5 seconds for furnaces, which is less than or 30 seconds and is therefore set equal to 0 seconds, according to Appendix C section 1.[1] For gas furnaces, t_P is equal to 3 minutes. For boilers, DOE calculated the values y_{IG} and $y_{IG,R}$ using t_{IG} (burner interrupted-ignition device on-time). For gas furnaces and boilers, t_{IG} = 0.62 min.[4] For oil boilers, t_{IG} is equal to 26 minutes for oil equipment without interrupted ignition and 45 seconds with oil equipment with interrupted ignition.[5] DOE calculated the values y and $y_{P,R}$ using t^+ (blower or pump on-delay) and t^- (blower or pump off-delay). For furnaces, $t^+ = 2$ min and $t^- = 0.5$ min, and for gas and oil boilers, $t^+ = 15$ minutes and $t^- = 0$, which are values obtained for the generic furnace models (see Chapter 7 Section 7.2.6). For gas furnaces, PE is equal to 75 W for non-condensing furnaces and 90 W for condensing furnaces (see Chapter 7 Section 7.2.6). For oil furnaces and boilers, PE is set to 220 W [6]. For gas boilers, PE is equal to 76 W using typical values from the March 2005 GAMA Directory.[2] For design options which include modulation, we set PE_R and PE_H to have the same values as PE, since it is assumed that there is no inducer modulation. For gas furnaces and boilers, PE_{IG}, $PE_{IG,R}$, and $PE_{IG,H}$ are set equal to 400 W.[7] For oil furnaces and boilers, PE_{IG} is equal to 45 watts for oil equipment without interrupted ignition and 25 watts with oil equipment with interrupted ignition.[8] For design options which include modulation, we set $PE_{IG,R}$ and $PE_{IG,H}$ to have the same values as PE_{IG}, since it is assumed that there is no ignition modulation. For furnaces, BE and BE_R values are calculated using equations in Appendix J for the different design options. For boilers, BE_H and BE are set equal to 70 W, while BE_R is set 80% of BE_H (56 W).[9]

L.2.3 Determination of National Average Number of Burner Operating Hours (BOH_{SS})

From the BSR/ASHRAE SPC103R test procedure,[1] the national average number of burner operating hours for furnaces and boilers is calculated in Appendix C section 1:

$BOH_{SS} = 2080 * 0.77 * A * (Q_{OUT} / (1 + \alpha)) - 2080 * B$, for single-stage furnaces and boilers, **Eq. 6**

$BOH_H = X_H * (2080) * (0.77) * A_H * (Q_{OUT} / (1 + \alpha)) - 2080 * B_H$, for two-stage furnaces and boilers at the maximum operating mode, **Eq. 7**

$BOH_R = X_R * (2080) * (0.77) * A_R * (Q_{OUT} / (1 + \alpha)) - 2080 * B_R$, for two-stage and step modulating furnaces and boilers operating at the reduced operating mode, **Eq. 8**

and

$BOH_M = X_H * (2080) * (0.77) * A_M * (Q_{OUT} / (1 + \alpha)) - 2080 * B_M$, for step modulating furnaces and boilers operating at the modulating operating mode, **Eq. 9**

where

2080	=	national average heating load hours,
0.77	=	adjustment factor to adjust the calculated design heating requirements and heating load hours to the actual heating load experienced by the heating system,
A	=	$100{,}000/ [341300(y_P * PE + y_{IG,R} * PE_{IG,R} + y * BE) + (Q_{IN} - Q_P) * Effy_{HS}]$[a],
A_H	=	$100{,}000/ [341300(y_P * PE_H + y_{IG,R} * PE_{IG,R} + y * BE_H) + (Q_{IN} - Q_P) * Effy_{U,H}]$[a],
A_R	=	$100{,}000/ [341300(y_{P,R} * PE_R + y_{IG,R} * PE_{IG,R} + y_R * BE_R) + (Q_{IN,R} - Q_P) * Effy_{U,R}]$[a],
A_M	=	$100{,}000/ [341300(y_P * PE_H + y_{IG,R} * PE_{IG,R} + y * BE_H) + (Q_{IN,M} - Q_P) * Effy_{U,M}]$[a],
B	=	$2 * (Q_P) * (Effy_{HS}) * (A) / 100{,}000$,
B_H	=	$2 * (Q_P) * (Effy_{U,H}) * (A_H) / 100{,}000$,
B_R	=	$2 * (Q_P) * (Effy_{U,R}) * (A_R) / 100{,}000$,
B_M	=	$2 * (Q_P) * (Effy_{U,M}) * (A_M) / 100{,}000$,
Q_{OUT}	=	maximum fuel input rate heating capacity,
α	=	oversize factor,
X_H	=	fraction of heating load at maximum fuel input rate operating mode,
X_R	=	fraction of heating load at reduced fuel input rate operating mode ($1-X_H$),
Q_{IN}	=	as defined in section L.2.1 of this appendix,
$Q_{IN,R}$	=	as defined in section L.2.1 of this appendix,
$Q_{IN,M}$	=	as defined in section L.2.1 of this appendix,
Q_P	=	as defined in section L.2.1 of this appendix,

[a] The BSR/ASHRAE test procedure does not deal with ignitor energy consumption. The ratio of ignitor on-time to burner on-time and the ignitor power consumption variables come from the DOE test procedure.[3]

y_P = as defined in section L.2.2 of this appendix,
$y_{P,R}$ = as defined in section L.2.2 of this appendix,
PE = as defined in section L.2.2 of this appendix,
PE_R = as defined in section L.2.2 of this appendix,
PE_H = as defined in section L.2.2 of this appendix,
y_{IG} = as defined in section L.2.2 of this appendix,
$y_{IG,R}$ = as defined in section L.2.2 of this appendix,
PE_{IG} = as defined in section L.2.2 of this appendix,
$PE_{IG,R}$ = as defined in section L.2.2 of this appendix,
$PE_{IG,H}$ = as defined in section L.2.2 of this appendix,
y = as defined in section L.2.2 of this appendix,
y_R = as defined in section L.2.2 of this appendix,
BE = as defined in section L.2.2 of this appendix,
BE_R = as defined in section L.2.2 of this appendix,
BE_H = as defined in section L.2.2 of this appendix,
$Effy_{HS}$ = ratio of the average length of the heating season in hours to the average heating load hours,
$Effy_{U,H}$ = average part load efficiency at the maximum fuel input rate,
$Effy_{U,R}$ = average part load efficiency at the reduced fuel input rate, and
$Effy_{U,M}$ = average part load efficiency at the modulating fuel input rate.

Equations 6 through 9 are modified to account for the fact that we know the house heating load (HHL) for each RECS household (see Chapter 7 section 7.6). First we set HHL equal to the factors in equations 6 through 9 used to approximate HHL:

$$HHL = 2080 * 0.77 * (Q_{OUT} / (1 + \alpha)) \qquad \textbf{Eq. 10}$$

Therefore α is set equal to:

$$\alpha = Q_{OUT} * (2080) * (0.77) / (HHL) - 1 \qquad \textbf{Eq. 11}$$

instead of being equal to the constant value 0.7 as defined in the BSR/ASHRAE SPC103 test procedure.[1]

The modified equations used in the LCC spreadsheet are as follows (Note that the maximum value for BOH is set to 8760):

$BOH_{SS} = A * HHL - 2080 * B$, for single-stage furnaces and boilers, **Eq. 12**

$BOH_H = X_H * A_H * HHL - 2080 * B_H$, for two-stage furnaces and boilers at the maximum operating mode, **Eq. 13**

$BOH_R = X_R * A_R * HHL - 2080 * B_R$, for two-stage and step modulating furnaces and boilers operating at the reduced operating mode, **Eq. 14** and

$BOH_M = X_H * A_M * HHL - 2080 * B_M$, for step modulating furnaces and boilers operating at the modulating operating mode, **Eq. 15**

To calculate factors A, A_H, A_R, A_M, B, B_H, B_R, and B_M, DOE calculated y_P, $y_{P,R}$, PE, PE_R, PE_H, y_{IG}, $y_{IG,R}$, PE_{IG}, $PE_{IG,R}$, $PE_{IG,H}$, y, y_R, BE, BE_R, BE_H, , PE, y_{IG}, PE_{IG}, y, BE, Q_{IN}, and Q_P y_P , as described in section L.2.2 of this appendix. For factor B, if $Q_P = 0$, then $B = 0$, which is true for all cases except for the baseline manufactured-home gas furnace and the baseline gas boiler. We calculated $Effy_{HS}$, heating seasonal efficiency, as defined in sections 11.2.11, 11.3.11.3, 11.4.11.3, and 11.5.11.3.[1] For $Q_P = 0$, $Effy_{HS}$ is equal to the annual fuel utilization efficiency (*AFUE*). For $Q_P > 0$, $Effy_{HS}$ is calculated using $Effy_{SS}$ (as defined in section 11.2.8.1[1]). $Effy_{SS}$ is calculated using Q_{OUT} (as defined below), K (factor that adjusts the jacket losses, where K = 1.7 for non-weatherized furnaces, 3.3 for weatherized furnaces, and 1 for boilers as described in section 11.2.8.1 [1]), and Lj (jacket loss, where Lj = 1 is the default value as described in section 11.2.8.1[1])

Q_{OUT} for all product classes is calculated using the following equations based on GAMA Directory 2005 data for Non-Weatherized Gas Furnaces[2]:

$Q_{OUT} = Q_{IN}$ (0.7247 * AFUE + 0.22346), for non-condensing equipment, and Eq. 16

$Q_{OUT} = Q_{IN}$ (0.8127 * AFUE + 0.17557), for condensing equipment. Eq. 17

DOE calculated X_H by using T_C (balance-point temperature as defined in section 11.4.8.4 [1]), α (the oversize factor, as calculated in Equation 11), Q_{OUT}, and $Q_{OUT,R}$ (reduced fuel input rate heating capacity). $Q_{OUT,R}$ is set equal to 69% Q_{OUT} for non-condensing equipment and 67% Q_{OUT} for condensing equipment, as derived using manufacturer product literature and Gas Appliance Manufacturers Association (GAMA) March 2005 Directory data for all listed two-stage furnace models.[2] X_R is set equal to $1-X_H$. For similar reasons as provided in Appendix D, section D.3.2, $Effy_{U,H} = Effy_{U,R}$ and therefore using the equation in section 11.5.11.3[1] is equal to $Effy_{SS}$. $Effy_{U,M}$ is calculated using the equation in section 11.4.9.2.3.[1]

L.3 SUMMARY TABLES

Tables L.4.1 through L.4.6 in this appendix contain data about the furnaces and boilers.

Table L.3.1 Non-Weartherized Gas Furnaces

Description	$Effy_{HS}$	t_P	PE	t_{IG}	P_{IG}	t^+	t^-
78% AFUE - Baseline	78%	5 sec	75	37 sec	400	120 sec	30 sec
80% AFUE - Increased HX Area	80%	5 sec	75	37 sec	400	120 sec	30 sec
80% AFUE - Modulation (2-Stage)	80%	5 sec	75	37 sec	400	120 sec	30 sec
81% AFUE - Increased HX Area	81%	5 sec	75	37 sec	400	120 sec	30 sec
81% AFUE - Modulation (2-Stage)	81%	5 sec	75	37 sec	400	120 sec	30 sec
90% AFUE	90%	5 sec	90	37 sec	400	120 sec	30 sec
92% AFUE - Increased HX Area	92%	5 sec	90	37 sec	400	120 sec	30 sec
92% AFUE - Modulation (2-Stage)	92%	5 sec	90	37 sec	400	120 sec	30 sec
92% AFUE - Modulation (Continuous)	92%	5 sec	90	37 sec	400	120 sec	30 sec
96% AFUE - Modulation (Continuous)	96%	5 sec	90	37 sec	400	120 sec	30 sec

Table L.3.2 Weartherized Gas Furnaces

Description	$Effy_{HS}$	t_P	PE	t_{IG}	P_{IG}	t^+	t^-
78% AFUE - Baseline	78%	5 sec	75	37 sec	400	120 sec	30 sec
80% AFUE - Increased HX Area	80%	5 sec	75	37 sec	400	120 sec	30 sec
81% AFUE - Increased HX Area	81%	5 sec	75	37 sec	400	120 sec	30 sec
82% AFUE - Increased HX Area	82%	5 sec	75	37 sec	400	120 sec	30 sec
83% AFUE - Increased HX Area	83%	5 sec	75	37 sec	400	120 sec	30 sec

Table L.3.3 Mobile Home Gas Furnaces

Description	$Effy_{HS}$	t_P	PE	t_{IG}	P_{IG}	t^+	t^-
75% AFUE - Baseline	79%	5 sec	75	37 sec	0	120 sec	30 sec
80% AFUE - Increased HX Area	80%	5 sec	75	37 sec	400	120 sec	30 sec
80% AFUE - Modulation (2-Stage)	80%	5 sec	75	37 sec	400	120 sec	30 sec
81% AFUE - Increased HX Area	81%	5 sec	75	37 sec	400	120 sec	30 sec
81% AFUE - Modulation (2-Stage)	81%	5 sec	75	37 sec	400	120 sec	30 sec
82% AFUE - Increased HX Area	82%	5 sec	75	37 sec	400	120 sec	30 sec
82% AFUE - Modulation (2-Stage)	82%	5 sec	75	37 sec	400	120 sec	30 sec
90% AFUE - Condensing	90%	5 sec	90	37 sec	400	120 sec	30 sec

Table L.3.4 Oil-Fired Furnaces

Description	$Effy_{HS}$	t_P	PE	t_{IG}	P_{IG}	t^+	t^-
78% AFUE - Baseline	78%	5 sec	220	26 min	45	120 sec	30 sec
80% AFUE - Increased HX Area	80%	5 sec	220	26 min	45	120 sec	30 sec
81% AFUE - Increased HX Area	81%	5 sec	220	26 min	45	120 sec	30 sec
81% AFUE - Interrupted Ignition	81%	5 sec	220	45 sec	25	120 sec	30 sec
81% AFUE - Modulation (2-Stage)	81%	5 sec	220	45 sec	25	120 sec	30 sec
82% AFUE - Increased HX Area	82%	5 sec	220	26 min	45	120 sec	30 sec
82% AFUE - Interrupted Ignition	82%	5 sec	220	45 sec	25	120 sec	30 sec
82% AFUE - Modulation (2-Stage)	82%	5 sec	220	45 sec	25	120 sec	30 sec
83% AFUE - Increased HX Area	83%	5 sec	220	26 min	45	120 sec	30 sec
83% AFUE - Interrupted Ignition	83%	5 sec	220	45 sec	25	120 sec	30 sec
83% AFUE - Modulation (2-Stage)	83%	5 sec	220	45 sec	25	120 sec	30 sec
84% AFUE - Increased HX Area	84%	5 sec	220	26 min	45	120 sec	30 sec
84% AFUE - Interrupted Ignition	84%	5 sec	220	45 sec	25	120 sec	30 sec
84% AFUE - Modulation (2-Stage)	84%	5 sec	220	45 sec	25	120 sec	30 sec
85% AFUE - Increased HX Area	85%	5 sec	220	26 min	45	120 sec	30 sec
85% AFUE - Interrupted Ignition	85%	5 sec	220	45 sec	25	120 sec	30 sec
85% AFUE - Modulation (2-Stage)	85%	5 sec	220	45 sec	25	120 sec	30 sec

Table L.3.5 Hot-Water Gas Boilers

Description	$Effy_{HS}$	t_P	PE	t_{IG}	P_{IG}	t^+	t^-
80% AFUE - Baseline	82%	180 sec	76	37 sec	0	15 min	0 sec
81% AFUE - Improved Heat Transfer Coef.	81%	180 sec	76	37 sec	400	15 min	0 sec
81% AFUE - Modulation (2-Stage)	81%	180 sec	76	37 sec	400	15 min	0 sec
82% AFUE - Improved Heat Transfer Coef.	82%	180 sec	76	37 sec	400	15 min	0 sec
82% AFUE - Modulation (2-Stage)	82%	180 sec	76	37 sec	400	15 min	0 sec
83% AFUE - Improved Heat Transfer Coef.	83%	180 sec	76	37 sec	400	15 min	0 sec
83% AFUE - Modulation (2-Stage)	83%	180 sec	76	37 sec	400	15 min	0 sec
84% AFUE - Improved Heat Transfer Coef.	84%	180 sec	76	37 sec	400	15 min	0 sec
84% AFUE - Modulation (2-Stage)	84%	180 sec	76	37 sec	400	15 min	0 sec
85% AFUE - Improved Heat Transfer Coef.	85%	180 sec	76	37 sec	400	15 min	0 sec
85% AFUE - Modulation (2-Stage)	85%	180 sec	76	37 sec	400	15 min	0 sec
86% AFUE	86%	180 sec	76	37 sec	400	15 min	0 sec
91% AFUE	91%	180 sec	76	37 sec	400	15 min	0 sec
99% AFUE	99%	180 sec	76	37 sec	400	15 min	0 sec

Table L.3.6 Hot-Water Oil Boilers

Description	**$Effy_{HS}$**	**t_P**	**PE**	**t_{IG}**	**P_{IG}**	**t^+**	**t^-**
80% AFUE - Baseline	80%	180 sec	220	26 min	45	15 min	0 sec
81% AFUE - Improved Heat Transfer Coef.	81%	180 sec	220	26 min	45	15 min	0 sec
81% AFUE - Interrupted Ignition	81%	180 sec	220	45 sec	25	15 min	0 sec
82% AFUE - Improved Heat Transfer Coef.	82%	180 sec	220	26 min	45	15 min	0 sec
82% AFUE - Interrupted Ignition	82%	180 sec	220	45 sec	25	15 min	0 sec
82% AFUE - Modulation (2-Stage)	82%	180 sec	220	45 sec	25	15 min	0 sec
83% AFUE - Improved Heat Transfer Coef.	83%	180 sec	220	26 min	45	15 min	0 sec
83% AFUE - Interrupted Ignition	83%	180 sec	220	45 sec	25	15 min	0 sec
83% AFUE - Modulation (2-Stage)	83%	180 sec	220	45 sec	25	15 min	0 sec
84% AFUE - Improved Heat Transfer Coef.	84%	180 sec	220	26 min	45	15 min	0 sec
84% AFUE - Interrupted Ignition	84%	180 sec	220	45 sec	25	15 min	0 sec
84% AFUE - Modulation (2-Stage)	84%	180 sec	220	45 sec	25	15 min	0 sec
85% AFUE - Improved Heat Transfer Coef.	85%	180 sec	220	26 min	45	15 min	0 sec
85% AFUE - Interrupted Ignition	85%	180 sec	220	45 sec	25	15 min	0 sec
85% AFUE - Modulation (2-Stage)	85%	180 sec	220	45 sec	25	15 min	0 sec
86% AFUE - Improved Heat Transfer Coef.	86%	180 sec	220	26 min	45	15 min	0 sec
86% AFUE - Interrupted Ignition	86%	180 sec	220	45 sec	25	15 min	0 sec
86% AFUE - Modulation (2-Stage)	86%	180 sec	220	45 sec	25	15 min	0 sec
90% AFUE	90%	180 sec	220	45 sec	25	15 min	0 sec
95% AFUE	95%	180 sec	220	45 sec	25	15 min	0 sec

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