Department for
Business, Energy
& Industrial Strategy

CHPQA – Metering Requirements: Uncertainty

Pete Edwards
CHPQA

November 2022

Talk Coverage

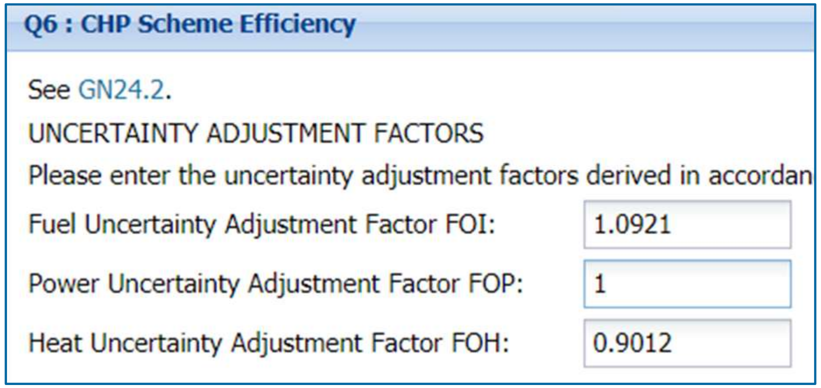
- Applicability to CHPQA
- What is uncertainty? % reading vs full-scale
- Relevance to CHPQA
- CHPQA best practice
- Determining uncertainty
- Excessive uncertainty
- Uncertainty adjustment factors (F_{OI}, F_{OP}, F_{OH})
- Management (and reduction) of uncertainty

Applicability to CHPQA

- The uncertainty of your monitoring arrangement must be reported to CHPQA when applying via the complex form route: F3 or F2+F4

- The overall uncertainty (U_o) of each metered or calculated energy input/output is required in forms: F3 or F2

- Uncertainty adjustment factors (F_{OI}, F_{OP} and F_{OH}) are required on Form F4. These are used to correct for excess uncertainties.



Q6 : CHP Scheme Efficiency

See GN24.2.

UNCERTAINTY ADJUSTMENT FACTORS

Please enter the uncertainty adjustment factors derived in accordan

Fuel Uncertainty Adjustment Factor FOI:	1.0921
Power Uncertainty Adjustment Factor FOP:	1
Heat Uncertainty Adjustment Factor FOH:	0.9012

Department for
Business, Energy
& Industrial Strategy

CHPQA

Relevant CHPQA Guidance

- Guidance on uncertainty (and bias) is provided in the following detailed CHPQA guidance notes:

GN13 – CHP Scheme Monitoring Information

GN17 – Uncertainty in Metered Inputs and Outputs

GN18 – Uncertainty in Calculated Energy Inputs and Outputs

GN19 – Adjustment of Energy Inputs and Outputs for Excessive Uncertainty

GN23 – Correction of Bias in Inputs and Outputs Information

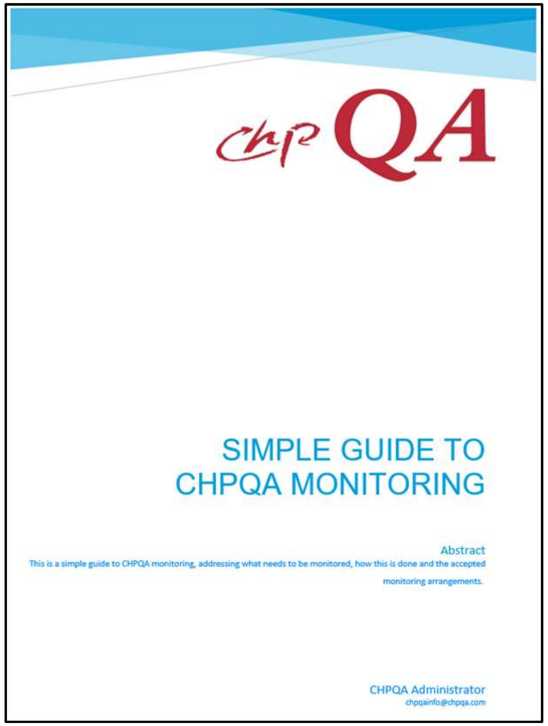
- Found online at: https://www.gov.uk/guidance/chpqa-guidance-notes

Department for
Business, Energy
& Industrial Strategy

CHPQA

New Simple Guidance

- Two new simplified guides related to metering:
  - Simple Guide to CHPQA Monitoring
  - Simple Guide to CHPQA Uncertainty

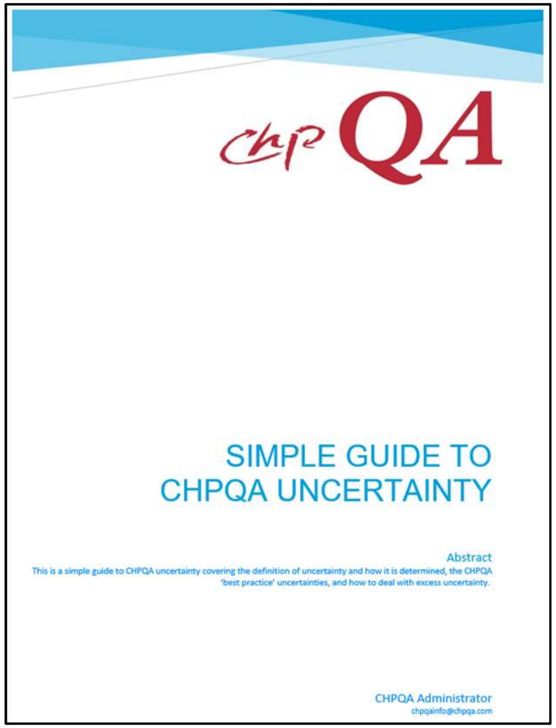


CHPQA

SIMPLE GUIDE TO
CHPQA MONITORING

Abstract
This is a simple guide to CHPQA monitoring, addressing what needs to be monitored, how this is done and the accepted monitoring arrangements.

CHPQA Administrator
chpqainfo@chpqa.com



CHPQA

SIMPLE GUIDE TO
CHPQA UNCERTAINTY

Abstract
This is a simple guide to CHPQA uncertainty covering the definition of uncertainty and how it is determined, the CHPQA 'best practice' uncertainties, and how to deal with excess uncertainty.

CHPQA Administrator
chpqainfo@chpqa.com

Department for
Business, Energy
& Industrial Strategy

chp QA

What is uncertainty?

- Any measurement is subject to imperfections, uncertainty is a quantitative indication of the quality of a measured value.
- Uncertainty is expressed as a range ±n% of the measured value.
- For the purposes of CHPQA, this is defined as:

the range of values, within which there is a high probability (usually >95%) that the true value of a measured (or calculated) variable is estimated to lie.

What is uncertainty?

Example

A manufacturer of a flow meter states that the uncertainty of their device is ±2%.

The flow meter records a water flowrate of 10l/s through a pipe.

The true flowrate through the pipe is therefore likely (greater than 95% probability) to lie within the range of 9.8l/s and 10.2l/s (an error band of ±0.2l/s).

What is uncertainty?

- The overall uncertainty (U_o) of a meter must include for all of its components
- A heat meter has four components: a flowmeter and two thermocouples, plus a calculator or transmitter
- Similarly, steam metering utilises a flow device, pressure and temperature sensors and a transmitter
- Overall uncertainty is determined by the root-sum-square (RSS) method as set out in GN17.24-17.25
- The overall uncertainty (U_o) of such a heat meter becomes:

$$U_o = \sqrt{U1^2 + U2^2 + U3^2}$$

% of Reading vs Full-scale

- Uncertainty of metered values can be quoted in two ways: % of reading and % of full-scale reading
- Full-scale reading is the maximum value that the meter can record.
- An uncertainty of ±1% of full-scale reading becomes an uncertainty of ±2% of the actual reading at 50% output.
- GN13.11 sets out uncertainty requirements of steam flows in terms of % reading and % full-scale

Relevance to CHPQA

- Monitoring of values (fuel, heat and power) determines a CHP Scheme’s performance
- The fiscal benefits available to a CHP Scheme are dependant on its performance
- Low uncertainty in monitored values gives confidence that a Scheme’s performance is being correctly determined and hence correct benefits received
- Conversely, high uncertainty casts doubt on measured values

Department for Business, Energy & Industrial Strategy

chp QA

Relevance to CHPQA

- CHPQA must therefore correct a CHP Scheme's performance for any excess uncertainty
- CHPQA have developed what it considers 'best practice' limits to uncertainty.
- Where uncertainty exceeds 'best practice', Uncertainty Adjustment Factors (F_{OI}, F_{OP} and F_{OH}) must be applied.

F_{OI} – Energy Inputs

F_{OP} – Power Outputs

F_{OH} – Heat Outputs

Department for Business, Energy & Industrial Strategy

chp QA

CHPQA best practice

- CHPQA have set out what it deems as best practice limits to uncertainty for all energy inputs and outputs.

- See table in GN13.11

• Fuel Inputs, kWh	±2.0% of reading
• Energy inputs as steam or hot water, kWh	As for steam or hot water as appropriate (see below)
• Heat metering, of hot water, thermal fluid or other liquid heat circulating loops, kWh,	Metering to BS EN 1434-1:2007, metrological Class 3 (typically 4.5% of reading) or better, with concessions for Schemes with TPC <2MWe), see GN16.15 – 16.16. The Measuring Instrument Directive MID 2004/22/EC Annex MI-004 is based on BS EN 1434-1:2007.
• Metering of steam flows and derivation of energy content, kWh	±2.0% of full scale ±3.0% of reading
• Electric power, kWh	Metering to applicable BS and Class dependant on rating, see GN15.7
• Indirect measurement or calculation of energy input or output, kWh	±2.0% of value, except for heat outputs from Schemes with TPC <2MWe where ±5.0% of value applies.

Department for Business, Energy & Industrial Strategy

CHP QA

CHPQA best practice - electricity

- Uncertainty (or class) requirements specific to power meters are detailed separately in Table GN15-1.

Table GN15-1 – Classification of Electricity Metering Equipment

Rated Capacity	Watt-Hour Meter Standard and Accuracy Class	Current Transformer Accuracy Class (Note 1)	Voltage Transformer Accuracy Class (Note 2)	Nominal Overall Uncertainty for CHPQA (Note 3)
>100 MVA	BS EN 62053 (2003) Class 0.2S	0.2S	0.2	±0.5%
<100 MVA	BS EN 62053 (2003) Class 0.5S	0.2S	0.5	±1.0%
<10 MVA	BS EN 62053 (2003) Class 1	0.5	1	±1.5%
≤1 MW	BS EN 62053 (2003) Class 2	0.5	1	±2.5%

- Refer also to the Balancing and Settlement Code.

Code of Practice Four Issue 6 Version 16.0

Balancing and Settlement Code

Code of Practice Four

CODE OF PRACTICE FOR THE CALIBRATION, TESTING AND COMMISSIONING REQUIREMENTS OF METERING EQUIPMENT FOR SETTLEMENT PURPOSES

Issue 6

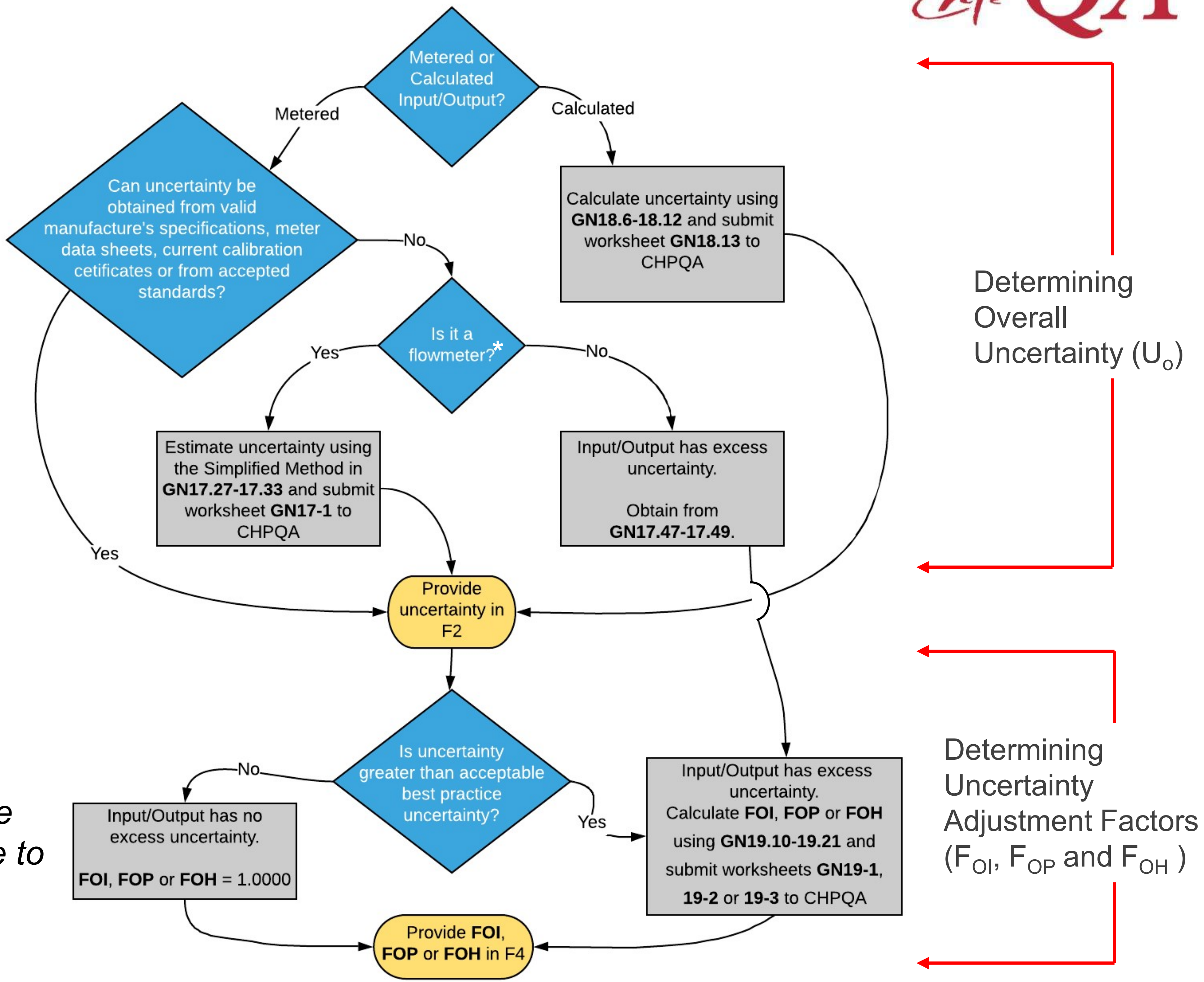
Version 16.0

Date: 03 November 2022

Balancing and Settlement Code Page 1 of 41 03 November 2022

Department for
Business, Energy
& Industrial Strategy

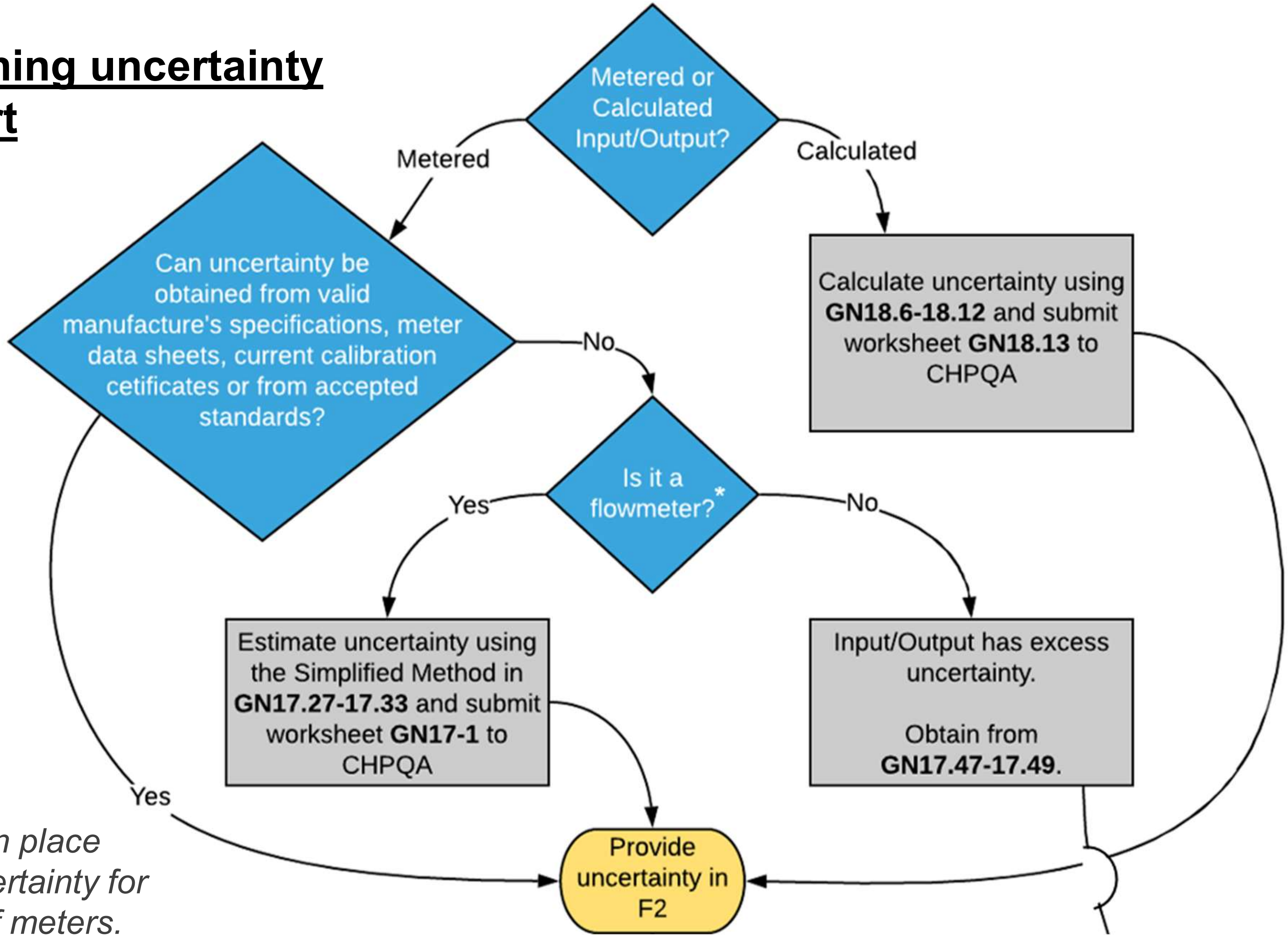
Uncertainty Flowchart



Flowchart from the new Simple Guide to Uncertainty

Determining uncertainty

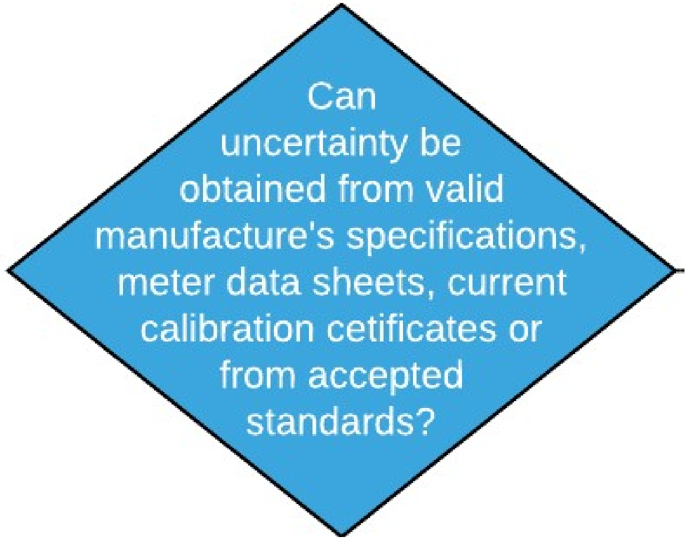
Determining uncertainty flowchart



**No method in place estimate uncertainty for other types of meters.*

Determining uncertainty

- In majority of cases, it should be possible to determine uncertainty at this point.



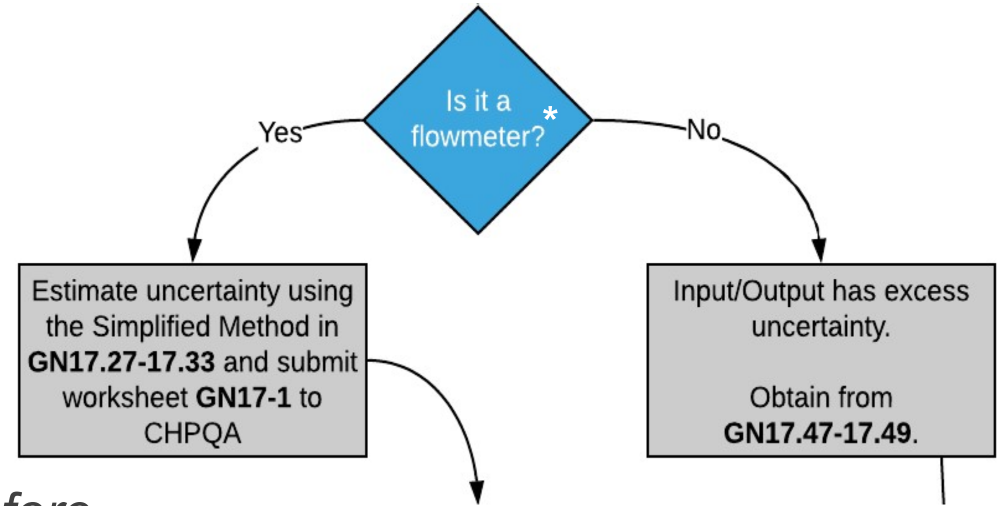
- Accepted sources:
  - Confirmation from manufacturer
  - Meter data sheets
  - Current calibration certificates
  - Fiscal meters should be within best practice – though you must have confirmation from your supplier

Department for Business, Energy & Industrial Strategy

CHPQA

Determining uncertainty

- Calculated energy inputs/outputs must determine uncertainty using GN18.6-18.12
- CHPQA have developed a Simplified Method of determining uncertainty for flow meters – see GN17.27-17.33.
- For other meter types, excess uncertainty is automatically imposed – see GN17.47-GN17.49.



**There is no method in place estimate uncertainty for other types of meters, therefore an automatic excess uncertainty is applied.*

Department for
Business, Energy
& Industrial Strategy

Determining uncertainty

- Simplified Method set out in GN17.27-17.33
- Note the effect of lack of calibration on uncertainty in tables GN17-3:

Time elapsed since transmitter calibration	Effective Uncertainty
≤ 2 years	0.0
> 2 – 3 years	2.0
> 3 – 5 years	4.0
> 5 years	10.0

and GN17-4:

Time elapsed since calibration or inspection	Effective Uncertainty Ue
≤ 5 years	0.0
> 5 – 7 years	3.0
> 7 – 10 years	7.0
> 10 years	10.0

Department for Business, Energy & Industrial Strategy

chp QA

Determining uncertainty

- The uncertainty of each energy input or output of your monitoring arrangement is requested in Question 5 of form F2 (or Q6 of F3).

Provide uncertainty in F2

Q5 : Scheme Details (Monitoring Arrangements)

See: GN13 , 14, 15, 16, 17, 18, 20 & 22

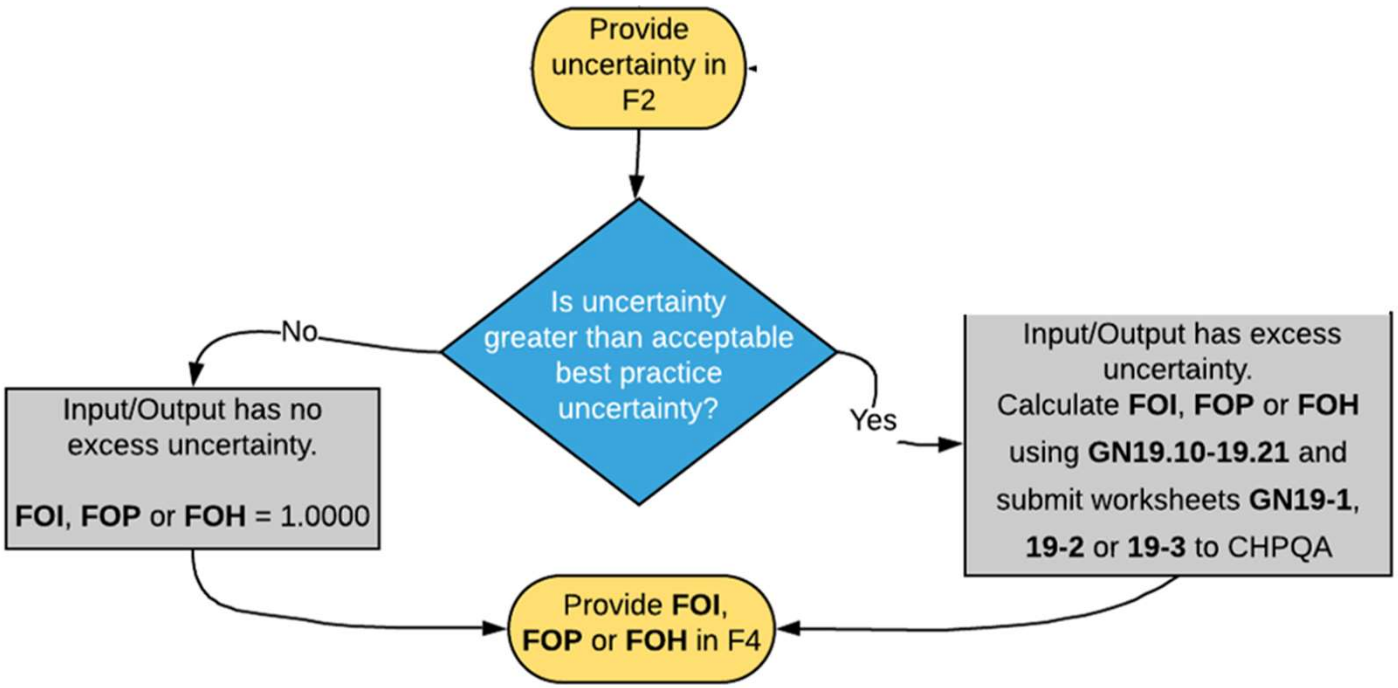
- Use this table to list all existing and proposed metering stations (including. the meters by which you are billed) for your Scheme inputs and outputs. See GN12.7 to GN12.13
- Identify each meter by tag number using the notation in the Guidance Notes. (Each meter should be identified on your Scheme line and energy flow diagrams). See GN12.3
- Provide details of all export metering (heat and electricity). See GN15.10 to GN15.14 & GN16.5 & GN16.7
- Attach details of any indirect methods used to derive unmetered inputs or outputs (include below the monitoring upon which these rely). See GN20 to GN22
- Identify the meter uncertainty % (= 100 - accuracy of reading %), attach supporting calculations. See GN17 & GN18

Tag prefix	Tag no.	User tag	Year installed		Metered service	Outputs Range	Outputs Units	Uncertainty +/-	
M	1	M1(FcQ)	2018		Fuel	80-1600	m3/hr	% 1.55	delete
Model type	Example Gas Turbine Meter		MPR meter	Yes	MPR no. 9339232669		Serial no. 1509112935		
M	2	M2(EQ)	2018		Electricity	N/A	MWh	% 1.55	delete
Model type	Example Power Meter - Class 2		MPR meter	No	MPR no. N/A		Serial no. 6243972		
M	3	M3(HQ)	2018		Heat	0.6-30000	m3/hr	% 1.05	delete
Model type	Example Heat Meter		MPR meter	No	MPR no. N/A		Serial no. 5351234		

Report to two decimal places

Excessive uncertainty

- Compare uncertainty against best practice stated in GN13.11 and GN15-1.
- If the uncertainty of an energy input/output exceeds best practice, it is deemed to have excessive uncertainty (UX).



Excessive uncertainty

- Excess uncertainty is simply the difference between the overall uncertainty of the energy input/output (U_o) and the best practice uncertainty (UBP).

If $\mathbf{U_o > UBP}$, then $\mathbf{UX = U_o - UBP}$

If $\mathbf{U_o \leq UBP}$, then $\mathbf{UX = 0.00}$

Where $\mathbf{U_o}$ = Uncertainty of value, **UBP** = Best practice uncertainty and **UX** = Excess uncertainty.

Uncertainty Adjustment Factors F_{OI}, F_{OP} and F_{OH}

- If an energy stream (fuel, heat or power) has no excessive uncertainty, we essentially apply no uncertainty adjustment factor:
  F_{OI}, F_{OP} and F_{OH} = 1.0000

- This must include for all inputs/outputs of that energy stream!

- Where there is excessive uncertainty associated with energy input/output, F_{OI}, F_{OP} and F_{OH} must be determined using GN19.10-19.21.

Input/Output has no excess uncertainty.

FOI, **FOP** or **FOH** = 1.0000

Input/Output has excess uncertainty.
Calculate **FOI**, **FOP** or **FOH** using **GN19.10-19.21** and submit worksheets **GN19-1**, **19-2** or **19-3** to CHPQA

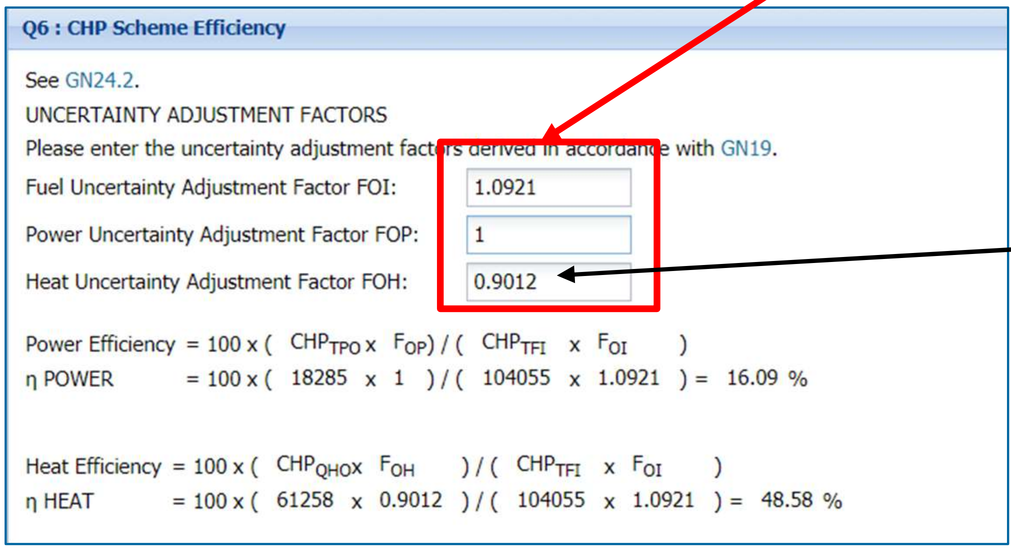
Department for Business, Energy & Industrial Strategy

chp QA

Uncertainty Adjustment Factors F_{OI}, F_{OP} and F_{OH}

- Uncertainty adjustment factors are requested in Question 6 of the F4 form.
- Note that they act to reduce heat and power efficiencies – hence reducing QI.

Provide **FOI**, **FOP** or **FOH** in F4



Q6 : CHP Scheme Efficiency

See GN24.2.

UNCERTAINTY ADJUSTMENT FACTORS

Please enter the uncertainty adjustment factors derived in accordance with GN19.

Fuel Uncertainty Adjustment Factor FOI:	1.0921
Power Uncertainty Adjustment Factor FOP:	1
Heat Uncertainty Adjustment Factor FOH:	0.9012

Power Efficiency = 100 x (CHP_{TPO} x F_{OP}) / (CHP_{TFI} x F_{OI})

η POWER = 100 x (18285 x 1) / (104055 x 1.0921) = 16.09 %

Heat Efficiency = 100 x (CHP_{QHO}x F_{OH}) / (CHP_{TFI} x F_{OI})

η HEAT = 100 x (61258 x 0.9012) / (104055 x 1.0921) = 48.58 %

Report to four decimal places

Adjustment factors reduce power and heat efficiencies

Management of uncertainty

- Uncertainty adjustment factors act to reduce the performance of a scheme. It is therefore in your best interests to minimise uncertainty.

- Optimise your CHPQA performance – keep calibrated! Develop an appropriate calibration schedule.

- Alternatively, meters may be replaced for new if this works out to be more economical.

- Evidence of current calibration certificates and a calibration schedule will be requested on site audit.

Department for Business, Energy & Industrial Strategy

chp QA

CHPQA Contact Details

CHPQA Administrator

The Gemini Building
Fermi Avenue
Harwell
Didcot
OX11 0QR

E-mail: **chpqainfo@chpqa.com**

Tel: 01235 753004

Web: **https://www.gov.uk/combined-heat-power-quality-assurance-programme**

Thank You