

# GUIDANCE NOTE 16

## CHP SCHEME HEAT OUTPUTS

### Qualifying Heat Outputs

#### GN16.1

CHP Qualifying Heat Output ( $CHP_{QHO}$ ) is the registered amount of useful heat supplied annually from a CHP Scheme ( $MWh_{th}$ ). It is heat output that is demonstrably utilised to displace heat that would otherwise be supplied from other sources.

Usually, for CHP Schemes  $>2$  MWe, heat outputs will be in the form of steam to be used in the Process Area. Other heat outputs may be hot water or heat transfer oil circulating systems that are used to transport heat for process or space heating. Some CHP Schemes use part or all of the exhaust gases from a gas turbine or engine for direct heating or drying applications.

Schemes may provide heat at various pressure and temperature levels and the energy output is the sum of these heat energy outputs from the Utilities Area to the Process Area.

$CHP_{QHO}$  excludes heat rejected to the environment **without any beneficial use**. Examples include, inter alia, heat lost from chimneys or exhausts and heat rejected in equipment such as condensers and radiators.

#### GN16.2

Heat from steam can be used within the CHP Scheme before the steam is supplied to the process and can also be returned to the CHP Scheme from the process as condensate after the steam has given up most, but not all, of its useful energy. In broad terms, the aim is to determine the useful heat supplied to the process (i.e. excluding the heat rejected in condensers, heat rejection radiators, and other facilities) and to encourage the use of heat from condensate. With this objective in view:

- Where steam is supplied within the CHP Scheme for duties such as de-aeration, condensate heating, make-up water and boiler feed-water heating (to boilers within the scheme boundary), this should not be counted as part of the useful heat supplied to site. Preheating make-up water and feed water for boilers outside the CHP Scheme boundary can be counted as part of the claimed useful heat.
- Recovery of heat from condensate, and re-use of condensate in a closed loop steam network, is obviously best practice where possible.

Excluding condensate heat from the total heat supplied to the user would tend not to encourage the recovery of heat from condensate. Therefore, the heat content of condensate return is not subtracted from the useful heat figure in determining the CHP Scheme's heat outputs

- Steam used for injection into gas turbines is not useful heat supplied to process. The value of this energy is reflected in increased power output and exhaust gas mass flow

### **GN16.3**

The heat content of steam supplied to the process is to be determined relative to a mean ambient temperature datum and a pressure datum. For the UK these shall be taken as 10°C (50°F) and 1.013 bar(a). Thus, the specific heat content (specific enthalpy) equals the specific enthalpy from steam tables or steam charts, which have a datum of 0°C (32°F) and 1.013 bar(a), minus the specific enthalpy of water at 10°C and 1.013 bar(a) on the same basis.

#### **Example**

Saturated steam to a site at 10 bar(a) ~ specific enthalpy (datum 0°C) = 2,778 kJ/kg

Water at 10°C ~ specific enthalpy (datum 0°C) = 42 kJ/kg

Heat to site ~ specific enthalpy (datum 10°C) = 2,778 – 42 = 2,736 kJ/kg

### **GN16.4**

Where exhaust gases are used for direct heating applications, the useful heat output is the difference in heat content of the exhaust gases between entering and leaving the application.

- Refer to GN21 for guidance on indirect determination of energy output and GN16.17 in reference to direct use of heat.

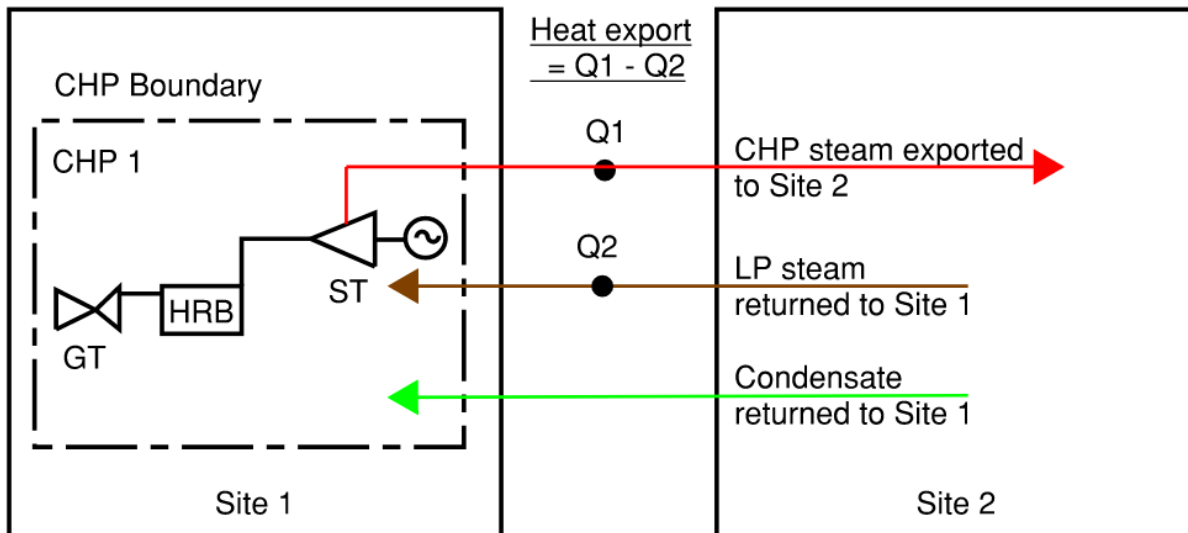
## **HEAT TRANSFERS AND NET HEAT EXPORTS FROM A SCHEME**

### **GN16.5**

To qualify as a useful heat output, heat supplied to off-site customers must be used in genuine applications. As part of the information necessary for Self-Assessment, applicants must include in a submission details of non-residential heat customers. Non-residential heat customers (who clearly share in the benefit from any fiscal benefits that the Scheme as a whole receives) will be subject to verification and audit. Heat supplied to residential users should not be disaggregated, but the total heat supplied for residential use as a whole should be recorded. See GN30.4 for a definition of residential use.

### **GN16.6**

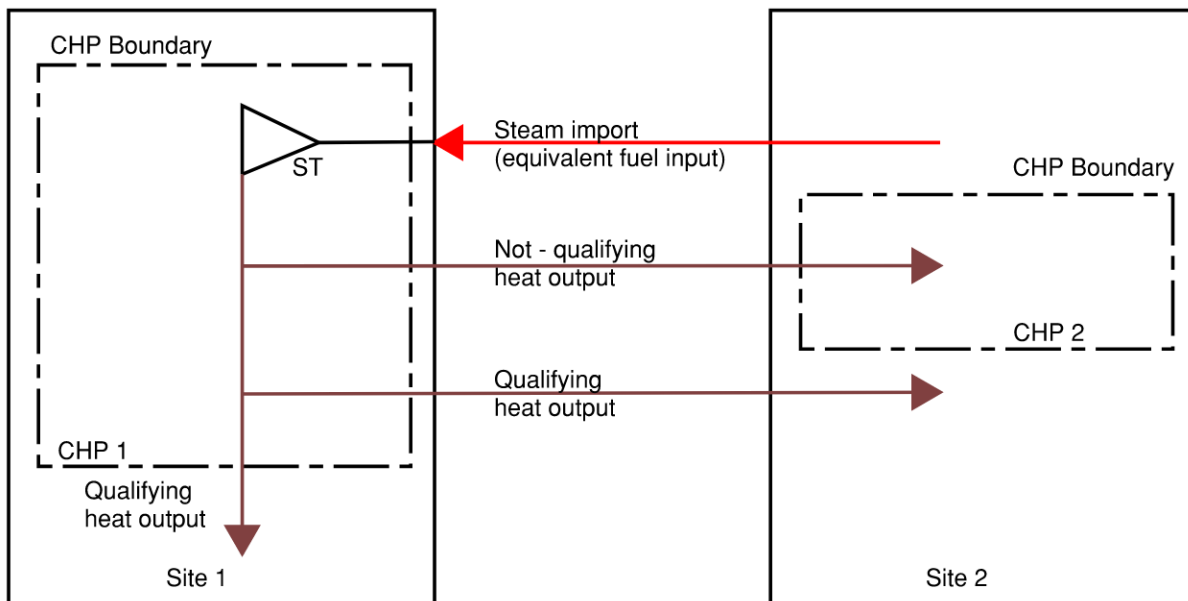
For a CHP Scheme that supplies one or more external heat customers, the useful heat exported is the net transfer of heat across site boundaries (i.e. heat supplied minus heat returned), excluding condensate return. For example, a Scheme may export steam to another site and receive some or all of this back within the Scheme boundary as steam at a reduced pressure or as condensate. In this case the qualifying heat output is the energy content of the steam exported (Q1 see Fig GN16-1) minus the energy content of the steam returned (Q2), both relative to a datum of water at ambient temperature. The heat content in any condensate returned will not be deducted from the heat supplied (see GN16.8).



**Fig GN16-1 Net Steam Exported to Site GN16.7**

Heat exported for use to generate power on another site is not classed as a heat export but as part of the internal heat transfer within a CHP Scheme.

Details must be provided on how this heat will be utilised. Some Schemes may export steam that was originally imported at a higher pressure as a heat input from another site. To qualify as useful heat outputs such heat must be used for process or space heating purposes.



**Fig GN16-2 Steam exports qualifying heat outputs**

If heat is exported to a customer, the following details must be declared and will be subject to Audit:

- Amount of exported heat in MWh, in Self-Assessment Period
- Description of usage
- Recipient of exported heat

## CONDENSATE RETURN

### GN16.8

Where a CHP Scheme generates steam that is used on site (outside the CHP Scheme boundaries) it is good practice to return as much as possible of the condensate to the CHP plant. Returned condensate is usually hot (80 - 100°C) so, besides reducing the quantity of fresh treated make-up water that is required to compensate for losses, it reduces the heat (steam) requirements of the de-aerator. This in turn results in a fuel saving either at the CHP plant or at the site boilers. Deducting the heat content of the condensate from the heat supplied to site provides no incentive for sites to maximise condensate recovery. Thus, the heat in returned condensate will not be deducted when determining a CHP Scheme's heat outputs, see GN16.2.

### Secondary Steam Turbine Drives

#### GN16.9

Where steam turbine-driven pumps or generators are embedded within the Process Area (Utilities Island, see GN11.8), the energy flow to and from the Utilities Island should be included in the CHP energy flow. For example, the steam heat used by the Utilities Island should be deducted from the CHP Scheme heat outputs to the process and, similarly, the power output from the Utilities Island should then be added to the CHP Scheme power outputs.

## METERING REQUIREMENTS

### Steam

#### GN16.10

For measurement of steam mass flow and energy content, meters with an overall uncertainty of  $\pm 2.0\%$  of full-scale or  $\pm 3.0\%$  of actual readings are required. Where appropriate, correction for steam pressure and temperature (superheated steam only) is required. The additional uncertainties associated with these corrections and other elements of the measuring system are included in the overall uncertainty.

- Refer to GN17 for guidance on Uncertainty in Metered Inputs and Outputs.

Orifice plates, nozzles and venturi tubes should be designed and installed in accordance with BS EN ISO 5167 Parts 1 to 4 :2022 or equivalent, and the mass flow calculation should be based on actual (not nominal) dimensions. The calculation of overall uncertainty should take into account the individual uncertainties associated with: (i) the installed orifice plate, nozzle or venturi system; (ii) the measurement of the differential pressure, static steam gauge pressure and steam temperature; and (iii) the transmitters and integrator errors etc. The additional uncertainties associated with these corrections and other elements of the measuring system may increase the overall uncertainty for measuring steam output mass flow to a value greater than  $\pm 2.0\%$  of full-scale or  $\pm 3.0\%$  of actual reading (refer to GN17).

Other types of flow meter capable of the required accuracy or better are permitted.

Dimensions and condition of orifice plates should be checked and other primary flow devices, transmitters and signal processing should be regularly calibrated as part of an agreed calibration schedule. There are no standards for calibrating differential pressure

gauges, but these should be calibrated by UKAS accredited bodies. Other devices should also be appropriately calibrated, for example, static pressure gauges in line with BS EN 837-1 & 3, and temperature sensors in line with BS EN IEC 60584-1 (thermocouple reference tables), BS EN IEC 60584-2 (thermocouple tolerances) and BS EN IEC 60584-3 (compensating tables) and BS EN IEC 60751 (platinum resistance thermometers).

Evidence of calibrations of steam (or heat) flow meters, including the primary flow device, would be expected to be available if a site were audited.

#### **GN16.11**

Metering of all steam and heat flows that contribute to the useful energy outputs of the CHP Scheme is required (see dispensation below). This may involve metering steam at several pressure levels. Metering stations must be located so that the steam used for parasitic heat loads within the CHP Scheme (e.g. de-aeration and feed-water heating or gas turbine steam injection) are excluded and steam that is vented or dumped to atmosphere is also excluded. If the main meter includes any such elements, these must be metered separately and deducted from the heat outputs.

**Dispensation from metering minor steam (or heat) flows:** A calculation of minor steam (or heat) flows (cumulative <10% of total useful heat output from the scheme) may be permitted providing that any such calculations are traceable to reliable data and the associated uncertainty can be determined.

## **CIRCULATING HOT WATER SYSTEMS (AND OTHER LIQUID- PHASE SYSTEMS)**

#### **GN16.12**

Schemes with TPC  $\leq 2$  MWe with no heat rejection facility and no fired boilers, are not required to meter heat outputs, as set out in GN13.2.

All other Schemes that supply heat by means of circulating hot water systems, or other liquid phase heat transfer medium, are required to monitor heat outputs.

There are 3 heat monitoring options for these latter Schemes:

- Option 1: Standalone commercially available heat meters (fully integrated heat meters)
- Option 2: Heat metering by computation within control systems, i.e. BMS (using flow and return temperatures and measuring flow rate)
- Option 3: Schemes with TPC  $\leq 2$  MWe with a dump cooler facility (use two temperature sensors and fixed flow rate)

For Schemes installed and commissioned after January 2008, only two options are permitted, namely:

- Option 1: Standalone Commercially available heat meters (fully integrated heat meters)
- Option 2: Heat metering by computation within control systems, i.e. BMS (use flow and return temperatures and measure flow rate)

## GN16.13

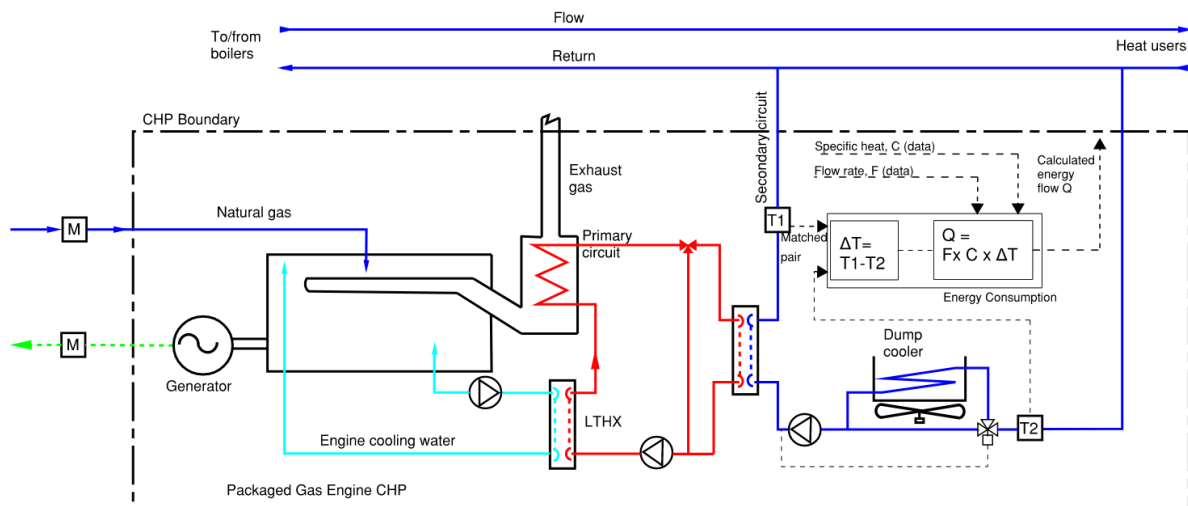
Where stand-alone commercially available heat meters are used these must be manufactured to metrological Class 3 or better as defined in BS EN 1434–1 2022. The use of such meters in conjunction with an appropriate calibration schedule will not require any adjustment for excessive uncertainty.

## GN16.14

Heat metering may be achieved by computation within control systems such as a BMS or plant DCS, using measured flow and return temperatures and the measured fluid circulation rate. In such cases the heat output shall be treated as a calculated value, with requirements in terms of maximum uncertainty for best practice as set out in GN13.11. It should be noted that the use of thermocouples to BS 1041-4:1992, BS EN IEC 60584-1 & -2, for fluid temperature measurements and temperature differential is likely to lead to excessive uncertainty unless a lesser uncertainty can be established by calibration. For such measurements matched pairs of platinum resistance thermometers to BS 1041-3:1989 and BS EN IEC 60751 are preferred.

## GN16.15

Schemes installed and commissioned prior to January 2008 with TPC  $\leq 2$  MWe that have a dump (or trim) cooler are permitted to calculate the heat output from the flow temperature and the return temperature before (upstream of) the dump cooler, with the assumption of a fixed circulation rate that is verifiable from test measurements. This method (Option 3) is illustrated by Fig GN16-3. The flow test measurements may be carried out as part of the calibration schedule using a non-intrusive flow meter (e.g. magnetic or ultrasonic). To be acceptable the test should demonstrate that any variation in flow with the operation of control valves (manual or automatic) within the circulating loop is not greater than  $\pm 5.0\%$ .



**Fig GN16-3 Heat Output Computation Option 3 for Schemes  $\leq 2$  MWe**

## GN16.16

The uncertainty associated with any proposed method for the calculation of heat output must be assessed using the methods prescribed in GN18. The levels of uncertainty deemed to be best practice are set out in GN13.11. The treatment of excessive uncertainty is covered in GN19.

## **Direct Use of Heat**

### **GN16.17**

In some industrial processes, the heat in the exhaust from the turbine or engine is used directly for drying purposes. There are a number of possible methods that may be used to determine the useful heat output (see GN21). Applicants should submit details of the proposed method. The overriding principal is that all calculations are traceable to reliable data and the overall uncertainty associated with the calculations can be determined.

## **SEPARATE HEAT OUTPUTS**

### **GN16.18**

Information provided under the CHPQA programme is used to prepare statistics on CHP in the UK. Until the UK ceased to be a member of the European Union, submissions were made to Eurostat which included a requirement to separate fuel to and heat from the prime mover from the fuel to and heat from heat only boilers (i.e. those performing the function of supplementary firing, auxiliary or top-up boilers), which do not produce heat which is subsequently used to generate power. This information does not form part of the self-assessment and although no longer a requirement for Eurostat reporting, it remains helpful in understanding current characteristics of CHP.