March 11, 2014

U.S. Department of Energy, Building Technologies Program
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Washington, D.C. 20585-0121
Attn: Ms. Brenda Edwards

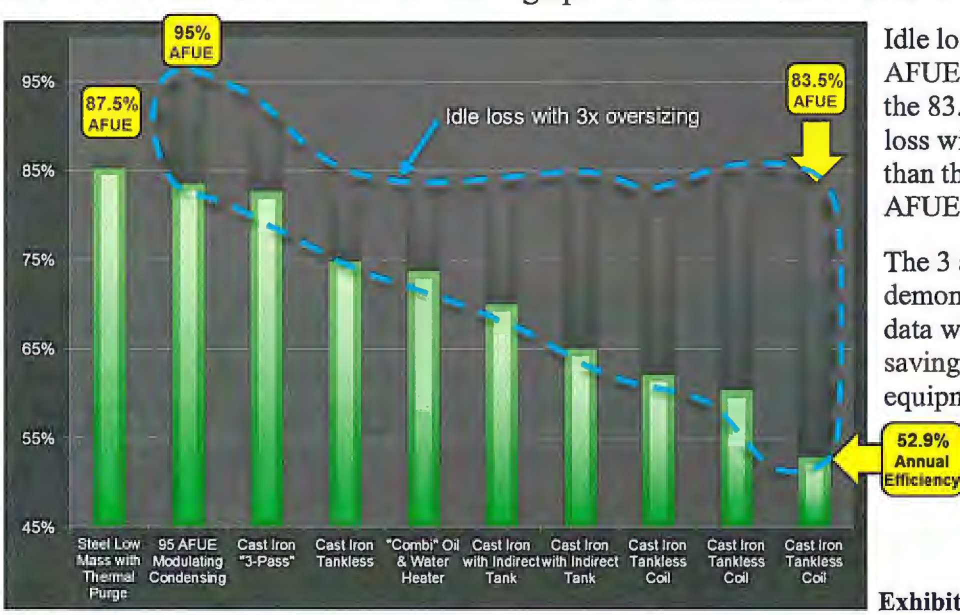
Reference: NODA for Energy Conservation Standards for Residential Boilers
Docket No: EERE-2012-BT-STD-0047 RIN: RIN 1904-AC88

Annual Fuel Utilization Efficiency (AFUE) for residential boilers was implemented nearly 30 years ago and has gone through little practical revision since that time. Independent studies demonstrate that field savings can be much greater than demonstrated with AFUE alone, and developing a standard that is more representative of annual efficiency and actual installed performance is the right thing to do for consumers and contractors.

Further, by ignoring integrated hydronic systems, the current procedure fails to recognize and act on a very significant energy savings opportunity. Respondents have indicated that up to 75% of boilers provide heat and hot water, and we expect integrated systems to become the norm in the future.

The following statements are derived from the NODA and other information sources as footnoted:

1) The average design day heat loss based on Heating Degree Day (HDD) data and the average hot water boiler input indicate an average oversizing factor between 3 and 4 on design day. This exceeds the 0.7 oversizing factor indicated in the AFUE standard by 239% and 187% for gas and oil boilers respectively.[1] This 3 to 4 times oversizing has a clear and direct impact on annual efficiency due to idle losses as shown in the below graph which also reflect a small hot water load.[2]



Idle loss is virtually ignored in AFUE. It is important to note that the 83.5% AFUE with 4.87% idle loss will consume 63% more fuel than the 0.15% idle loss 87.5 AFUE model shown.

The 3 and 4 oversizing factors demonstrated with the NODA data will show even greater savings potential with an equipment upgrade.

Exhibit 1

2) The NODA documents indicate steady state efficiency is between 0.29% and 0.89% higher than AFUE for non-condensing hot water boilers, and is 2.53% lower than AFUE for condensing boilers. Replacing the AFUE metric with steady state efficiency plus a latent heat of condensation component could vastly reduce manufacturer testing burden.[3]

   The development of a "Smart Standard" that incorporates an idle loss metric could be simultaneously implemented, greatly improving the ability of contractors and consumers to make informed decisions about energy savings and equipment selection. Idle loss values for classes of boilers could be prescriptive, further reducing testing burden. For innovative and more highly performing systems, a test method for idle loss could be implemented and the idle loss used instead. This or a similar process would foster innovation and recognize better performing systems, while simultaneously reducing test burden.

3) The NODA analysis showing minimal impact on AFUE based on water temperature represents the operation of temperature reset controls. With changes of less than 1% demonstrated, temperature reset controls would be highly ineffective without accounting for idle loss. Simply put, idle loss or energy wasted at the end of the heating cycle, not during the burner operation, greatly impacts annual energy efficiency. [4]

   AFUE assumes that the heating boiler is in the conditioned space and heat lost is gained in the conditioned space. In practice, much of this heat energy is wasted in basements, up chimneys, and out draft hoods and draft regulators. Furthermore, if combined heat and hot water boilers are considered to be in the conditioned space, then heat lost in summer time while heating domestic water should have an impact on air conditioning cooling loads.

4) Because the AFUE test method states that all controls must be disabled prior to commencing testing, AFUE does not account for the impact of energy saving controls. This limitation in the test method means that consumers and contractors cannot make informed decisions about innovative systems. The combination of controls and equipment design can deliver powerful solutions for energy savings that are not reflected in AFUE alone. This situation is an impediment to the development and marketing of truly innovative and effective controls.

5) Although AFUE does not apply to boilers that make hot water, hot water is in effect just a small load that recurs several times a day. System controls and integration are even more critical to deliver high efficiency with combined heat and hot water systems.

6) AFUE is used for both boilers and furnaces, implying that these very different appliances may be compared with AFUE ratings. I feel that due to the typically high distribution efficiency of boilers and the significant distribution losses of conventionally ducted systems, these metrics should be separate and distinct. Guidance should be given to consumers reflecting distribution efficiency, especially if a more accurate rating method is employed for boilers.

7) Full Fuel Cycle (FFC) efficiency analysis should also be incorporated for cross class comparisons between fossil fired heat and hot water systems and electric grid based systems. Low electric power generation efficiency combined with high transmission and distribution losses creates a false sense of high efficiency regarding vapor compression cycle heating equipment driven by an electric motor when compared to direct fired heating equipment.

In closing, I reference the following response received from the Department of Energy's National Renewable Energy Labs Uniform Methods Project Comment Process for Residential Furnaces and Boilers in section (3) Savings Calculations, October 8, 2012:

> *Though we agree that AFUE is not the best measure to capture efficiency it is the most widely used measure of efficiency to qualify furnaces and boiler for efficiency rebates.*

This needs to be corrected.

I firmly believe these important points and much needed improvements to AFUE are both technologically feasible and economically justified.

Respectfully submitted,

Roger D. Marran

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President

[1] Data from EERE-2012-BT-STD-0047-0013.xlsm workbook [Shipment] downloaded on 3/7/2014. 91.9% of shipments are to the states of NY, CT, ME, NH, RI, VT, MA, NJ, PA, DE, DC, MD, IL, IA, MN, ND, SD, WI, IN, OH, OR, WA. Weather data is a summary of these states from the workbook [Weather Data] with an additional column that calculates the design day heating degree days (HDD) as a percentage of the January HDD's; the average for these states is 5.2%. Based on the January Average Monthly Fuel Consumption peak values of 16.8 MMBTU/month (HWGB) and 21.3 MMBTU/month (HWOB) shown in the [Energy Use] workbook, the maximum design day fuel consumption range is 5.2% of the monthly use or from 873,600 BTU/day to 1,107,600 BTU/day or 36,400 BTU/hr to 46,150 BTU/hr; further adjusting for 82% efficiency yields an annual average design day heat loss of 29,848 BTU/hr to 37,843 BTU/hr.

The January average energy consumption per hour can be estimated as 16.8 MMBTU/month / 31 days in January / 24 hours per day. This implies that during the heating season, the typical load averages approximately 23 MBH to 28 MBH for gas and oil water boilers respectively.

Further, table 7-B.2.7 Comparison of Derived Input Capacity to Shipment Weighted Data and Model Data provided in the NODA indicates an average 2013 boiler input rate of 151,000 BTU/hr and 158,000 BTU/hr for gas and oil water boilers respectively. This implies an average oversizing factor of 4 to 5, 298% and 256% higher than the .7 oversizing factor indicated in the AFUE standard.

Location ID	States	Shipments	Running Sum
3	New York	25.6%	25.6%
1	CT, ME, NH, RI, VT	16.0%	41.5%
2	Massachusetts	11.3%	52.8%
4	New Jersey	10.5%	63.3%
5	Pennsylvania	10.1%	73.4%
14	DE, DC, MD	5.5%	78.8%
6	Illinois	3.4%	82.2%
10	IA, MN, ND, SD	3.1%	85.2%
9	Wisconsin	2.4%	87.7%
7	Indiana, Ohio	2.2%	89.9%
27	OR, WA	2.0%	91.9%
8	Michigan	1.8%	93.7%
13	Virginia	1.8%	95.5%
22	Colorado	1.5%	97.0%
23	ID, MT, UT, WY	0.7%	97.8%
26	California	0.5%	98.2%
25	NV, NM	0.4%	98.6%
28	Alaska	0.3%	98.9%
12	Missouri	0.2%	99.1%
16	NC, SC	0.2%	99.3%
20	AR, LA, OK	0.1%	99.4%
19	Tennessee	0.1%	99.5%
11	Kansas, Nebraska	0.1%	99.6%
18	AL, KY, MS	0.1%	99.7%
21	Texas	0.1%	99.8%
24	Arizona	0.1%	99.9%
30	West Virginia	0.1%	100.0%
15	Georgia	0.0%	100.0%
17	Florida	0.0%	100.0%
29	Hawaii	0.0%	100.0%
31	**United States**	**100.0%**	

Monthly Fuel (Gas/LPG/Oil) Use					1	2	3	4	5	6	7	8	9	10	11	12	
Annual Fuel Use					Average Monthly Fuel Energy Consumption (MMBtu/month)												(MMBtu/yr)
				Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual (MMBtu/yr)
	iPC		iEL		31	28	31	30	31	30	31	31	30	31	30	31	
1	1	HWGB	0	82% AFUE - Baseline	16.8	14.3	11.8	6.8	3.5	1.0	0.1	0.2	1.4	5.7	9.0	14.0	84.7
2	1	HWGB	1	83% AFUE - Increased HX Area	16.6	14.1	11.6	6.7	3.5	1.0	0.1	0.2	1.4	5.7	8.9	13.8	83.6
3	1	HWGB	2	84% AFUE - Increased HX Area	16.4	14.0	11.5	6.6	3.4	1.0	0.1	0.2	1.4	5.6	8.8	13.6	82.6
4	1	HWGB	3	85% AFUE - Increased HX Area	16.2	13.8	11.3	6.5	3.4	1.0	0.1	0.2	1.4	5.5	8.7	13.4	81.5
5	1	HWGB	4	90% AFUE - Condensing Baseline	15.6	13.3	10.9	6.3	3.3	1.0	0.1	0.2	1.3	5.3	8.4	13.0	78.6
6	1	HWGB	5	92% AFUE - Increased HX Area	15.4	13.1	10.8	6.2	3.2	1.0	0.1	0.2	1.3	5.3	8.3	12.8	77.7
7	1	HWGB	6	96% AFUE - Max Tech	14.8	12.5	10.3	6.0	3.1	0.9	0.1	0.2	1.2	5.0	7.9	12.3	74.3
8	2	SGB	0	80% AFUE - Baseline	9.0	7.7	6.5	4.0	2.1	0.8	0.4	0.4	0.8	2.8	4.8	7.4	38.6
9	2	SGB	1	82% AFUE - Increased HX Area	8.8	7.5	6.4	3.9	2.1	0.8	0.3	0.4	0.7	2.7	4.7	7.2	37.7
10	2	SGB	2	83% AFUE - Max Tech	8.7	7.5	6.3	3.8	2.1	0.7	0.3	0.4	0.7	2.7	4.6	7.1	37.2
11	3	HWOB	0	84% AFUE - Baseline	6.8	5.9	4.3	2.3	0.9	0.1	0.0	0.0	0.3	2.1	3.8	6.0	32.5
12	3	HWOB	1	85% AFUE - Increased HX Area	6.7	5.8	4.2	2.2	0.9	0.1	0.0	0.0	0.3	2.1	3.7	5.9	32.1
13	3	HWOB	2	86% AFUE - Increased HX Area	6.6	5.7	4.2	2.2	0.9	0.1	0.0	0.0	0.3	2.1	3.7	5.9	31.8
14	3	HWOB	3	91% AFUE - Condensing (Max Tec	6.4	5.6	4.0	2.1	0.9	0.1	0.0	0.0	0.3	2.0	3.6	5.7	30.7
15	4	HWOB	0	82% AFUE - Baseline	21.3	18.1	14.9	8.6	4.5	1.3	0.1	0.3	1.8	7.3	11.4	17.7	107.5
16	4	HWOB	1	84% AFUE - Increased HX Area	20.8	17.7	14.6	8.4	4.4	1.3	0.1	0.3	1.7	7.1	11.2	17.3	104.9
17	4	HWOB	2	85% AFUE - Increased HX Area	20.6	17.5	14.4	8.3	4.3	1.3	0.1	0.3	1.7	7.0	11.0	17.1	103.7
18	4	HWOB	3	86% AFUE - Max Tech	20.4	17.3	14.3	8.2	4.3	1.3	0.1	0.3	1.7	7.0	10.9	16.9	102.5

Table 7-B.2.7 Comparison of Derived Input Capacity to Shipment Weighted Data and Model Data

Product Class	DOE Derived Average		2013 DOE Boiler Models*		Shipment Weighted Output Capacity for Cast Iron Boilers**			
	Input Capacity	Output Capacity	Input Capacity	Output Capacity	1970	1980	1990	2000
Gas-Fired Hot Water Boilers	164	145	151	131	124	122	113	116
Gas-Fired Steam Boilers	179	135	172	142	153	153	138	139
Oil-Fired Hot Water Boilers	176	144	158	137	148	154	147	144
Oil-Fired Steam Boilers	179	148	190	162	1	1	1	1
Electric Boiler	164	147	NA	NA	NA	NA	NA	NA

* Based on October 2013 AHRI directory as well as other sources (see Appendix 7-D.

** Based on AHRI (formerly GAMA) shipment data provided in April 2002.

Weather Loc Code	State	City	January Design Day HDD %	Heating ODT	Cooling ODT	2003 HDD	2003 CDD	2009 HDD	2009 CDD	10-year Average Monthly HDD Data JAN
BDL	CT	HARTFORD	4.8%	7.0	88	4377	1459	6072	610	1204
BDR	CT	BRIDGEPORT	5.2%	9.0	85	558	4747	5484	889	1076
DCA	DC	WASHINGTON	5.4%	17.0	93	6962	849	4124	1427	885
ILG	DE	WILMINGTON	5.1%	14.0	89	4529	1321	4789	1031	1000
ALO	IA	WATERLOO	5.2%	-10.0	89	6735	6	7253	448	1449
BRL	IA	BURLINGTON	5.5%	-3.0	91	6889	369	5687	810	1233
CID	IA	CEDAR RAPIDS	5.0%	-5.0	89	639	3686	6977	419	1404
DBQ	IA	DUBUQUE	5.1%	-7.0	86	6699	833	7204	345	1421
DSM	IA	DES MOINES	5.3%	-5.0	90	8448	697	8124	898	1310
MCW	IA	MASON CITY	5.0%	-11.0	88	5827	550	7856	338	1514
OTM	IA	OTTUMWA	5.3%	-4.0	92	3908	623	6317	588	1310
SUX	IA	SIOUX CITY	5.2%	-7.0	90	7833	576	6913	678	1393
MLI	IL	MOLINE	5.4%	-4.0	91	5025	1155	6250	636	1280
ORD	IL	CHICAGO	5.2%	0.0	90	4269	350	8417	585	1256
PIA	IL	PEORIA	5.7%	-4.0	90	5534	656	5841	752	1221
RFD	IL	ROCKFORD	5.2%	-4.0	89	3206	1498	6738	433	1330
SPI	IL	SPRINGFIELD	5.5%	2.0	91	5606	610	5234	933	1155
UIN	IL	QUINCY	5.3%	3.0	90	5411	783	5460	849	1178
EVV	IN	EVANSVILLE	5.7%	9.0	92	5494	1096	4397	1283	981
FWA	IN	FORT WAYNE	5.1%	1.0	88	2143	2504	6077	601	1247
IND	IN	INDIANAPOLIS	5.6%	2.0	89	1909	2482	5203	953	1131
LAF	IN	WEST LAFAYETTE	5.3%	3.0	90	4207	718	5436	826	1178
SBN	IN	SOUTH BEND	5.1%	1.0	88	2239	2752	6426	545	1253
BOS	MA	BOSTON	5.0%	9.0	87	5796	800	5694	581	1111
ORH	MA	WORCESTER	4.8%	4.0	83	4739	895	6699	370	1273
BWI	MD	BALTIMORE	5.4%	13.0	91	849	3153	4745	1086	989
SBY	MD	SALISBURY	5.3%	16.0	90	1338	3406	4345	1149	929
AUG	ME	AUGUSTA	4.8%	-3.0	84	3105	2187	7467	278	1410
BGR	ME	BANGOR	4.8%	-6.0	84	5294	418	8098	248	1475
CAR	ME	CARIBOU	4.6%	-13.0	82	127	5071	9415	149	1880
HUL	ME	HOULTON	4.8%	-13.0	85	8489	496	9316	176	1630
PWM	ME	PORTLAND	5.0%	-1.0	83	8324	605	7107	294	1318
AXN	MN	ALEXANDRIA	4.8%	-16.0	86	702	4975	8922	340	1675
DLH	MN	DULUTH	4.8%	-16.0	81	4803	1061	9517	118	1676
HIB	MN	HIBBING	4.8%	-20.0	81	7313	406	10159	64	1780
INL	MN	INT'L FALLS	4.9%	-25.0	83	3002	1722	10648	72	1853
MSP	MN	MINNEAPOLIS	5.1%	-12.0	88	6493	476	7613	646	1512
RST	MN	ROCHESTER	5.0%	-12.0	85	3787	1410	7884	321	1531
STC	MN	SAINT CLOUD	4.7%	-11.0	88	3971	1336	8704	301	1625
BIS	ND	BISMARCK	5.3%	-19.0	90	2697	2247	9130	332	1595
FAR	ND	FARGO	4.8%	-18.0	88	4502	1820	9304	362	1718
GFK	ND	GRAND FORKS	4.8%	-22.0	89	4870	1010	9928	269	1803
ISN	ND	WILLISTON	5.3%	-21.0	92	8419	313	9721	297	1635
MOT	ND	MINOT	5.3%	-20.0	89	6018	379	9559	314	1606
P11	ND	DEVIL'S LAKE	4.9%	-21.0	87	6020	353	10245	236	1771
CON	NH	CONCORD	4.9%	-3.0	87	2053	2284	7462	325	1380
LEB	NH	LEBANON	4.7%	-3.0	86	2625	1864	7312	371	1439
ACY	NJ	ATLANTIC CITY	5.3%	13.0	89	9819	3	4893	994	975
EWR	NJ	NEWARK	5.0%	14.0	91	4608	1771	4790	1021	1016
ALB	NY	ALBANY	5.1%	-1.0	86	9790	0	6644	433	1303
ART	NY	WATERTOWN	5.0%	-6.0	83	2510	2047	7707	298	1434
BGM	NY	BINGHAMTON	4.8%	1.0	82	1237	677	7067	261	1328
BUF	NY	BUFFALO	4.8%	6.0	84	4338	1288	6651	361	1242
GFL	NY	GLENS FALLS	4.9%	-5.0	85	7748	420	7612	285	1437
LGA	NY	NEW YORK	5.1%	15.0	89	9575	417	4647	1041	978
MSS	NY	MASSENA	4.8%	-8.0	84	8311	630	7980	298	1531
ROC	NY	ROCHESTER	4.8%	5.0	86	3595	1449	6765	315	1241
SYR	NY	SYRACUSE	5.0%	2.0	86	8793	305	6687	439	1271
UCA	NY	UTICA	5.9%	-6.0	85	6291	322	4680	1683	1198
CAK	OH	AKRON CANTON	4.9%	6.0	86	1288	2700	6131	497	1208
CLE	OH	CLEVELAND	5.1%	5.0	87	544	3582	5833	664	1166
CMH	OH	COLUMBUS	5.4%	5.0	89	2831	1564	5243	874	1109
CVG	OH	CINCINNATI	5.6%	6.0	90	6861	721	4950	874	1063
DAY	OH	DAYTON	5.2%	4.0	86	6335	883	5802	732	1171
FDY	OH	FINDLAY	5.1%	3.0	87	4750	954	5901	698	1212
MFD	OH	MANSFIELD	4.9%	5.0	85	6266	597	6214	468	1229
TOL	OH	TOLEDO	5.2%	1.0	88	6295	592	6283	592	1231
YNG	OH	YOUNGSTOWN	5.0%	4.0	86	7336	1010	6239	443	1215
AST	OR	ASTORIA	5.6%	29.0	72	4017	1202	4871	39	646
BKE	OR	BAKER	5.0%	6.0	91	2417	1463	7529	220	1176
EUG	OR	EUGENE	6.0%	22.0	88	5025	1367	4999	331	723
MFR	OR	MEDFORD	5.5%	23.0	95	1882	3846	4459	1043	780
PDT	OR	PENDLETON	6.6%	5.0	93	6515	439	5713	720	910
PDX	OR	PORTLAND	5.9%	23.0	87	8029	125	4357	635	718
RDM	OR	REDMOND	5.9%	9.0	90	7483	724	6737	313	946
SLE	OR	SALEM	5.9%	23.0	86	1270	3217	4660	457	712
ABE	PA	ALLENTOWN	4.9%	9.0	86	9300	25	5725	622	1134
AOO	PA	ALTOONA	5.1%	5.0	86	2248	2212	6109	433	1176
BFD	PA	BRADFORD	4.8%	-1.0	80	853	4649	8059	74	1367
CXY	PA	HARRISBURG	5.1%	11.0	90	6263	1130	5097	866	1049
DUJ	PA	DU BOIS	4.7%	5.0	84	5580	938	6753	254	1276
ERI	PA	ERIE	4.8%	9.0	84	4928	1490	6183	423	1187
IPT	PA	WILLIAMSPORT	5.0%	7.0	87	8967	180	5636	644	1165
PHL	PA	PHILADELPHIA	5.2%	14.0	90	7092	243	4557	1219	986
PIT	PA	PITTSBURGH	5.3%	5.0	87	6233	611	5681	617	1141
PVD	RI	PROVIDENCE	5.1%	9.0	88	3108	1379	5717	579	1104
ABR	SD	ABERDEEN	4.9%	-15.0	91	8332	0	8872	329	1624
FSD	SD	SIOUX FALLS	5.1%	-11.0	90	2381	2353	7670	481	1479
HON	SD	HURON	5.3%	-14.0	91	10000	203	8070	469	1494
PIR	SD	PIERRE	5.4%	-10.0	95	5892	587	7738	577	1384
RAP	SD	RAPID CITY	5.9%	-7.0	91	7598	880	7738	362	1228
BTV	VT	BURLINGTON	5.0%	-7.0	85	6359	723	7413	392	1427
MPV	VT	MONTPELIER	4.7%	-6.0	83	6381	543	7998	237	1501
ALW	WA	WALLA WALLA	6.7%	7.0	95	2864	1874	5062	1144	869
BLI	WA	BELLINGHAM	8.5%	15.0	76	2497	1525	5568	115	767
GEG	WA	SPOKANE	5.8%	2.0	89	5010	1020	6942	599	1094
OLM	WA	OLYMPIA	5.6%	22.0	83	4517	22	5614	178	772
SEA	WA	SEATTLE TACOMA	5.5%	26.0	81	1386	3185	4879	319	706
UIL	WA	QUILLAYUTE	5.4%	27.0	74	4487	881	5869	44	702
YKM	WA	YAKIMA	5.8%	5.0	92	7401	652	6204	699	1029
AUW	WI	WAUSAU	5.0%	-12.0	85	2340	2206	8337	277	1547
EAU	WI	EAU CLAIRE	4.9%	-11.0	87	6738	732	8208	333	1546
GRB	WI	GREEN BAY	5.1%	-9.0	85	7508	355	8005	275	1452
LSE	WI	LACROSSE	5.1%	-9.0	89	6130	1158	7334	536	1452
MKE	WI	MILWAUKEE	5.4%	-4.0	87	7023	813	6816	474	1288
MSN	WI	MADISON	5.1%	-7.0	87	5832	676	7343	368	1424

Average for states with 91.9% of boiler shipments: **5.2%**

[2] Butcher, T. 2007. "Performance of Integrated Hydronic Systems." BNL Report BNL-79814-IR. http://www.osti.gov/bridge/purl.cover.jsp?purl=/924431-kio3fU/ . Table 3 and appendices for AFUE values.

Table 3. Results of Analysis of Annual Performance with Each Unit

Unit	Description	Steady State Thermal Efficiency (%)	Idle Loss (%)	Annual Efficiency[1] (%) Oversize = 2	Annual Efficiency[1](%) Oversize = 3	Summer DHW oil use (gal) Oversize = 2	Annual Oil Use (gal)[2] Oversize =2
1	Oil, cast iron boiler with tankless	83.7	1.2	77.9	74.9	.54	897
2	Oil, cast iron boiler with indirect	78.4	2.1	72.9	65.1	.74	1007
3	Oil, steel boiler with purge control	86.5	.15	85.7	85.3	.36	816
4	Oil condensing boiler	92.0	1.5	84.2	80.3	.54	830
5	Oil, well insulated cast iron	87.5	.69	84.4	82.7	.42	828
6	Oil, water heater used also for heating	81.5	1.2	75.9	73.0	.56	921
7	Oil, combi System	79.5	.8	75.8	73.8	.51	923
8	Gas atmospheric with tankless	72.5	1.7	65.6	62.2	.72	1065
9	Gas atmospheric water heater	74.5	.65			.51	976
8+9	Gas boiler + separate gas water heater			66.6	64.7	.51	1081
10	Old cast iron boiler	72.8	2.1	64.5	60.4	.79	1085
11	Gas cond. modulating	88.5	.60	85.3	83.6	.42	819
12a	tankless mode	78.0	4.87	60.0	52.9	1.22	1165
12b	indirect mode	78.0	1.16	72.8	70.1	.57	960

1. Based on oversize factor stated, not actual firing rate tested.

[3] EERE-2012-BT-STD-0047-0012.xlsm workbook [Energy Use].

Difference Between AFUE and Steady State Efficiency			
HWGB	non,condensing	0.29	82
HWGB	90-91 AFUE	0.14	90
HWGB	92+ AFUE	-2.53	92
SGB		0.31	100
HWOB		0.89	
SOB		1.22	

		Level	Description	AFUE	Average Return Temp	AFUE_Adj	Diff Between AFUE and $Eff_{SS,M}$ (%)
		Energy Use Calculations					
1	HWGB	0	82% AFUE - Baseline	82%	150	81.4%	0.29%
2	HWGB	1	83% AFUE - Increased HX Area	83%	150	82.4%	0.29%
3	HWGB	2	84% AFUE - Increased HX Area	84%	150	83.4%	0.29%
4	HWGB	3	85% AFUE - Increased HX Area	85%	150	84.4%	0.29%
5	HWGB	4	90% AFUE - Condensing Baseline	90%	150	87.0%	0.14%
6	HWGB	5	92% AFUE - Increased HX Area	92%	150	89.0%	-2.53%
7	HWGB	6	96% AFUE - Max Tech	96%	150	93.0%	-2.53%
8	SGB	0	80% AFUE - Baseline	80%	150	80.0%	0.31%
9	SGB	1	82% AFUE - Increased HX Area	82%	150	82.0%	0.31%
10	SGB	2	83% AFUE - Max Tech	83%	150	83.0%	0.31%
11	HWOB	0	84% AFUE - Baseline	84%	150	83.4%	0.89%
12	HWOB	1	85% AFUE - Increased HX Area	85%	150	84.4%	0.89%
13	HWOB	2	86% AFUE - Increased HX Area	86%	150	85.4%	0.89%
14	HWOB	3	91% AFUE - Condensing (Max Te	91%	150	88.0%	0.89%
15	SOB	0	82% AFUE - Baseline	82%	150	82.0%	1.22%
16	SOB	1	84% AFUE - Increased HX Area	84%	150	84.0%	1.22%
17	SOB	2	85% AFUE - Increased HX Area	85%	150	85.0%	1.22%
18	SOB	3	86% AFUE - Max Tech	86%	150	86.0%	1.22%

[4] EERE-2012-BT-STD-0047-0012.xlsm in workbook [AFUE Existing] and in "TSD_NODA_Appendix_7-B_Determination_of_Boiler_Energy_Use_in_the_LCC_Analysis.pdf"; excerpts shown below.

Import Parameters	1	2	3	4	5	6
From Bldg Data	**HWGB**	**SGB**	**HWOB**	**SOB**	**HWEB**	**SEB**
Household Region	1	1	5	1	3	5
Age of Boiler (in 2009)	15	6	26	26	0	26
Intermdeiate Parameters						
Percentile (for AFUE)	86%					
AFUE for Existing Unit	83%	82%	84%	82%		
Return Temperature	150	150	150	150		
Export Parameters						
To Energy Use, Instalation Cost						
Adjusted AFUE	82%	81%	83%	81%	98%	98%

Table 7-B.2.12 summarizes the AFUE adjustments used in the analysis. The adjusted AFUE values reflect the efficiency of boilers for the fraction of households and buildings that utilize hydronic heat distribution systems which operate at return water temperatures different from 120°F.

Table 7-B.2.12 Adjustment to AFUE Based on RWT Application

	Low RWT (100°F)	Medium RWT (120°F)[1]	High RWT (150°F)
Non-Condensing	-	As Report	-0.6%
Condensing	+3%	As Report	-3%