National Appliance and Equipment Energy Efficiency Program

Analysis of Potential for Minimum Energy Performance Standards

for

Packaged Boilers

Prepared for the Australian Greenhouse Office

by

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Final Report

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Mark Ellis & Associates is a consultancy service specialising in the design, management and evaluation of sustainable energy policies and programs. MEA brings over 17 years experience in Europe and Australasia to the following areas of expertise:

- energy and greenhouse policy
- greenhouse modelling
- design of energy efficiency strategies
- implementation and management of energy efficiency programs
- energy information and advisory services
- green pricing schemes
- energy sector micro-economic reform
- low energy planning and building design
- environmental impacts of energy generation technologies and fuels

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EXECUTIVE SUMMARY

This report covers equipment used to generate hot water for domestic central heating systems and for various commercial uses, excluding:

- Industrial boilers and commercial boilers with greater than 100kW thermal output;
- Domestic and commercial water heating equipment covered by the existing minimum energy performance standard for electric storage water heaters (AS 1056.1:1991, amendment 3, 1996) and water heaters covered by the report: “Analysis of Potential for Minimum Energy Performance Standards for Miscellaneous Water Heaters” (MEA 2001);
- Instant boiling water heaters as used for providing hot beverages.

For the purposes of this report, a packaged boiler is defined as a product that uses an energy source, for example natural gas, oil or electricity, to generate hot water or steam. The term 'packaged' refers to the complete assembly of a vessel, combustion equipment, insulation, piping and controls that is factory-assembled and shipped as a single unit.

For commercial and domestic applications, packaged boilers can be classified as follows:

- Those that generate low temperature hot water (<100^{o}C) used for example in domestic central heating systems (also can be used for hot water);
- Those that produce high temperature hot water (>100^{o}C, under pressure), used for example in food processing;
- And those that generate steam for use in industrial processes.

Domestic central heating boilers are generally in the size range 4kW to 60kW for single residences and up to 350kW for multi-residential applications. Commercial units range from 50kW to 5MW.

In Australia, the great majority of packaged boilers are fired by natural gas or liquid fuel. Other energy sources include electricity, solid fuels, waste materials, etc.

The most common applications for packaged boilers in Australia include:

- Domestic central heating systems (also known as hydronic heating);
- Commercial space heating;
- Domestic hot water in multi-unit residential buildings including hotels and motels;
- Commercial and industrial hot water supply, for example to a laundry or abattoir;
- Hot water for process use; and
- Steam for industrial process heating (steam boilers are generally larger than the 100kW thermal output threshold applied in this report and are not discussed further).

Market Profile

Domestic

Domestic boilers are generally the low temperature hot water type, being almost exclusively used in central space heating applications. There is an annual market of about 6,000 units and the total stock is estimated at 90,000 units (see note).

Note: This is a very low market penetration (about 1.2% of households) compared to northern Europe. The annual replacement market in both UK and Italy exceeds 1 million units and in the UK, more than 90% of households have gas central heating boilers (Baxi, 2000).

Packaged boilers in domestic applications may also supply numbers of dwellings such as in multi-unit residential buildings, motels, etc. Some manufacturers classify this application as 'commercial' rather than 'domestic' so the estimates obtained in this section can only be regarded as approximate.

Industry sources suggest that the market for domestic packaged boilers is growing and that the majority are gas or oil fired, with no sources reporting electric units. Imported accounted for 23% of the total sales in 1999.

Commercial

The market for commercial packaged boilers in the range considered in this report is around 500 units per year, and the installed stock is estimated to be around 7,500 units. The majority are gas, oil or solid fuel fired.

Industry sources suggest the commercial market is flat or declining. Imported products accounted for approximately 24% of the total sales in 1999.

Standards

Australian Standard AS2593: 1995 specifies requirements for the design and manufacture boilers which are intended to be operated to produce steam or hot water for periods without human supervision. The Standard covers all types of fuel firing. It contains no energy performance requirements or test method.

Packaged boilers are subject to performance regulation in the EU, Canada and US. In addition, the US Energy Star program and Federal Energy Management Program cover packaged boilers.

The EU has a voluntary labelling scheme which is not widely used. The UK has introduced its own labelling scheme which is due to be withdrawn when a European directive on boiler energy labelling is introduced.

Greenhouse Emissions

Domestic Sector

Emissions have been estimated using the following assumptions:

- that most domestic boilers are used in the cooler climate areas to provide hydronic heating;
- they operate for 8 hours per day for 3 months of the year.
- average boiler capacity in the domestic sector is 18kW, average boiler efficiency is 80%.

Total gas consumption is estimated at 5.3PJ (1,500GWh/a). Estimated annual emissions are 270kt CO_2-e, or 1.8% of emissions from all water heating tasks in the domestic sector.

Commercial Sector

Most commercial applications for these boilers are assumed to have a relatively high load, since heavy users of hot water are more likely opt for specialised boilers as the most economic means of hot water production. We have therefore assumed year-round operation, 10 hours per working day.

In the size range under consideration (up to 100kW output), the average boiler output is assumed to be 75kW, with an average efficiency of 80%. For the purpose of this analysis, all boilers are assumed to be gas fired.

Total gas consumption is estimated at 6.6PJ (1,800GWh/a) and annual emissions is approximately 340 kt CO_2-e per annum, or 43% of emissions from all water heating tasks in the commercial sector (excluding water boiling for use in hot beverages).

Trends

We note the following aspects of the Australian market:

- The market is relatively small and fairly static (industry sources report the domestic market growing slowly and the commercial market flat or declining);
- The majority of units are gas fired;
- The market is hard to define and may have overlap with domestic water heaters.

Recommendations

It is estimated that the introduction of MEPS could increase average efficiency of new boilers by as much as 10% and reduce emissions by 27kt CO_2-e per year at the end of 15 years. Ultimately, applying a MEPS to boilers to increase their efficiency to this maximum practical level would mean enforcing condensing flue boilers.

The estimated potential savings due to MEPS on boilers is approximately 0.2% of total emissions due to water heating tasks in the domestic sector in this sector, and approximately 4.3% of total emissions due to water heating tasks in the commercial sector.

In our opinion, the low level of potential greenhouse saving, together with the economic impact derived from the relatively low heating requirements in Australia, does not justify initiating a specific MEPS for boilers. However, considering the overlap between boilers and water heaters, certainly in the domestic sector, an improved efficiency standard for gas water heaters could have a beneficial impact on boilers. It is proposed that this issue should be considered within the scope of the MEPS for water heaters (see MEA 2001).

In addition, a number of other approaches should be considered.

Additional Strategies

There is currently no requirement for boilers to display information relating to their efficiency, running average costs or similar, despite evidence that the star rating for gas storage water heaters appears to have caused manufacturers to improve efficiencies. Given the relatively small size of the boiler market, it is likely that the cost of establishing a mandatory labelling program would not be justified. However, since there is some overlap with water heaters, particularly in the domestic sector, a similar labelling program to that which currently operates for gas water heaters would be one means of providing consumer information.

The following recommendations are made regarding voluntary labelling schemes:

- that NAEEEC explore the application of the US Energy Star program to packaged boilers in the capacity range in question;
- that NAEEEC explore the inclusion of boilers in the labelling scheme for gas water heaters and in any extensions of that scheme, including whether the current test methodology in AG102 is appropriate;
- that information regarding the relative efficiency of different boilers is made publicly available, for example through a website such as ‘www.energyrating.gov.au’.

In view of the use of boilers in the tenanted housing sector, it is also recommended that NAEEEC explore with housing authorities and any other major landlords the development of a targeted ‘best practice’ program to encourage the use of condensing boilers.

Due to the relatively small contribution made by boilers in Australia, as a proportion of overall emissions, a financial incentive program, of the type operated by the Energy Saving Trust in the UK, is unlikely to be cost-effective. However, efficient boilers would be likely to benefit from some types of programs aimed at encouraging high efficiency water heaters.

1. PURPOSE

This report has been commissioned by the Australian Greenhouse Office as part of the National Appliance and Equipment Energy Efficiency Program (NAEEEP). Its purpose is to explore the potential for energy and greenhouse savings through the introduction in Australia of Minimum Energy Performance Standards (MEPS) for packaged boilers.

2. SCOPE

This report covers equipment used to generate hot water for domestic central heating systems and for various commercial uses.

Excluded from the scope of this report are:

- Industrial boilers and commercial boilers with greater than 100kW thermal output (to be covered in later work);
- Domestic and commercial water heating equipment covered by the existing minimum energy performance standard for electric storage water heaters (AS 1056.1:1991, amendment 3, 1996) and water heaters covered by the report: “Analysis of Potential for Minimum Energy Performance Standards for Miscellaneous Water Heaters” (MEA 2001);
- Instant boiling water heaters as used for providing hot beverages.

3. PRODUCT DESCRIPTION

3.1 General

For the purposes of this report, a packaged boiler is defined as a product that uses an energy source, for example natural gas, oil or electricity, to generate hot water or steam. The term 'packaged' refers to the complete assembly of a vessel, combustion equipment, insulation, piping and controls that is factory-assembled and shipped as a single unit.

For commercial and domestic applications, packaged boilers can be classified as follows:

- Those that generate low temperature hot water (<100^{o}C) used for example in domestic central heating systems (also can be used for hot water);
- Those that produce high temperature hot water (>100^{o}C, under pressure), used for example in food processing;
- And those that generate steam for use in industrial processes.

Domestic central heating boilers are generally in the size range 4kW to 60kW for single residences and up to 350kW for multi-residential applications. Commercial units range from 50kW to 5MW.

In Australia, the great majority of packaged boilers are fired by natural gas or liquid fuel. Other energy sources include electricity, solid fuels, waste materials, etc.

There is a wide range of boiler designs used for commercial and industrial applications. Some of the variable features include:

- Fuel type: commercial units are usually electric or gas fired and coal, gas, oil, sawdust and other waste fuels such as bagasse may be used in industrial boilers.
- Boilers may be located locally or remotely relative to the end user
- Manual or automatic control
- Water tube or fire tube, high/low fire or fully modulating
- Different number of passes depending on the application
- Have economisers and use condensate for feed

- Burner designs may be single jet, multiple jet, ring type, pilot flame, dual fuel, single pipe, two pipe. The pattern, length, swirl, number and homogeneity of flame can vary considerably and vary with air pollution limitations, and all of these factors affect efficiency and part load performance.

3.2 Applications

The most common applications for packaged boilers in Australia include:

- Domestic central heating systems (also known as hydronic heating);
- Commercial space heating;
- Domestic hot water in multi-unit residential buildings including hotels and motels;
- Commercial and industrial hot water supply, for example to a laundry or abattoir;
- Hot water for process use; and
- Steam for industrial process heating.

In Australia (in contrast to northern Europe and North America), domestic space heating in this capacity range is normally supplied by packaged reverse cycle air conditioners. There is some use of domestic hot water 'central heating' systems in the southern states of Australia but market penetration rates are an order of magnitude lower than in northern Europe.

Other uses include provision of steriliser steam, although there is a trend to hot water units and direct electric heated sterilisers rather than boilers, so this market is declining.

3.3 Types of boiler

The following Table indicates the major three types of boilers commonly used in Australia.

Table 1: Classification of Boilers

Type	Typical temperature range	Typical size range
Low temperature hot water	80 to 95^{o}C	10kW to 5,000kW
High temperature hot water	100 to 200^{o}C	50kW to 6,000kW+
Steam	150 to 250^{o}C	500kW to 50,000kW+

Steam boilers are generally larger than the 100kW thermal output threshold applied in this report and are not discussed further.

4. IDENTIFICATION OF STAKEHOLDERS

This section identifies organisations that are considered stakeholders in the types of water heaters under review. (See Appendix A for further details)

4.1 Manufacturers

There are several local manufacturers in the commercial market, including Forbes (South Australia), Thompson (Brisbane), Tomlinson and Maxitherm. These companies make packaged boilers in the range 300kW to 50,000kW.

Tomlinson and Hunt import complete package boilers, from US and Italy respectively.

Hendy (Vic) and Cambro (Vic) manufacture domestic central heating boilers. Hunt Heating is a major supplier of imported domestic central heating boilers.

It is estimated that approximately one quarter of the market for packaged boilers in the domestic and commercial sectors is met by imported products. See Section 6 for further details.

There are several dozen major manufacturers in Europe, where the domestic boiler market is very large. Significant European manufacturers include: Bosch, Baxi (which owns several other brands including Ocean and Potterton), Sime, ELM Leblanc (France), Geminox (France), Junkers (Germany),

Glow-worm (UK). Units from some of these manufacturers are imported by Australian distributors, which are often independent local plumbing and heating companies.

4.2 Trade Associations

Boiler and Pressure Vessel Association of Australia (see Appendix A for contact details).

5. MARKET PROFILE

5.1 Domestic

Domestic boilers are generally the low temperature hot water type, being almost exclusively used in central space heating applications. There is an annual market of about 6,000 units and the life expectancy of a unit is 15 to as much as 30 years. The total stock is therefore estimated at 90,000 units (see note).

Note: This is a very low market penetration (about 1.2% of households) compared to northern Europe. The annual replacement market in both UK and Italy exceeds 1 million units and in the UK, more than 90% of households have gas central heating boilers (Baxi, 2000)..

Packaged boilers in domestic applications may also supply numbers of dwellings such as in multi-unit residential buildings, motels, etc. Some manufacturers classify this application as 'commercial' rather than 'domestic' so the estimates obtained in this section can only be regarded as approximate.

Industry sources suggest that the market for domestic packaged boilers is growing slowly. Industry sources suggest that the majority are gas or oil fired, with no sources reporting electric units.

By comparison, the market in Europe is growing at 1% to 2% per annum, and "gas combination [boilers] and high performance (condensing) are the only sectors with long term growth potential" (Baxi, 2000).

5.2 Commercial

Industry information suggests that the market for commercial packaged boilers in the range considered in this report is around 500 units per year. Systems typically have a life expectancy of around 15 years and on this basis installed stock is likely to be around 7,500 units.

Industry sources suggest that the majority are gas, oil or solid fuel fired. There are some electric units and no information is readily available on what fraction of the market they represent.

Industry sources suggest the commercial market is flat or declining.

6. INDUSTRY LINKS

The majority of boiler types under review are manufactured in Australia by Australian and overseas-owned companies. The market is supplied by the companies mentioned in previous sections and by a very large number of national and local heating and plumbing companies.

As shown in the Table below, in 1999 Australia imported 1,547 boilers worth $5.9m.

Table 2: Imports of Boilers, 1999 (ABS, 2000)

Product	Quantity	Value
Watertube boiler	27	$3,475,000
Vapour generating	121	$536,000
Superheated water	7	$3,000
Central heating	1,392	$1,933,000

Total	1,547	$5,947,000

The relatively small number and large value of the watertube boiler reflects the large size of these units. The watertube boilers in the above table are likely to be for industrial uses and larger capacity than covered in this report.

Central heating boilers can be assumed to be for the domestic market. The estimated annual market is 6,000 units and therefore imports account for 23% of the total sales.

Assuming the 'vapour generating' and 'superheated water' boilers in the above table represent the commercial market, imports account for approximately 24% of the total 500 units annual sales.

7. STANDARD DEVELOPMENT

This section identifies relevant standards which apply, or may apply to the types of boilers under review in this report, and summarises their content.

7.1 Australia

Further details are contained in Appendix B.

AS2593: 1995 Boilers. Unattended and limited attendance, Amendment No. 1: 1998

7.1.1 Scope

This Standard specifies requirements for the design and manufacture boilers which are intended to be operated to produce steam or hot water for periods without human supervision. It includes special features within the control, management and supervision systems, associated valves and fittings, housing and installation, as well as, requirements and responsibilities for checking, testing and maintenance of these boilers.

The Standard covers all types of fuel firing, these are as follows:

- Gaseous fuels.
- Oil fuel with closed flashpoint greater than 23°C.
- Solid fuels, including solid-fuel-in-suspension.
- Waste heat fluids.
- Electric power.

7.1.2 Requirements and Criteria

This standard contains no energy performance requirements or test method.

7.1.3 Status

Published in 5 July 1995, Amendment 1, 5 March 1998. It is currently being redrafted by the Standards Australia/New Zealand Standard Committee ME/1, Pressure Equipment, to cover the changes within the pressure equipment industry regarding the introduction of self regulation.

7.2 Summary of overseas standards

Packaged boilers are subject to performance regulation in the EU, Canada and US. In addition, the US Energy Star program and Federal Energy Management Program cover packaged boilers.

The EU has a voluntary labelling scheme which is not widely used. The UK has introduced its own labelling scheme which "is temporary as it will be withdrawn when a European directive on boiler energy labelling is introduced" (DETR, 2000a).

It is should be noted that the climates in North America and Europe are generally significantly cooler than most parts of Australia and therefore heating loads are much higher.

Further details are contained below and in Appendices C to H.

Note: Canada and the United States differentiate between 'packaged boilers' and 'furnaces' however in Australia, products are called either boilers or water heaters, where appropriate.

In Canada and the United States:

- "warm air furnace" means a self-contained oil- or gas-fired unit designed to supply heated air through ducts to spaces that require it. This definition includes combination warm air furnace/electric air conditioning units but does not include unit heaters and duct furnaces.
- "packaged boiler" means a boiler that is shipped complete with heating equipment, mechanical draft equipment, and automatic controls; usually shipped in one or more sections.

7.2.1 Canada

The following minimum energy performance standards apply to boilers and furnaces in Canada.

Table 3: Canadian MEPS for Gas Boilers

PRODUCT CLASS	MINIMUM AFUE June 30, 1999
Low-pressure steam systems	> 75%
Hot water systems	> 80%

Where AFUE = Annual fuel utilisation efficiency

Table 4: Canadian MEPS for Oil-Fired Boilers

PRODUCT CLASS	MINIMUM SEUE December 31, 1998
< 88 kW (300 000 Btu/h)	80%

Where SEUE = Seasonal energy utilisation efficiency

Table 5: Canadian MEPS for Gas Furnaces

PRODUCT CLASS	MINIMUM AFUE	MINIMUM TE
	February 3, 1995	
> 65.92 kW (225 000 Btu/h) using single-phase electric current	78%	
> 65.92 kW (225 000 Btu/h) using three-phase electric current	78% or	80%
> 65.92 kW (225 000 Btu/h)		80%

Where AFUE = annual fuel utilisation efficiency. TE = thermal efficiency

Table 6: Canadian MEPS for Oil-Fired Furnaces

PRODUCT CLASS	MINIMUM SEUE December 31, 1998
< 66 kW (225 000 Btu/h)	> 78%

Where SEUE = Seasonal energy utilisation efficiency

Further details are provided in Appendix C.

7.2.2 United States

Commercial Boilers and Furnaces

Commercial scale boilers and furnaces have been subject to minimum energy performance standards since 1994. In January 2001 these standards have been updated with effect from October 2003. The current and future requirements are shown in the following Table.

Table 7: US MEPS for Commercial Boilers and Furnaces

Equipment Type	Category	Energy Efficiency Descriptor	Implemented after January 1, 1994	Implemented after October 29, 2003
Gas-fired Packaged Boiler	> 300,000 Btu/h	Min. Thermal Efficiency (E_t)	80%	80%
		Max. Standby Loss *		Q/800 + 110√Vr (Btu/hr)
Oil-fired Packaged Boiler	> 300,000 Btu/h	Min. Thermal Efficiency (E_t)	83%	78%
		Max. Standby Loss *		Q/800 + 110√Vr (Btu/hr)
Gas-fired Warm Air Furnace	> 225,000 Btu/h	Min. Thermal Efficiency (E_t)	80%	80%
Oil-fired Warm Air Furnace	> 225,000 Btu/h	Min. Thermal Efficiency (E_t)	80%	80%

Q = the Nameplate rating in Btu/hr.

Vr = is the rated volume in gallons.

Domestic Boilers and Furnaces

The following minimum energy performance standards apply to domestic scale boilers and furnaces in the US:

Table 8: US MEPS for Domestic Sized Boilers and Furnaces

Product class	AFUE[1] (percent)	Effective date
1. Furnaces (excluding classes noted below) (percent)	78	01/01/92
2. Mobile Home Furnaces (percent)	75	09/01/90
3. Small furnaces (other than furnaces designed solely for installation in mobile homes) having an input rate of less than 45,000 Btu/hr		
(A) Weatherized (outdoor)	78	01/01/92
(B) Non-weatherized (indoor)	78	01/01/92
4. Boilers (excluding gas steam) (percent)	80	01/01/92
5. Gas steam boilers (percent)	75	01/01/92

[1] Annual Fuel Utilisation Efficiency

Energy Star for domestic boilers and furnaces

Under the Energy Star program, domestic boilers with an AFUE of 85% or greater, and domestic furnaces with an AFUE of 90% or greater, qualify for the use of Energy Star logo.

Further details of US standards and programs are provided in Appendix D.

7.2.3 Europe

A number of European standards relate to boilers and are identified in Appendix E. EU Directive 92/42/EEC sets energy performance standards for new hot water boilers fired by liquid or gaseous fuels, as shown in the following Table. The full text of the Directive is in Appendix G.

Table 9: European Energy Efficiency Boiler Requirements

Type of boiler	Range of power output	Efficiency at rated output		Efficiency at partload	
	KW	Average boiler-water temperature (in ^{o}C)	Efficiency requirement expressed (in %)	Average boiler-water temperature (in ^{o}C)	Efficiency requirement expressed (in %)

Standard boilers	4 to 400	70	> 84 + 2 logPn	> 50	> 80 + 3 logPn
Low temperature boilers (*)	4 to 400	70	> 87,5 + 1,5 logPn	40	> 87,5 + 1,5 logPn
Gas condensing boilers	4 to 400	70	> 91 + 1 logPn	30 (**)	97 + 1 logPn

No legislation is currently in place in the EU requiring boiler manufacturers to provide an energy label. A voluntary scheme, known as star rating, is defined in the European Boiler Efficiency Directive. In this scheme ratings boilers are awarded a number of stars according to their measured full-load efficiency, part-load efficiency, and power. Standard boilers are mainly 1-star or 2-star rated whereas condensing boilers may be 3-star, 4-star or 5-star. Legislation provides the necessary protection against improper use. However, the star rating scheme is little used in practice, and the European Commission has recognised its unpopularity and is now developing an alternative.

Meanwhile a temporary scheme to define energy efficiency bands on an "A" to "G" scale has been developed in the UK. It was included within the consultation exercise held by the government in June 1999 to ascertain the type of boiler efficiency information required by consumers. The scheme is based on measured 'Seasonal Efficiency of Domestic Boilers in the UK' ("SEDBUK") efficiency figures and is included with other data in the boiler efficiency database published by DETR under the Energy Efficiency Best Practice Programme (DETR, 2000a). An outline of the labelling scheme is given in Appendix H.

8. GREENHOUSE EMISSIONS

8.1 Total Sector Emissions for Hot Water

8.1.1 Domestic Sector

Emissions due to water heating in the domestic sector are about 15.2 Mt CO_2-e in 1999/2000 [EES 1999] – although this figure includes only water heaters, it is likely that the water heating component of many domestic boilers is included. Any addition emissions due to boilers will be small.

8.1.2 Commercial Sector

Emissions due to water heating in the commercial sector are about 0.79 Mt CO_2-e in 1999/2000. This is 52% of emissions estimated from water heating and cooking [derived from EMET & Solarch 1999].

8.2 Total Emissions for Packaged Boilers

8.2.1 Domestic Sector

Emissions have been estimated using the market and stock data presented in Section 4. To determine energy consumption, average annual operating hours have been estimated, as well as average boiler capacity and efficiency.

It is assumed that the majority of domestic boilers are used in the cooler climate areas to provide hydronic heating, and they do this for 8 hours per day for 3 months of the year.

Average boiler capacity in the domestic sector is assumed to be 18kW, based on industry sources and data from the UK (see note). Average boiler efficiency is assumed to be 80%, again based on industry sources. The firing fuel is assumed to be natural gas.

Note: The generally accepted range of power ratings of boilers for domestic use is 4kW to 60kW, and the majority of those installed lie in the range 12kW to 24kW

Total gas consumption is estimated at 5.3PJ (1,500GWh/a). Estimated annual emissions are 270kt CO_2-e, or 1.8% of emissions from all water heating tasks in the domestic sector.

8.2.2 Commercial Sector

Emissions from boilers in the commercial sector have been estimated using a similar methodology as above.

Most commercial applications for these boilers are assumed to have a relatively high load, since heavy users of hot water are more likely opt for specialised boilers as the most economic means of hot water production. We have therefore assumed year-round operation, 10 hours per working day.

In the size range under consideration (up to 100kW output), the average boiler output is assumed to be 75kW. The average efficiency is assumed to be 80% as for domestic boilers.

According to industry sources, most commercial boilers are gas fired. No data are available on what fraction of the total may be fired by other fuels and for the purpose of this analysis, all boilers are assumed to be gas fired.

Total gas consumption is estimated at 6.6PJ (1,800GWh/a) and annual emissions is approximately 340 kt CO_2-e per annum, or 43% of emissions from all water heating tasks in the commercial sector (excluding water boiling for use in hot beverages).

Table 10: Estimated Annual Greenhouse Emissions from Boilers, 2000

Emissions	Domestic	Commercial
Kt/annum	273	337

9. ENERGY EFFICIENCY ISSUES

9.1 Areas of Improvement

9.1.1 Boiler

There are a number of general areas where improvements can be made to the efficiency of packaged boilers including:

- Recovering heat that would otherwise be lost through hot flue gas;
- Standby losses due to pilot lights in some gas systems;
- Reduction of heat losses: from all boiler pipes and surfaces;
- Reduction of heat losses due to the design of pressure and temperature valves;
- Burner efficiency;
- Set-up and maintenance in gas and oil systems. For example, the air/fuel ratio has a major impact on energy efficiency. Poor set-up and/or maintenance can result less efficient, off-design operation.
- Heat exchanger design.

9.1.2 Related systems

Other factors affecting the efficiency of the system, but not directly associated with the boiler technology, include:

- Heat losses from pipes connecting the boiler to the point of use.
- The location of installed product, ie. Where it is in relation to the point of use so as to minimise heat losses from pipe runs.
- Efficiency is also strongly influenced by peripheral issues including controls for the whole system. Common causes of poor efficiency are poor matching of boiler capacity with load and poor steam system design and maintenance. Efficiency can be also reduced by poor maintenance, commissioning or modifications.

9.2 Means of Improvement

9.2.1 Condensing flues

The overall boiler efficiency can be increased significantly if the flue gas is cooled below its dew point, that is below the temperature at which water contained in it condenses and releases its latent heat of vaporisation. Such a boiler is known as a condensing boiler. Condensing boilers have a higher efficiency than conventional, non-condensing types partly due to the recovery of the latent heat in the exhaust but also because they tend to have larger heat exchanger areas and operate with a higher efficiency even in 'non-condensing' mode.

9.2.2 Reducing Heat Losses

While heat losses are more significant in determining the efficiency of storage water heaters, boilers also contain insulated components. Using higher levels of insulation, achieved either by increasing the thickness of insulation used or by using a material with a high insulation value, increases the overall efficiency.

As is the case with storage water heaters, heat losses also occur due to temperature 'bridges' through insulation, primarily as a result of temperature and/or pressure release valves. These are usually made of brass and have high thermal conductivity, resulting in the transfer of heat from the tank to the external environment.

9.2.3 Location

The correct positioning of boiler systems can reduce pipe runs and thereby cut heat losses through pipes. However, in many cases the options for suitable locations are limited due to available space and building openings, etc. In addition, in the case of retrofits, installation is considerably easier if the existing connections are used.

9,2,4 Boiler design

Basic design parameters, such as the specification of the heat exchanger and the burner in a boiler, can have a significant effect on efficiency.

There has been considerable development effort in the areas of burners in recent years with the growing need for low NO_x designs.

9.2.5 Effect of improvements

The impact of the various measures described in this section is that currently available boilers have a wide range of efficiencies. These are illustrated in the UK's 'Boiler Efficiency Database' (DETR, 2000a), which shows conventional (non-condensing) boilers having a 'Seasonal Efficiency' in the range 68.1% to 82.1%. The best condensing boiler has a 'Seasonal Efficiency' of 91.3%.

10. APPROPRIATE MEPS FOR AUSTRALIA

10.1 Discussion of Trends

As part of the discussion regarding the appropriateness of MEPS for package boilers, it is important to understand a number of aspects of the Australian market. These are summarised as follows:

- The market is relatively small and fairly static (industry sources report the domestic market growing slowly and the commercial market flat or declining);
- The majority of units are gas fired;
- The market is hard to define and may have overlap with domestic water heaters.

10.2 Recommendations

MEPS could be introduced for all kinds of packaged boilers based on a minimum thermal efficiency level, which would need to be defined. The basis of the thermal efficiency calculation could follow the 'Seasonal Efficiency' model (used for example by UK and Canada) or the 'Thermal Efficiency' model (used by Canada and the US).

It is estimated that the introduction of MEPS could increase average efficiency of new boilers by as much as 10% and reduce emissions by 27kt CO_2-e per year at the end of 15 years. Ultimately,

applying a MEPS to boilers to increase their efficiency to this maximum practical level would mean enforcing condensing flue boilers. Most applications in the domestic and commercial markets would be suitable for condensing boilers. In the UK it is estimated that 95% of domestic central heating boilers could be replaced with condensing flue boilers (DETR, 2000b).

In the domestic sector, the estimated potential savings due to MEPS on boilers is approximately 0.2% of total emissions due to water heating tasks in this sector. See table below.

Table 11: Boiler Emissions and Potential Savings as a proportion of Total Task Emissions, Domestic Sector

Residual Boiler Emissions	1.6%
MEPS Savings Potential	0.2%
Total Task Emissions	98.2%

In the commercial sector, the estimated potential savings due to MEPS on boilers is approximately 4.3% of total emissions due to water heating tasks in this sector. See table below.

Table 12: Boiler Emissions and Potential Savings as a proportion of Total Task Emissions, Commercial Sector

Residual Boiler Emissions	38.8%
MEPS Savings Potential	4.3%
Total Task Emissions	57.4%

However, such an approach would have economic implications because of the relatively low heating requirements in Australia and the long payback times, as a condensing boiler costs significantly more than a standard one (see following section).

In our opinion, the low level of potential greenhouse saving does not justify initiating a specific MEPS for boilers. However, considering the overlap between boilers and water heaters, certainly in the domestic sector, an improved efficiency standard for gas water heaters could have a beneficial impact on boilers. It is proposed that this issue should be considered within the scope of the MEPS for water heaters (see MEA 2001).

In addition, a number of other approaches should be considered.

10.3 Other Programs

10.3.1 Information Programs

There is currently no requirement for boilers to display information relating to their efficiency, running average costs or similar. For gas water heaters (which are subject to an industry labelling scheme), a recent evaluation of the effectiveness of the program by George Wilkenfeld and Associates suggests that some improvement in the overall efficiency of gas water heaters has occurred between 1987 and the current time. The presence of star rating for gas storage appliances appears to have caused manufacturers to improve efficiencies to achieve the next whole star rating, where this is within reach [GWA, 2000]. This suggests that some form of labelling program may be suitable for boilers.

Given the relatively small size of the boiler market, it is likely that the cost of establishing a mandatory labelling program would not be justified. However, since there is some overlap with water heaters, particularly in the domestic sector, a similar labelling program to that which currently operates for gas water heaters would be one means of providing consumer information.

The following recommendations are made regarding voluntary labelling schemes:

- that NAEEEC explore the application of the US Energy Star program to packaged boilers in the capacity range in question;
- that NAEEEC explore the inclusion of boilers in the labelling scheme for gas water heaters and in any extensions of that scheme, including whether the current test methodology in AG102 is appropriate;
- that information regarding the relative efficiency of different boilers is made publicly available, for example through a website such as ‘www.energyrating.gov.au’.

10.3.2 Targeting Housing Authority Properties

As mentioned previously, multi-unit residential buildings represent a substantial proportion of the boiler market. Some of this is the tenanted sector owned by housing authorities and private landlords. Although investment in energy efficiency in this sector is hindered by 'split incentives', overseas experience has demonstrated that landlords can benefit considerably through increased occupation, prompt payment of rents, reduced maintenance and, in some cases, rent increases [DOE, 1993].

It is therefore recommended that NAEEEC explore with housing authorities and any other major landlords the development of a targeted 'best practice' program to encourage the use of condensing boilers.

10.3.3 Financial Programs

In the UK, the Energy Saving Trust has operated an incentive program to encourage purchase of condensing boilers since 1993 (see Appendix F). This has proved highly effective in raising sales levels and reducing the capital costs.

Due to the relatively small contribution made by boilers in Australia, as a proportion of overall emissions, a similar program is unlikely to be cost-effective. However, efficient boilers would be likely to benefit from some types of programs aimed at encouraging high efficiency water heaters.

11 ECONOMIC IMPLICATIONS

Using the earlier estimates for utilisation of a domestic central heating boiler in Australia, the annual energy saving per boiler from switching from an 80% efficient conventional boiler to a 90% efficient condensing boiler would be about 1,600kWh/a. At a residential gas price of 3.6c/kWh, the financial saving would be $60 per year. In the UK, the price differential between a conventional boiler and a condensing boiler is around £300 (see Appendix F) or about $750.

The simple payback for the additional capital cost of a condensing boiler in Australia would therefore be over 10 years. There is thus little incentive for consumers to pay the additional capital required for a condensing boiler.

REFERENCES

ABS, 2000 — Import data.

DETR, 2000a — *Boiler Efficiency Database*, at www.sedbuk.com

DETR, 2000b — *Boilers for domestic space heating and hot water in the United Kingdom*, at www.mtprog.com

DOE, 1999 — *Benefits to the Landlord on Energy Efficient Housing*. Best Practice Case Studies 186 & 187. Published by UK Energy Efficiency Office. In addition see the following Case Studies: 65, 168, 177, 180, 190, 193, 195, 201, 203, 204, 205, 235, 239, 249.

EES, 1999 — *Australian Residential Building Sector Greenhouse Gas Emissions 1990-2010*. Published by the Australian Greenhouse Office, 1999.

Ellis, 1998 — *Finance for Energy Efficiency*. Scoping Study for NSW SEDA, October 1998.

EMET & Solarch, 1999 — *Australian Commercial Building Sector Greenhouse Gas Emissions 1990-2010*. Published by the Australian Greenhouse Office, 1999.

EST 1994 — *Condensing Boiler Program, evaluation of first year pilot scheme and option appraisal*. Energy Saving Trust, London.

EST 1998 — *Partnerships that Work for a Better Future: Review of 1997/98 and Workplan for 1998/99.* Energy Saving Trust, London.

GWA 1993 — *Benefits and Costs of Implementing Minimum Energy Performance Standards for Household Electrical Appliances in Australia*. George Wilkenfeld & Associates. July 1993.

GWA, 2000 *Energy Labelling of Gas Water Heaters: Maximising the Potential Benefits*. Draft Report to the Australian Greenhouse Office by George Wilkenfeld and Associates, Sydney. March 2000

MEA 2001 *Analysis of Potential for Minimum Energy Performance Standards for Miscellaneous Water Heaters*. Mark Ellis & Associates. Final Report, March 2001.

APPENDIX A: MAILING LIST OF INTERESTED PARTIES

A.1 Organizations

A1.1 Australian Aluminium Council

Executive Director, P.O. Box 63, Dickson ACT 2602

A.1.2 Australian Corrosion Association,

Executive Officer, PO Box 5142, Clayton, Vic 3168

A.1.3 Australian Building Codes Board,

Project Manager, Code and Regulation Development, G.P.O. Box 9839, Sydney NSW 2001

A.1.4 Australian Chamber of Commerce and Industry

Commercial Manager, P.O. Box E14, Kingston ACT 2604

A.1.5 Australian Electrical and Electronic Manufacturers Association (AEEMA)

Contact: Mark Amos, Level 1, Lonsdale Street, Braddon ACT 2601

Phone: 02 6247 4655 Facsimile: 02 6247 9840

A.1.6 Australian Gas Association

National Office. 7 Moore Street, Canberra ACT 2601

Phone: 02 6247 3955 Facsimile: 02 6272 1566

A.1.7 Australian Greenhouse Office

John Gorton Building, GPO Box 621, Canberra ACT 2601

Phone: 02 6274 1888 Facsimile: 02 6274 1795

A.1.8 Australian Industry Group

Contact: National Manager Trade Policy, GPO Box 817, Canberra ACT 2601

A.1.9 Australian Institute of Engineer Surveyors

The President, P.O. Box 1092, Lane Cove NSW 1595

A.1.10 Australian Institute of Energy

The Secretary, P.O. Box 230, Wahroonga NSW 2076

A.1.11 Australian Institute of Petroleum

Manager Engineering, Level 23, 500 Collins Street, Melbourne Vic 3000

A.1.11 Boiler and Pressure Vessel Manufacturers Association of Australia

The Secretary, 380 St Kilda Rd. St Kilda Melbourne Vic 3004.

Ian Binger. Tel: 03 9280 0111

A.1.12 Bureau of Steel Manufacturers of Australia

The Secretary, P.O. Box 431, Five Dock NSW 2046

A.1.13 Electricity Engineers New Zealand

Executive Director, P.O. Box 5324. Wellington 6015 New Zealand

A.1.14 Electricity Supply Association of Australia

Assistant Director Technical, P.O. Box A2492, South Sydney NSW 1235

A.1.15 Institute of Materials Engineering Australasia

Chief Executive Officer, Suite 205, 21 Bedford Street, North Melbourne Vic 3051

A.1.16 Institution of Engineers, Australia

Policy Analyst (Engineering), Engineering House, 11 National Circuit, Barton ACT 2600

A.1.17 Institute of Hospital Engineering Australia

Federal Secretary, P.O. Box 1405, Port Macquarie NSW 2444

A.1.18 Institution of Professional Engineers, New Zealand

The Secretary, P.O. Box 12241, Thorndon, Wellington. NEW ZEALAND

A.1.19 National Association of Testing Authorities, Australia

The Director, 7 Leeds Street, Rhodes NSW 2138

A.1.20 New Zealand Engineering Federation

The Secretary, P.O. Box 11543, Wellington, NEW ZEALAND

A.1.21 New Zealand Heavy Engineering Research Association

The Information Manager, P.O. Box 76-134, Manukau City, NEW ZEALAND

A.1.22 New Zealand Institute of Welding

The Secretary, Wellington, NEW ZEALAND

A.1.23 New Zealand Petrochemical Users Group

The Secretary, Wellington NEW ZEALAND

A.1.24 New Zealand Timber Industry Federation

The Secretary. P.O. Box 308, Wellington, NEW ZEALAND

A.1.15 Welding Technology Institute of Australia

The Secretary, P.O. Box 6165, Silverwater NSW 2128

A.2 Manufacturers

A.2.1 Clyde Babcock Hitachi

P.O. Box 1559, Milton Qld 4064

A.2.2 Forbes Australia

Mr Peter Forbes, Port Road, West Croydon SA 5008

Tel: (08) 8268 8877599

A.3.3 Hunt Engineering Pty Ltd (Boiler Division)

Mr Garry Anderson, 8 Redwood Drive, Dingley VIC 3172

Tel: (03) 9558 7077

A.2.4 John Thompson Package Boilers

73 Industrial Avenue, WACOL Qld 4076

A.2.5 Knapp Lewer Pty Ltd

P.O. Box 238, Moonah Tas 7009

A.2.6 Maxitherm Boilers Pty Ltd

Mr Allan Millward, (sales) or Mr John Truscott, (technical), 329 Horsley Road, Milperra NSW 2214

Tel: (02) 9792 1011, or (03) 9357 9888

A.2.7 Tomlinson Boilers Pty Ltd

Mr Robert Hockley, 81 Warren Road, Smithfield NSW 2164

Tel: (03) 9416 8544

A.3 Regulators

These regulators consider the health and safety aspects of pressure equipment. Consideration of energy conservation in pressure equipment may be beyond their scope of operation.

A.3.1 Occupational Health & Safety Inspectorate

WorkCover ACT, P.O. Box 224, Civic Square ACT 2608

A.3.2 Workplace Health and Safety

Department of Employment, Training and Industrial Relations, GPO Box 4160, Brisbane Qld 4001

A.3.3 Department of Industries and Business

GPO Box 4160, Darwin NT 0801

A.3.4 Department of Infrastructure, Energy and Resources

P.O. Box 56, Rosny Park Tas 7018

A.3.5 Occupational Safety and Health

Department of Labour New Zealand, P.O. Box 3705, Wellington 6015, NEW ZEALAND

A.3.6 Victorian WorkCover Authority

(Engineering Unit), GPO Box 4306, Melbourne VIC 3001

A.3.7 WorkCover NSW

(Boiler and Pressure Vessel Branch), GPO Box 5364. Sydney NSW 2001

A.3.8 WorkSafe Western Australia

Construction and Engineering, P.O. Box 294. West Perth WA 6872

A.3.9 AGL Gas Company (NSW) Ltd

P.O. Box 944. North Sydney NSW 2059

A.4 Testing Interests

The most likely source of Testing Laboratory interest would be those typical of commercial refrigerators and through certification bodies such as:

A.4.1 QAS

1 The Crescent, Homebush NSW 2150, Sydney Australia

Toll Free: 1300 360 314, Phone: (612) 97464900, Fax: (612) 9746 8460

Email: customerservice@qas.com.au

A.4.2 NATA

7 Leeds Street, Rhodes NSW 2138,

Ph: +61 2 9736 8222 Fax: +16 9743 5311

APPENDIX B: AUSTRALIAN STANDARDS

This Appendix identifies relevant standards which apply, or may apply to the types of boilers under review in this report.

B.1 AS2593: 1995 Boilers. Unattended and limited attendance, Amendment No. 1: 1998

B.1.1 Scope

This Standard specifies requirements for the design and manufacture of unattended and limited attendance boilers which are intended to be operated to produce steam or hot water for periods without human supervision. It includes special features within the control, management and supervision systems, associated valves and fittings, housing and installation, as well as, requirements and responsibilities for checking, testing and maintenance of these boilers.

B.1.2 Summary

The boilers covered by this Standard are fixed land installations and limitations are given regarding pressure and power output, together with design types.

Water-tube, fire-tube, electrically heater and small boilers with specified design pressure and output criteria are designated as unattended boiler design. Whilst any type of boiler may be used as a limited attendance boiler, again with pressure and power output limitations.

The Standard covers all types of fuel firing, these are as follows:

- Gaseous fuels.
- Oil fuel with closed flashpoint greater than 23°C.
- Solid fuels, including solid-fuel-in-suspension.
- Waste heat fluids.
- Electric power.

The Standard is complete with details of installation, commissioning and maintenance regimes for the boilers, together with description of personnel to carry out these tasks. It shows a table details of power output limitation coupled with maximum permissible pressure, it does not refer to efficiencies directly, but no doubt power inputs could be referenced to enable minimum efficiencies to be attained.

B.1.3 Status

Published in 5 July 1995, Amendment 1, 5 March 1998. This Standard was prepared by the Standards Australia/New Zealand Standard ME/1 Committee, Pressure Equipment to supersede the original Standard published in 1990. The 1990 edition was the result of requests from the pressure equipment industry associations, manufacturers and the regulatory authorities for a safe practical Standard on this power plant area to enable safe economies to be achieved in various industrial processes. The boiler product Standard AS 1228—1997 is referenced in this Standard.

It is currently being redrafted by the Standards Australia/New Zealand Standard Committee ME/1, Pressure Equipment, to cover the changes within the pressure equipment industry regarding the introduction of self regulation.

APPENDIX C: CANADIAN STANDARDS

C.1 Gas boilers

C.1.1 Scope

Self-contained gas-fired boilers that use propane or natural gas, are intended for use in a low-pressure steam or hot water central heating system, and have an input rate of less than 88 kilowatts (300 000 Btu/h).

C.1.2 Compliance Date

December 31, 1998

For verification mark – June 30, 1999

C.1.3 Criteria and Requirements

TableC1: Canadian MEPS for Gas Boilers

PRODUCT CLASS	MINIMUM AFUE June 30, 1999
Low-pressure steam systems	> 75%
Hot water systems	> 80%

Where AFUE = Annual fuel utilization efficiency

C.1.4 Test Standard

CGA P.2-1991

C.1.5 Requirements for the energy efficiency report

- type of product (gas boiler);
- brand name;
- model number;
- manufacturer;
- name of the organization or province that carried out the boiler verification and authorized the verification mark that will be affixed to the boiler;
- type of fuel used by the product (propane or natural gas);
- type of boiler system (low-pressure steam or hot water);
- input rate in kW (Btu/h); and
- annual fuel utilization efficiency.

C.2 Oil-fired boilers

C.2.1 Scope

Oil-fired boilers that are intended for use in a low-pressure steam or hot water central heating system and have an input rate of less than or equal to 88 kilowatts (300 000 Btu/h).

C.2.2 Test Standard

CAN/CSA-B212-M93

C.2.3 Compliance Date

December 31, 1998

For verification mark – June 30, 1999

C.2.4 Criteria and Requirements

Table C2: Canadian MEPS for Oil-Fired Boilers

PRODUCT CLASS	MINIMUM SEUE December 31, 1998
< 88 kW (300 000 Btu/h)	[3] 80%

Where SEUE = Seasonal energy utilization efficiency

C.2.5 Requirements for the energy efficiency report

- type of product (oil-fired boiler);
- brand name;
- model number;
- manufacturer;
- name of the organization or province that carried out the boiler verification and authorized the verification mark that will be affixed to the boiler;
- input rate in kW (Btu/h); and
- seasonal energy utilization efficiency.

C.3 Gas Furnaces

C.3.1 Scope

Automatic operating gas-fired central forced-air furnaces that use propane or natural gas and have an input of not more than 117.23 kW (400 000 Btu/h), but does not include furnaces for mobile homes or recreational vehicles.

C.3.2 Test Standard

CAN/CGA-2.3-M93

C.3.3 Compliance Date

February 3, 1995

C.3.4 Criteria and Requirements

Table C3: Canadian MEPS for Gas Furnaces

PRODUCT CLASS	MINIMUM AFUE	MINIMUM TE
	February 3, 1995	
> 65.92 kW (225 000 Btu/h) using single-phase electric current	78%	
> 65.92 kW (225 000 Btu/h) using three-phase electric current	78% or	80%
> 65.92 kW (225 000 Btu/h)		80%

Where AFUE = annual fuel utilization efficiency. TE = thermal efficiency

C.3.5 Requirements for the energy efficiency report

- type of product (residential gas furnace);
- brand name;
- model number;
- manufacturer;
- name of the organization or province that carried out the furnace verification and authorized the verification mark that will be affixed to the furnace;
- heating capacity;
- either the annual fuel utilization efficiency or the thermal efficiency; and
- whether the furnace configuration is upflow, downflow, horizontal or lowboy.

C.4 Oil-fired furnaces

C.4.1 Scope

Oil-fired warm-air furnaces, other than furnaces for mobile homes or recreational vehicles, that have an input rate of less than or equal to 66 kilowatts (225 000 Btu/h).

C.4.2 Test Standard

CAN/CSA-B212-M93

C.4.3 Compliance Date

December 31, 1998

C.4.4 Criteria and Requirements

Table C4: Canadian MEPS for Oil-Fired Furnaces

PRODUCT CLASS	MINIMUM SEUE December 31, 1998
< 66 kW (225 000 Btu/h)	> 78%

Where SEUE = Seasonal energy utilization efficiency

C.4.5 Requirements for the energy efficiency report

- type of product (oil-fired furnace);
- brand name;
- model number;
- manufacturer;
- name of the organization or province that carried out the furnace verification and authorized the verification mark that will be affixed to the furnace;
- input rate in kWh (Btu/h); and
- seasonal energy utilization efficiency.

APPENDIX D: US STANDARDS

Boilers in the United States are typically classified as shown in Table D1 below.

Table D1: Classification of US Boilers

Gross Output Capacity	Boiler Classification
< 0.3 million Btu/h	Residential
0.3 - 10 million Btu/h	Commercial
> 10 million Btu/h	Commercial / Industrial

Further definitions used in US standards include:

Electric boiler means an electrically powered furnace designed to supply low pressure steam or hot water for space heating application. A low pressure steam boiler operates at or below 15 pounds per square inch gauge (psig) steam pressure; a hot water boiler operates at or below 160 psig water pressure and 250° F. water temperature.

Electric central furnace means a furnace designed to supply heat through a system of ducts with air as the heating medium, in which heat is generated by one or more electric resistance heating elements and the heated air is circulated by means of a fan or blower.

Furnace means a product which utilizes only single-phase electric current, or single-phase electric current or DC current in conjunction with natural gas, propane, or home heating oil, and which:

(a) Is designed to be the principal heating source for the living space of a residence;

(b) Is not contained within the same cabinet with a central air conditioner whose rated cooling capacity is above 65,000 Btu per hour;

(c) Is an electric central furnace, electric boiler, forced-air central furnace, gravity central furnace, or low pressure steam or hot water boiler; and

(d) Has a heat input rate of less than 300,000 Btu per hour for electric boilers and low pressure steam or hot water boilers and less than 225,000 Btu per hour for forced-air central furnaces, gravity central furnaces, and electric central furnaces, gravity central furnaces, and electric central furnaces.

Gravity central furnace means a gas fueled furnace which depends primarily on natural convection for circulation of heated air and which is designed to be used in conjunction with a system of ducts.

Outdoor furnace or boiler is a furnace or boiler normally intended for installation out-of-doors or in an unheated space (such as an attic or a crawl space).

Vented wall furnace means a self-contained vented heater complete with grilles or the equivalent, designed for incorporation in, or permanent attachment to, a wall of a residence and furnishing heated air circulated by gravity or by a fan directly into the space to be heated through openings in the casing.

Relevant standards and other programs for residential and commercial boilers in the United States are described below.

D.1 Commercial Boilers and Warm-Air Furnaces

D.1.1 Criteria and Requirements

Commercial sized boilers and warm-air furnaces have been covered by standards since the 1992 Energy Policy and Conservation Act (EPCA).

The term "warm air furnace" means a self-contained oil- or gas-fired furnace designed to supply heated air through ducts to spaces that require it and includes combination warm air furnace/electric air conditioning units but does not include unit heaters and duct furnaces. The term "packaged boiler" means a boiler that is shipped complete with heating equipment, mechanical draft equipment, and automatic controls; usually shipped in one or more sections.

On January 12, 2001, the Department of Energy announced amendments to Rule CFR Part 431of the EPCA, with regard to some categories of commercial boilers, for implementation from the October 29, 2003.

The two standards are shown in the following Table.

Table D2: US MEPS Level for Commercial Boilers

Equipment Type	Category	Energy Efficiency Descriptor	EPCA Act 1992	CFR 431
			Implemented after January 1, 1994	Implemented after October 29, 2003
Gas-fired Packaged Boiler	> 300,000 Btu/h	Min. Thermal Efficiency (E_t)	80%	80%
		Max. Standby Loss *		Q/800 + 110√Vr (Btu/hr)
Oil-fired Packaged Boiler	> 300,000 Btu/h	Min. Thermal Efficiency (E_t)	83%	78%
		Max. Standby Loss *		Q/800 + 110√Vr (Btu/hr)
Gas-fired Warm Air Furnace	> 225,000 Btu/h	Min. Thermal Efficiency (E_t)	80%	80%
Oil-fired Warm Air Furnace	> 225,000 Btu/h	Min. Thermal Efficiency (E_t)	80%	80%

E_t = Thermal efficiency is the boiler's energy output divided by energy input, as defined by ANSI Z21.13. In contrast to combustion efficiency (E c), E_t accounts for radiation and convection losses through the boiler's shell.

Q = the Nameplate rating in Btu/hr.

Vr = is the rated volume in gallons.

- Hot water supply boilers having more than 140 gallons of storage capacity are not required to meet the standby loss requirement if the tank surface is thermally insulated to R 12.5, and if a standing pilot light is not installed.

D.1.2 Test Standard

The EPCA 1992 specified ASHRAE/IES Standard 90.1 as the prescribed test standard. This standard was revised in 1999. It is presumed that CFR 431 does not alter the test standard.

D.2 Residential Boilers and Warm-Air Furnaces

D.2.1 Criteria and Requirements

Standards for residential boilers and warm-air furnaces are contained in Code of Federal Regulations (CFR 430), under the EPCA 1992, as shown in the following Table.

Table D3: US MEPS for Domestic Sized Boilers and Furnaces (CFR 430)

Product class	AFUE [1] (percent)	Effective date
1. Furnaces (excluding classes noted below) (percent)	78	01/01/92
2. Mobile Home Furnaces (percent)	75	09/01/90
3. Small furnaces (other than furnaces designed solely for installation in mobile homes) having an input rate of less than 45,000 Btu/hr		
(A) Weatherized (outdoor)	78	01/01/92
(B) Non-weatherized (indoor)	78	01/01/92
4. Boilers (excluding gas steam) (percent)	80	01/01/92
5. Gas steam boilers (percent)	75	01/01/92

[1] Annual Fuel Utilization Efficiency, as determined in § 430.22(n)(2) of this part.

D.2.2 Test Standard

The Test Standard is contained in Appendix N of CFR 430.

D.2.3 Labelling rules

Residential boilers and warm-air furnaces are covered by an energy labelling requirement in the United States, under CFR430. A description of the label and information requirements is included in Appendix G1-G8.

D.2 Federal Energy Management Program (FEMP)

In recognition of the purchasing power of the Federal US government, the FEMP sets specification guidelines for Agencies buying boilers. Agencies are required to specify products which at least match the recommended efficiency levels shown in the following Table.

Table D4: US FEMP Boiler Efficiency Recommendations

Product Type (Fuel / Heat Medium)	Rated Capacity (Btu/h)	Recommended Thermal Efficiency	Best Available Thermal Efficiency
Natural Gas / Water	300,000 - 2,500,000	80% E t	86.7% E t
	2,500,001 - 10,000,000	80% E t	83.2% E t
Natural Gas / Steam	300,000 - 2,500,000	79% E t	81.9% E t
	2,500,001 - 10,000,000	80% E t	81.2% E t
#2 Oil / Water	300,000 - 2,500,000	83% E t	87.7% E t
	2,500,001 - 10,000,000	83% E t	85.5% E t
#2 Oil / Steam	300,000 - 2,500,000	83% E t	83.9% E t
	2,500,001 - 10,000,000	83% E t	84.2% E t

Thermal efficiency (E t), also known as "boiler efficiency" or "overall efficiency," is the boiler's energy output divided by energy input, as defined by ANSI Z21.13. In contrast to combustion efficiency (E c), E t accounts for radiation and convection losses through the boiler's shell.

D.4 Energy Star

To qualify for an energy star label, vendors must agree to sell one or more products that meet the energy efficiency requirements contained in the following Table.

Table D5: Energy Star Requirements for Residential Products

Product Type	Size	AFUE Requirement
Gas or Oil-fired Boilers	< 300,000 Btu/h	Greater of equal to 85%
Gas or Oil-fired Furnace	< 225,000 Btu/h	Greater or equal to 90%

D.5 ACEEE Top-Rated Energy Efficiency Appliances

The American Council for an Energy Efficient Economy (ACEEE) publishes a list of new gas and oil-fired boilers and furnaces, within categories by heating capacity. The list identifies top performing products within each category and lists their corresponding AFUE. This list was updated in December 2000.

APPENDIX E: EUROPEAN STANDARDS

Domestic gas and/or liquid fuel boilers with a rated power of from 4 kW to 400kW are subject to MEPS under Directive 92/42/EC.

Others boiler types are not subject to any efficiency requirements at the EU level but do have some requirements at Member State level.

The following British and European Standards cover the various designs of packaged hot water boiler and are mainly of the welded steel or cast iron sectional boilers

BS EN 197: 1994. Gas fired central heating boilers: Types B_{11} and B_{11BS} fitted with atmospheric burners of nominal heat input not exceeding 70 kW.

BS EN 483: 2000. Gas fired central heating boilers: Type C boilers of nominal heat input not exceeding 70 kW.

BS EN 656: 2000. Gas fired central heating boilers: Type B boilers of nominal heat input exceeding 70 kW, but not exceeding 300 kW.

BS EN 677: 1998. Gas fired central heating boilers: Specific requirements for condensing boilers with a nominal heat input not exceeding 70 kW.

BS 799: 1998: Cast iron boilers for central heating and indirect hot water supply (rated output 44 kW and above).

BS 855: 1990: Welded steel boilers for central heating and indirect hot water supply (rated output 44 kW to 3 MW).

APPENDIX F: UK CONDENSING BOILER PROGRAM [EST 1994] [EST 1998]

In the UK, condensing boilers save up to 20% of energy consumed in a modern heating/hot water boiler, and up to 30% compared to older style models. The major barriers associated with condensing boilers have been the high capital cost (up to £400 higher than conventional), lack of awareness and technical risk associated with a 'new' technology.

In May 1993, the Energy Saving Trust (EST) commenced a pilot program to promote condensing boilers.

The mechanism used was a widely promoted £200 rebate for owner-occupiers. Annual sales of condensing boilers to this sector were originally around 2,500. In the first 10 months of the program, 5,200 rebates were issued, with monthly sales rising to 1,000 towards the end of this period.

In assessing the performance of the this pilot, the EST noted that increased demand resulting from the program (10 months) had led to a reduction in the price differential of £310 compared to the average boiler. The program was well supported by the industry/trade, although in the short period available, little progress had been made in overcoming reluctance by boiler installers.

Subsequently the program has gone through a number of alterations. During 1997/98, with a £200 cashback and vigorous installer training, 9,000 customers participated.

The program ceased in 2000.

APPENDIX G: EU DIRECTIVE 92/42/EEC

COUNCIL DIRECTIVE 92/42/EEC of 21 May 1992 on efficiency requirements for new hot-water boilers fired with liquid or gaseous fuels

THE COUNCIL OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Economic Community, and in particular Article 100a thereof,

Having regard to the proposal from the Commission (1),

In cooperation with the European Parliament (2),

Having regard to the opinion of the Economic and Social Committee (3),

Whereas Decision 91/565/EEC (4) provides for the promotion of energy efficiency in the Community under the SAVE programme;

Whereas it is important to promote measures aimed at the progressive establishment of the internal market in the period up to 31 December 1992; whereas the internal market encompasses an area without internal frontiers, in which the free circulation of goods, persons, services and capital is assured;

Whereas the Council resolution of 15 January 1985 on the improvement of energy-saving programmes in the Member States (5) invites Member States to pursue and where necessary increase their efforts to promote the more rational use of energy by the further development of integrated energy-saving policies;

Whereas the Council resolution of 16 September 1986 concerns new Community energy-policy objectives for 1995 and convergence of the policies of the Member States (6), and in particular the objective of improving the efficiency of final energy demand by at least 20 %;

Whereas Article 130r of the Treaty provides that action by the Community relating to the environment shall have the objective of ensuring a prudent and rational utilization of natural resources;

Whereas it is appropriate to take as a base a high level of protection in proposals for the approximation of the provisions laid down by law, regulation or administrative action in Member States and concerning health, safety, environmental protection and consumer protection;

Whereas the Council resolution of 21 June 1989 declares 'that the Community should take proper account of potential climatic change linked to the greenhouse effect' (7) and the Council's conclusions of 29 October 1990 state that CO_2 emissions in the year 2000 should be stabilized throughout the Community at their 1990 level;

Whereas the importance of the domestic and tertiary sector, which absorbs a major proportion of the final consumption of energy in the Community, is considerable;

Whereas this sector will become even more important through trends towards more central heating and a general increase in thermal comfort;

Whereas better boiler efficiency is in the consumer's interest; whereas energy saving will be reflected in fewer imports of hydrocarbons; whereas reduction in the Community's energy dependence will have a positive impact on its trade balance;

Whereas Council Directive 78/170/EEC of 13 February 1978 on the performance of heat generators for space heating and the production of hot water in new or existing non-industrial buildings and on the insulation of heat and domestic hot-water distribution in new non-industrial builings (8), has given rise to the establishment of substantially different efficiency levels between one Member State and another;

Whereas the requirement of high efficiency for hot-water boilers will reduce the range of technical properties of equipment placed on the market, thus facilitating series production and making for economies of scale; whereas the absence of a measure laying down energy requirements at a sufficiently high level may result, with the completion of the internal market, in a significant drop in the efficiency levels of heating installations through the spread on the market of low-efficiency boilers;

Whereas local climatic conditions and the energy and occupancy characteristics of buildings differ greatly within the Community; whereas Member States must take this diversity into account when determining the conditions for putting boilers into service in implementation of this Direcitve; whereas these circumstances justify the fact that Member States where back-boilers and boilers designed to be installed in the living space are widely installed at the date of the adoption of this Directive should continue to authorize, within specific limits, the placing on their markets and the putting into service of such boilers; whereas these arrangements should be subject to particular surveillance by the Commission;

Whereas this Directive, which is aimed at eliminating technical barriers with regard to boiler efficiency, must follow the new approach established by the Council resolution of 7 May 1985 (9) which specifically lays down that legislative harmonization is limited to the adoption, by means of directives based on Article 100 of the EEC Treaty, of the essential requirements with which products put on the market must conform and that 'these essential requirements shall be worded precisely enough in order to create legally binding obligations which can be enforced and to enable the certification bodies to certify products as being in conformity, having regard to those requirements in the absence of standards';

Having regard to Directive 83/189/EEC (10) laying down a procedure for the provision of information in the field of technical standards and regulations;

Having regard to Decision 90/683/EEC (11) concerning the modules for the various phases of the conformity assessment procedures which are intended to be used in the technical harmonization directives;

Whereas boilers complying with the efficiency requirements should bear the CE mark and, where appropriate, signs in order to enable them to move freely and to be put into service in accordance with their intended purpose within the Community;

Having regard to Directive 89/106/EEC (12) on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products;

Whereas efficiency requirements to encourage the rational use of energy as laid down in Council Directive 90/396/EEC of 29 June 1990 on the approximation of the laws of the Member States relating to appliances burning gaseous fuels (13) should be established for the gas boilers referred to in this Directive,

Article 1

This Directive, which comes under the SAVE programme concerning the promotion of energy efficiency in the Community, determines the efficiency requirements applicable to new hot-water boilers fired by liquid or gaseous fuels with a rated output of no less than 4 kW and no more than 400 kW, hereinafter called 'boilers'.

Article 2

Definitions:

boiler : the combined boiler body-burner unit, designed to transmit to water the heat released from burning,

appliance: - the boiler body designed to have a burner fitted, - the burner designed to be fitted to a boiler body,

effective rated output (expressed in kW) : the maximum calorific output laid down and guaranteed by the manufacturer as being deliverable during continuous operation while complying with the useful efficiency indicated by the manufacturer,

useful efficiency (expressed in %): the ratio between the heat output transmitted to the boiler water and the product of the net calorific value at constant fuel pressure and the consumption expressed as a quantity of fuel per unit time,

part load (expressed in %): the ratio between the effective output of a boiler operating intermittently or at an output lower than the effective rated output and the same effective rated output;

average temperature of the boiler water: the average of the water temperatures at the entry and exit of the boiler,

standard boiler: a boiler for which the average water temperature can be restricted by design,

back-boiler: a boiler designed to supply a central-heating system and to be installed in a fireplace recess as part of a back boiler/gas fire combination,

low-temperature boiler: a boiler which can work continuously with a water supply temperature of 35 to 40^{o}C, possibly producing condensation in certain circumstances, including condensing boilers using liquid fuel,

gas condensing boiler: a boiler designed to condense permanently a large part of the water vapour contained in the combustion gases,

boiler to be installed in the living space: a boiler with an effective rated output of less than 37 kW, designed to provide heat to the part of the living space in which it is installed by means of the emission of heat from the casing having an open expansion chamber, supplying hot water using gravity circulation; such boilers shall bear on their casings the explicit indication that they must be installed in living space.

Article 3

1. The following shall be excluded from this Directive:

   - hot-water boilers capable of being fired by different fuels including solid fuels,

   - equipment for the instantaneous preparation of hot water,

   - boilers designed to be fired by fuels the properties of which differ appreciably from the properties of the liquid and gaseous fuels commonly marketed (industrial waste gas, biogas, etc),

   - cookers and appliances designed mainly to heat the premises in which they are installed and, as a subsidiary function, to supply hot water for central heating and sanitary hot water,

   - appliances with rated outputs of less than 6 kW using gravity circulation and designed solely for the production of stored sanitary hot water,

   - boilers manufactured on a one-off basis.

2. In the case of boilers with a dual function, that of heating premises and also providing sanitary hot water, the efficiency requirements referred to in Article 5 (1) concern the heating function only.

Article 4

1. Member States may not prohibit, restrict or impede the placing on the market or entry into service within their territories of appliances and boilers which satisfy the requirements of this Directive, save as otherwise laid down in the Treaty or other Directives or Community provisions.

2. Member States shall take all necessary measures to ensure that boilers cannot be put into service unless they satisfy the efficiency requirements set out in Article 5 (1) and the conditions for entry into service which the Member States lay down on the basis of local climatic conditions and the energy and occupancy characteristics of the buildings.

3. However, Member States where back-boilers and/or boilers that are to be installed in the living space, are widely installed at the date of the adoption of the present Directive, shall continue to authorize their entry into service, provided that their efficiency both at rated output and at 30 % part load is not more than 4 % below the requirements laid down in Article 5 (1) for standard boilers.

4. The effects of the provisions in paragraphs 2 and 3 shall be constantly monitored by the Commission and analysed in the report to be submitted under Article 10. To this end the Member States shall forward to the Commission any information it requires to submit to the Council the proposed amendments, provided for in that Article, designed to ensure at all events the energy efficiency and free movement of boilers in the Community.

Article 5

1. Boilers must comply with the following useful efficiency requirements:

   - at rated output, i.e. operating at rated output Pn expressed in kW, at an average boiler-water temperature of 70°C, and

   - a part load, i.e. operating at 30 % part load, at an average boiler-water temperature which varies according to the type of the boiler.

The useful efficiency requirements to be complied with are set out in the following table:

Table G1: European Energy Efficiency Boiler Requirements

Type of boiler	Range of power output	Efficiency at rated output		Efficiency at partload	
	KW	Average boiler-water temperature (in °C)	Efficiency requirement expressed (in %)	Average boiler-water temperature (in °C)	Efficiency requirement expressed (in %)
Standard boilers	4 to 400	70	> 84 + 2 logPn	> 50	> 80 + 3 logPn
Low temperature boilers (*)	4 to 400	70	> 87,5 + 1,5 logPn	40	> 87,5 + 1,5 logPn
Gas condensing boilers	4 to 400	70	> 91 + 1 logPn	30 (**)	97 + 1 logPn

> = greater or equal to

(*) Including condensing boilers using liquid fuels.

(**) Temperature of boiler water-supply.

1. The harmonized standards relating to the requirements of this Directive drawn up under mandate from the Commission in accordance with Directive 83/189/EEC and 88/182/EEC (14) shall determine, inter alia, the verification methods valid for production and measurements. Appropriate tolerances must be incorporated in the efficiency levels.

Article 6

1. Under the procedures laid down in Article 7, Member States may decide to apply a specific system of labels enabling the energy performance of boilers to be clearly ascertained. This system shall apply to boilers the efficiency of which is superior to the requirements for standard boilers set out in Article 5 (1).

   If its efficiency at rated output and its efficiency at part load are equal to or greater than the relevant values for standard boilers, a boiler shall be awarded an * as set out in Annex I, section 2.

   If its efficiency at rated output and its efficiency at part load are three or more points higher than the relevant values for standard boilers a boiler shall be awarded **.

   Every extra step of efficiency of three points at rated output and at part load will allow the attribution of an extra * as set out in Annex II.

2. Member States may not authorize any other label likely to be confused with those referred to in paragraph 1.

Article 7

1. Member States shall deem that boilers which comply with the harmonized standards, the reference numbers of which have been published in the Official Journal of the European Communities and for which the Member States have published the reference numbers of the national standards transposing those harmonized standards, to be in conformity with the essential efficiency requirements stipulated in Article 5 (1). Such boilers must bear the CE mark referred to in Annex 1, section 1, and be accompanied by the EC declaration of conformity.

2. The conformity of series-produced boilers shall be certified by:

   - examination of the efficiency of a boiler type in accordance with module B as described in Annex III,

   - a declaration of conformity to the approved type in accordance with module C, D or E as described in Annex IV.

   For boilers burning gaseous fuels, the procedures for assessing the conformity of their efficiency shall be those used to assess conformity to the safety requirements laid down in Directive 90/396/EEC on the approximation of the laws of the Member States relating to appliances burning gaseous fuels.

3. When appliances marketed separately are placed on the market, they must bear the CE mark and be accompanied by the EC declaration of conformity, which defines the parameters enabling them after assembly to achieve the useful efficiency levels laid down in Article 5 (1).

4. The CE mark of conformity to the requirements of this Directive and to the other provisions concerning the granting of the CE mark, and also the inscriptions specified in Annex I, shall be affixed on boilers in a visible, easily legible and indelible manner. The affixing on such products of any other mark, sign or indication liable to create confusion with the CE mark both as regards its significance or in its appearance shall be prohibited.

Article 8

1. Each Member State shall notify the Commission and the other Member States of the bodies it has appointed to carry out the tasks relating to the procedures referred to in Article 7, hereinafter called 'notified bodies'.
   The Commission shall allocate identification numbers to those bodies and shall inform the Member States thereof.
   Lists of the notified bodies shall be published by the Council in the Official Journal of the European Communities and shall be continually updated.

2. Member States shall implement the minimum criteria laid down in Annex V for the appointment of such bodies. Bodies which satisfy the criteria laid down in the corresponding harmonized standards shall be deemed to comply with the criteria laid down in that Annex.

3. A Member State which has notified a particular body must withdraw that notification if it finds that the body concerned no longer satisfies the criteria referred to in paragraph 2. It shall immediately inform the other Member States and the Commission accordingly and shall withdraw the notification.

Article 9

1. By 1 January 1993, Member States shall adopt and publish the provisions necessary to comply with this Directive. They shall forthwith inform the Commission thereof.

   They shall apply those provisions form 1 January 1994.

   When Member States adopt those provisions, they shall contain a reference to this Directive or shall be accompanied by such a reference on the occasion of their official publication. The methods of making such a reference shall be laid down by the Member States.

2. Until 31 December 1997, Member States shall permit the placing on the market and putting into service of appliances complying with the national rules and schemes in force within their territories on the date of the adoption of this Directive.

Article 10
Three years after the implementation of this Directive the Commission shall submit a report to the European Parliament and to the Council on the results achieved. That report shall be accompanied by proposals for any changes to be made to this Directive in the light of those results and of advances in

technology.

Article 11

This Directive is addressed to the Member States.

Done at Brussels, 21 May 1992.

ANNEX I

CONFORMITY MARKS AND ADDITIONAL SPECIFIC MARKINGS

1. Conformity mark

The conformity mark consists of the letters CE as shown below and the last two figures of the year in which the mark was affixed.

2. Additional specific markings

The energy performance label awarded under Article 6 of this Directive consists of the following symbol: *

ANNEX II

AWARD OF ENERGY-PERFORMANCE LABELS

Efficiency requirements to be met both at nominal output and at part-load of 0,3 Pn

Label	Efficiency requirement at nominal output Pn and at an average boiler-water temperature of 70 °C %	Efficiency requirement at part-load of 0,3 Pn and at an average boiler-water temperature of > 50 °C %
*	> 84 + 2 log Pn	> 80 + 3 log Pn
**	> 87 + 2 log Pn	> 83 + 3 log Pn
***	> 90 + 2 log Pn	> 86 + 3 log Pn
****	> 93 + 2 log Pn	> 89 + 3 log Pn

> = greater or equal to

APPENDIX H: SEDBUK (SEASONAL EFFICIENCY OF DOMESTIC BOILERS IN UK)

The method was developed under the Government's Energy Efficiency Best Practice Programme with the co-operation of boiler manufacturers, and provides a basis for fair comparison of different models.

SEDBUK is the average annual efficiency achieved in typical domestic conditions, making reasonable assumptions about pattern of usage, climate, control, and other influences. It is calculated from the results of standard laboratory tests together with other important factors such as boiler type, ignition arrangement, internal store size, fuel used, and knowledge of the UK climate and typical domestic usage patterns.

For estimating annual fuel costs SEDBUK is a better guide than laboratory test results alone. It can be applied to most gas and oil domestic boilers for which data is available from tests conducted to the relevant European standards. The SEDBUK method is used in SAP (1998).

H.1 SAP (Standard Assessment Procedure)

SAP is the UK Government's standard methodology for home energy rating. It provides a reliable means of calculating the energy efficiency performance of dwellings. The SAP scale runs from 1 (the least energy efficient) to 100 (extremely energy efficient), with a score of 80 or more considered to represent a very energy efficient dwelling.

SAP ratings allow comparisons of energy efficiency to be made and can show the likely effect of improvements to a dwelling in terms of energy use. Using energy ratings, designers, developers, housebuilders, and home owners can take energy efficiency factors into consideration when building new dwellings or refurbishing existing ones. Energy ratings can be used at the design stage to improve energy efficiency and reduce future fuel bills and CO_2 production.

The Building Regulations require a SAP assessment to be carried out for all new dwellings and conversions. Local authorities, housing associations, and other landlords also use SAP ratings to estimate the energy efficiency performance of their housing. The latest version is SAP (1998), which came into effect on 1 July 1999.

H.2 Energy Efficiency Bands

As a simple guide to efficiency, a scheme has been created with SEDBUK efficiency bands assigned to boilers on an "A" to "G" scale. The band is shown in the database and may be used on product literature and labels, though there is no requirement for manufacturers to do so. The scheme is temporary as it will be withdrawn when a European directive on boiler energy labelling is introduced.

Table 16: UK boiler efficiency bands

Band	SEDBUK range
A	90% and above
B	86% - 90%
C	82% - 86%
D	78% - 82%
E	74% - 78%
F	70% - 74%
G	below 70%

H.3 Explanations of the boiler data

Original name of manufacturer

Name of boiler manufacturer, or company responsible for the boiler in the UK, at the time the boiler was manufactured, as it appears on the boiler casing and owners' instruction leaflet.

Current name of manufacturer

Current name of manufacturer, or company responsible for the boiler in the UK, which may not be the same as the original name.

Model name

Name of boiler model, as it appears on the boiler casing or leaflet of owners' instructions. For boilers that comply with EN483 this should be "the trade name of the appliance" shown on the data plate, as specified in EN483 8.1.2. If the same boiler is sold under more than one model name then separate entries for each may appear in the database.

Model qualifier

Qualifier to model name, if needed in addition to the model name to discriminate between different versions of same model.

Boiler ID

Boiler identifier, which, in conjunction with manufacturer's name, is unique for the model. It may be GC (formerly Gas Council) number for a gas boiler or OFTEC Registration number for an oil boiler, or some other unique reference chosen by the manufacturer and marked on the boiler.

First year of manufacture

First year of manufacture, if known.

Final year of manufacture

Final year of manufacture, or "current" if still in production. If no longer produced but date production ceased is unknown, then "obsolete".

Fue/

Fuel type, which will be one of "gas", "LPG", or "oil". If the same boiler may use more than one type of fuel then separate entries for each may appear in the database.

Mounting position

Boiler mounting position, which will be one of "unknown", "floor", "wall", "either floor or wall", or "back boiler". Exposure rating Exposure rating, which will be one of "unknown", "indoor only", or "outdoor".

Main type

Main boiler type, for the purpose of SAP efficiency calculation. It will be one of "regular" (see SAP (1998) Appendix D clause D1.3), "combi" (clause D1.6), or "CPSU" (clause D1.13).

Condensing

Either "non-condensing" or "condensing" (see SAP (1998) Appendix D clause D1.2).

Flue type

Flue type, which will be one of "unknown", "open" or "room-sealed".

Fan assistance

Whether or not flue is fan assisted. It will be one of "unknown", "no fan", or "fan".

Boiler power

Output power (to water) of the boiler in kW. For BED-compliant boilers this is the rated output as required for the purpose of Council of the European Communities Directive 92/42/EEC. If the power was declared only in BTU/hr then it will have been converted using the factor 1 BTU/hr = 0.000293 kW. If the boiler is range rated then both the lower and higher limits of the range will be given.

Energy efficiency band

The energy efficiency band, determined by the range in which the SEDBUK efficiency value lies. See page describing energy efficiency bands for explanation. This will be blank if the SEDBUK figure is unknown (ie; if efficiency category is not "SEDBUK").

SAP seasonal efficiency

Seasonal efficiency for use in SAP, expressed as a percentage and rounded to the nearest 0.1%. This will be obtained by one of the methods defined as the efficiency category.

Efficiency category

Category of SAP efficiency, which will be one of "SEDBUK" (see separate page for explanation), "SAP default" (meaning taken from SAP (1998) Table 4b), or "estimated" (for obsolete boilers only).

SAP equation used

The number of the SEDBUK equation used to calculate SAP efficiency, as defined in SAP (1998) Appendix D Tables D2.3 and D2.4. Number 0 indicates that no SEDBUK calculation has been performed. The equation number must be consistent with boiler type and other properties (whether gas/oil, instantaneous/storage/CPSU, and on-off/modulating).

Ignition

Whether or not has a permanent pilot light.

Burner control

Whether on-off or variable (variable may be either stepped or modulating).

Electrical power while boiler is firing

Average electrical power consumed while the boiler is firing, in watts. This includes fans, motors, heaters, and other electrical equipment but excludes any pump used to circulate water outside the boiler.

Electrical power while boiler is not firing

Average electrical power consumed while the boiler is not firing, in watts. This includes fans, motors, heaters, and other electrical equipment but excludes any pump used to circulate water outside the boiler.

Store type

For a storage combination boiler this will be "primary" or "secondary" according to whether the internal hot water store contains mainly primary water or secondary water. It applies only to storage combination boilers and CPSUs.

Store loss in test

This will be "excluded" or "included" according to whether heat loss from the internal hot water store has been excluded or included in the efficiency tests carried out. It applies only to storage combination boilers and CPSUs.

Store volume

The total water volume (primary and secondary) of the internal hot water store in litres. It applies only to storage combination boilers and CPSUs.

Store insulation thickness

The thickness of the insulation applied to the internal hot water store, in mm. It applies only to storage combination boilers and CPSUs.

Store insulation type

The material used to insulate the internal hot water store, which will be one of "mineral wool", "polyurethane foam", or "fibreglass". It applies only to storage combination boilers and CPSUs.

Store temperature

The average temperature of the hot water in contact with the exterior walls of the internal hot water store in degrees Celsius. It applies only to storage combination boilers and CPSUs.

Store heat loss

The measured heat loss from the internal hot water store in watts. It applies only to storage combination boilers and CPSUs.