OIL FIRING TECHNICAL ASSOCIATION

SUPPLEMENT 1 TO OFTEC STANDARD

OFS A101

DETERMINATION OF EFFICIENCY AND HEAT OUTPUTS OF OIL AND GAS FIRED RANGE COOKER BOILERS WITH TWIN BURNERS FOR SAP 2005 - DIRECT CASE MEASUREMENT METHOD

Promoting excellence in
Oil heating and cooking

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1 Introduction and scope

The revised Building Regulations Approved Document L1 2005 requires that manufacturers of range cooker boilers declare certain performance data i.e. seasonal efficiency and case emissions for their products to enable calculations of the CO_2 emissions of a building in which the range cooker boilers may be installed to be calculated using SAP 2005 calculation methods. This supplement is applicable only to range cooker boilers with twin burners and is not applicable to range cookers fitted with condensing boilers.

Range cookers are combined heating and cooking appliances, which are designed to provide some heat from their case into the space in which they are located.

To provide the data for these SAP 2005 calculations the heat to water efficiency of a range cooker with boiler is determined by the direct measurement method whilst the total appliance efficiency and space heating output is determined indirectly by the flue loss method with the range cooker being operated at both nominal heat output (100 %) and additionally at part load output (30 %). The full and part load measurement techniques for heat to water efficiency are compatible with those for regular oil and gas boilers and hence will give parity (or near parity) within the SEDBUK scenario.

Some suitable full and part load measurement techniques for determining the heat to water efficiency and flue loss space heating output for range cooker boilers are given in OFTEC Standard OFS A101 and EN 304:1992 (plus Amendment 1:1998) for oil fired range cookers and EN 483, EN 656 and EN 1020 for gas fired range cookers.

Whilst the flue loss test is the accepted definitive method of test where heat to space from the case deduced from the test results is greater than 200 W. However the uncertainty of measurement associated with both the heat to water by the direct method and the overall heat output of the range cooker by the flue losses method may on rare occasions give low or apparent negative calculated values in heat to space values for those cooker boilers where the heat to space values from the case are less than 200 W and where the associated heat to water values are high.

Therefore where the flue loss method gives heat to space values from the case of less than 200 W and where the case temperatures of the range cooker are below 80 °C, then the direct method of measuring the heat to space from the case as detailed in section 2 below may be used to establish the case emission figure subject to a maximum figure of 200 W.

2. Direct method of measuring the heat to space from case

2.2 Measurement of appliance surface temperature

2.2.1 General

The surface temperature of each of the appliances' exterior surfaces shall be measured against ambient temperature. In order to accurately measure the mean surface temperature it is essential a sufficient number of temperature measurement points be chosen on each surface so that the measurement points gives a reasonably good estimate of the mean temperature of that surface.

If the appliance construction is symmetrical in relation to flueways and other construction and also in respect of front, back and side walls then it is permissible to only measure the temperature of only one side wall and one half of the other surfaces. Detailed requirements on choosing the specific measurement points are given in 2.2.2

If the construction is not symmetrical or has significant differences then all independent surfaces must be measured separately and more measurement points will be needed as detailed in 2.2.2.

The mean surface temperature should be given as weighted mean surface temperature. Calculation is based on values of separate measurement points and their representing surface area as detailed in 2.4.

2.2.2 Selection of measurement points

If the appliance has a symmetrical temperature profile then the appliance's back, front, top and side external surfaces shall be divided into two identical surface areas by a vertical line. The mean differential surface temperature of only one half of the back, front and top surfaces and only one of the side walls surfaces shall be measured. Each surface area to be measured shall then be further sub-divided into smaller areas not exceeding 0.3 m x 0.3 m and at least one measurement point is needed for each of these smaller areas. The temperature measurement shall be made at the symmetrical centre point of the surface areas that it is representing.

NOTE. It may be necessary to undertake a preliminary temperature survey to check that the temperature profiles of the surfaces are symmetrical.

The differential surface temperature of any door shall be measured from at least two points. The surface area of the door shall be divided by vertical and horizontal lines into four identical areas. One measurement point shall be placed on the centre point of the bottom left hand area and the other measurement point on the centre point of the top right hand area.

If the appliance is not symmetrical in respect of temperature, geometry and flue ways or surfaces then each of the appliance's surfaces shall be sub-divided into small areas not exceeding 0.3 m x 0.3 m and at least one measurement point shall be required for each 0.3 m x 0.3 m area. The temperature measurement shall be made at the symmetrical centre point of the surface area that it is representing.

The mean differential surface temperature of the appliance shall be calculated based on area-weighted differential temperature measurement points as detailed in 2.4. A typical example of the positioning of the measurement points is given in figure 1.

2.3 Installing temperature probes to the appliance surface

If thermocouples or other temperature probes are used then they shall be installed such that the actual surface temperature measurements meet the uncertainty requirements of ± 2 °C. Either commercially available adhesive patch thermocouples shall be used or alternatively either special glue or nail polish shall be used to ensure a good contact is made between the thermocouple and the appliance surface.

2.4 Calculation of mean differential surface temperatures

Firstly calculate the mean differential surface temperature of each individual external surface of the appliance (e.g. top, front etc.). For each of these external surfaces calculate from the mean value of the readings over the test period of each differential thermocouple measurement point and weight by the actual surface area that the measurement point represents. A typical calculation is detailed in example 1 below.

Example 1

Top surface having four measurement points. Two measurement points have an area of 0.3 m by 0.3 m i.e. 0.09 m^2 and mean differential temperature values of 60 K and 55 K respectively over the test period. The other two measurement points have an area of 0.25 m by 0.25 m i.e. 0.0625 m^2 and mean differential temperature values of 50 K and 55 K respectively over the test period. The mean value of the differential temperature of the surface would be calculated as follows:

$$Mean\ value = \frac{(60 \times 0{,}09\ ) + (55 \times 0{,}09) + (50 \times 0{,}0625\ ) + (55 \times 0{,}0625\ )}{(0{,}09 \times 2\ ) + (0{,}0625 \times 2\ )} = 55{,}45\,K$$

NOTE. If the actual surface areas of the measurement points are all of the same area then the mean differential temperature of the surface can be calculated as the arithmetic mean of the individual differential readings of each measurement point.

Secondly calculate the mean differential temperature of the appliance from the calculated mean of each of the individual external surfaces from step 1 and weight by the actual surface area of the individual surface of the appliance that it represents e.g. front, top etc. A typical calculation is detailed in example 2 below.

Example 2

The individual mean calculated differential surface temperatures from step 1 are given in column 2 and the corresponding surface area of each of the appliance sides is given in column 3 of the table 1 below. Column 4 is the weighted value and is calculated by multiplying the value in column 2 by the value in column 3 for each of the appliance surfaces. The mean value for the differential surface temperature of the appliance is calculated by dividing the total weighted value by the total surface area.

Table 1 – Example of calculation of mean differential surface temperature

	Mean calculated value of differential temperature K	Surface area m^2	Weighted Value
Top	65	0.75	48.75
Front	70	1.50	105.00
Back	60	1.50	90.00
Sides	55	2.00	110.00
Totals		5.75	353.75
Mean value for appliance	61.5	Mean value = Total weighted value / Total surface area	

2.5 Calculation of heat output from mean surface temperature

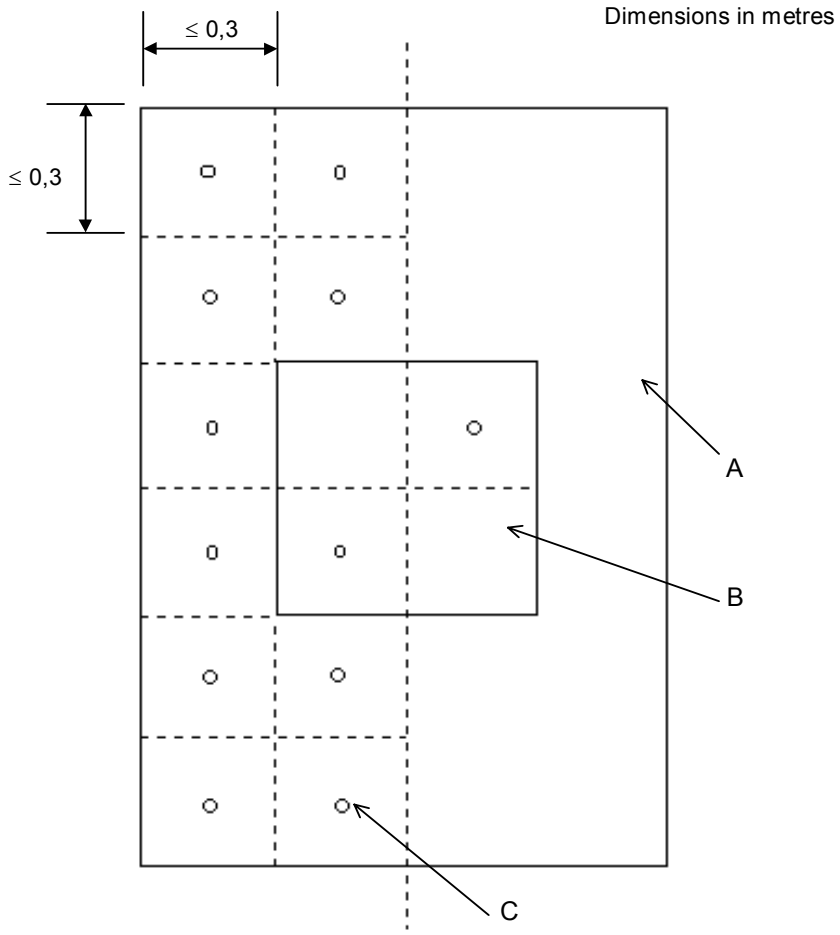
The heat output *Q* (in W) from the surface area *A* is calculated as an approximation by assuming the rate of heat release to be due to radiation and convection according to the equation A1.

$$Q/(kA) = q = \sigma F[(T_s + 273.15K)^4 - (T_r + 273.15K)^4] + C(T_s - T_r)^n \quad \text{(A1)}$$

where:

q is heat release rate at time *t* (W/m^2),
k is a scaling factor
A is total surface area of the appliance (m^2),
σ = 5.67 $\times 10^{-8}$ W $m^{-2}K^{-4}$ (Stefan-Bolzmann's constant),
F is the view factor,
T_s is the mean surface temperature (^oC) at time *t*,
T_r is ambient temperature (^oC)
C and *n* are constants for convection.

In practise for turbulent flow a value of *n* = 1.36 may be assumed. The view factor *F* depends on the emissivity of the surface material of the appliance and also on the room walls and as an approximation a value of 0.8 can be used. Similary a value for *C* of 1.2 W m^{-2} K^{-n} may be used.



Key

A Appliance front
B Door
C Measurement point

Figure 1 – Example of location of differential surface temperature points on appliance