



CHPQA – Metering Requirements: Uncertainty

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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 accordance with the following table:	
Fuel Uncertainty Adjustment Factor FOI:	<input type="text" value="1.0921"/>
Power Uncertainty Adjustment Factor FOP:	<input type="text" value="1"/>
Heat Uncertainty Adjustment Factor FOH:	<input type="text" value="0.9012"/>



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

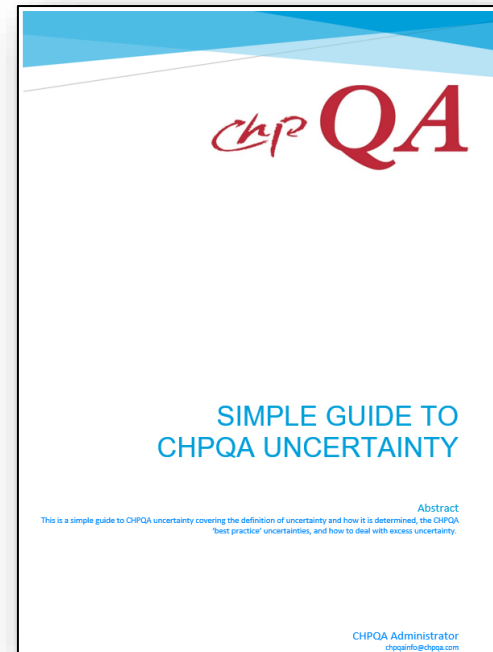
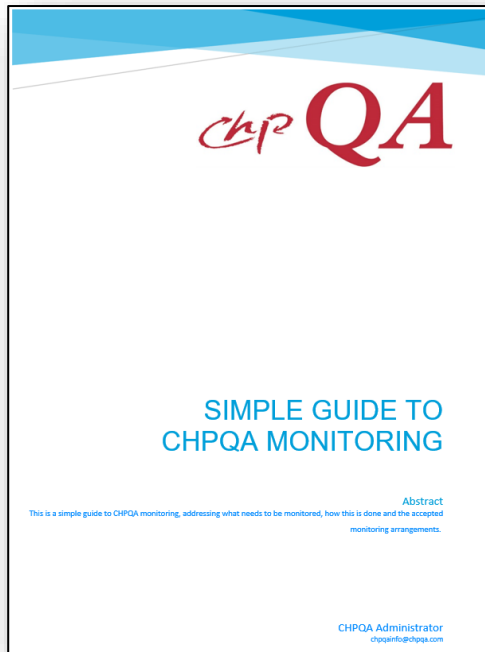
GN23 – Correction of Bias in Inputs and Outputs Information

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



New Simple Guidance

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





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 $\pm n\%$ 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 $\pm 2\%$.

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 ± 0.2 l/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 $\pm 1\%$ of full-scale reading becomes an uncertainty of $\pm 2\%$ 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



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



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

<ul style="list-style-type: none"> Fuel Inputs, kWh 	±2.0% of reading
<ul style="list-style-type: none"> Energy <u>inputs</u> as steam or hot water, kWh 	As for steam or hot water as appropriate (see below)
<ul style="list-style-type: none"> 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.
<ul style="list-style-type: none"> Metering of steam flows and derivation of energy content, kWh 	±2.0% of full scale ±3.0% of reading
<ul style="list-style-type: none"> Electric power, kWh 	Metering to applicable BS and Class dependant on rating, see GN15.7
<ul style="list-style-type: none"> 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.



CHPQA best practice - electricity

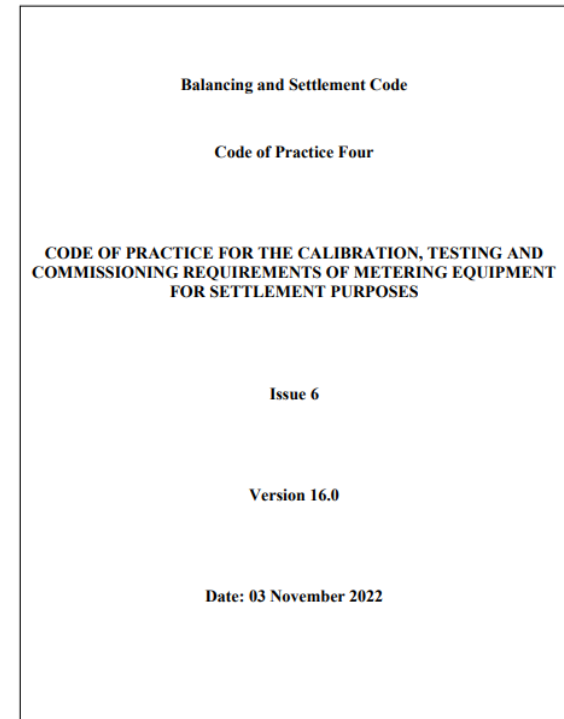
- Uncertainty (or class) requirements specific to power meters are detailed separately in Table GN15-1.

Code of Practice Four

Issue 6 Version 16.0

Table GN15-1 – Classification of Electricity Metering Equipment

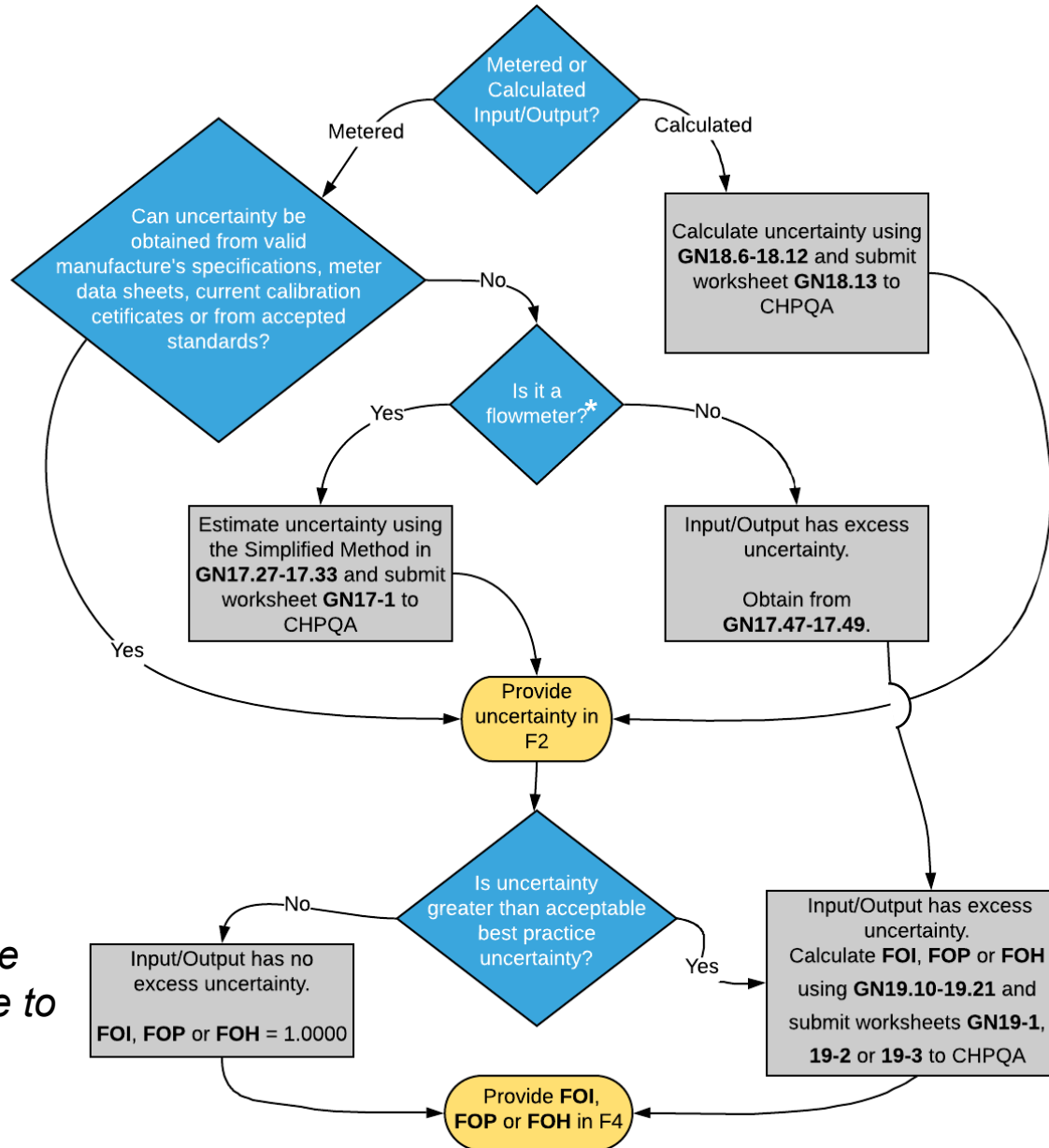
Rated Capacity	Watt-Hour Meter Standard and Accuracy Class	Current Transformer Accuracy Class (Note 1)	Voltage Transformer Accuracy Class (Note 2)	Nominal Overall Uncertainty for CHPQA (Note 3)
>100 MVA	BS EN 62053 (2003) Class 0.2S	0.2S	0.2	±0.5%
<100 MVA	BS EN 62053 (2003) Class 0.5S	0.2S	0.5	±1.0%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



Uncertainty Flowchart



Determining Overall Uncertainty (U_o)

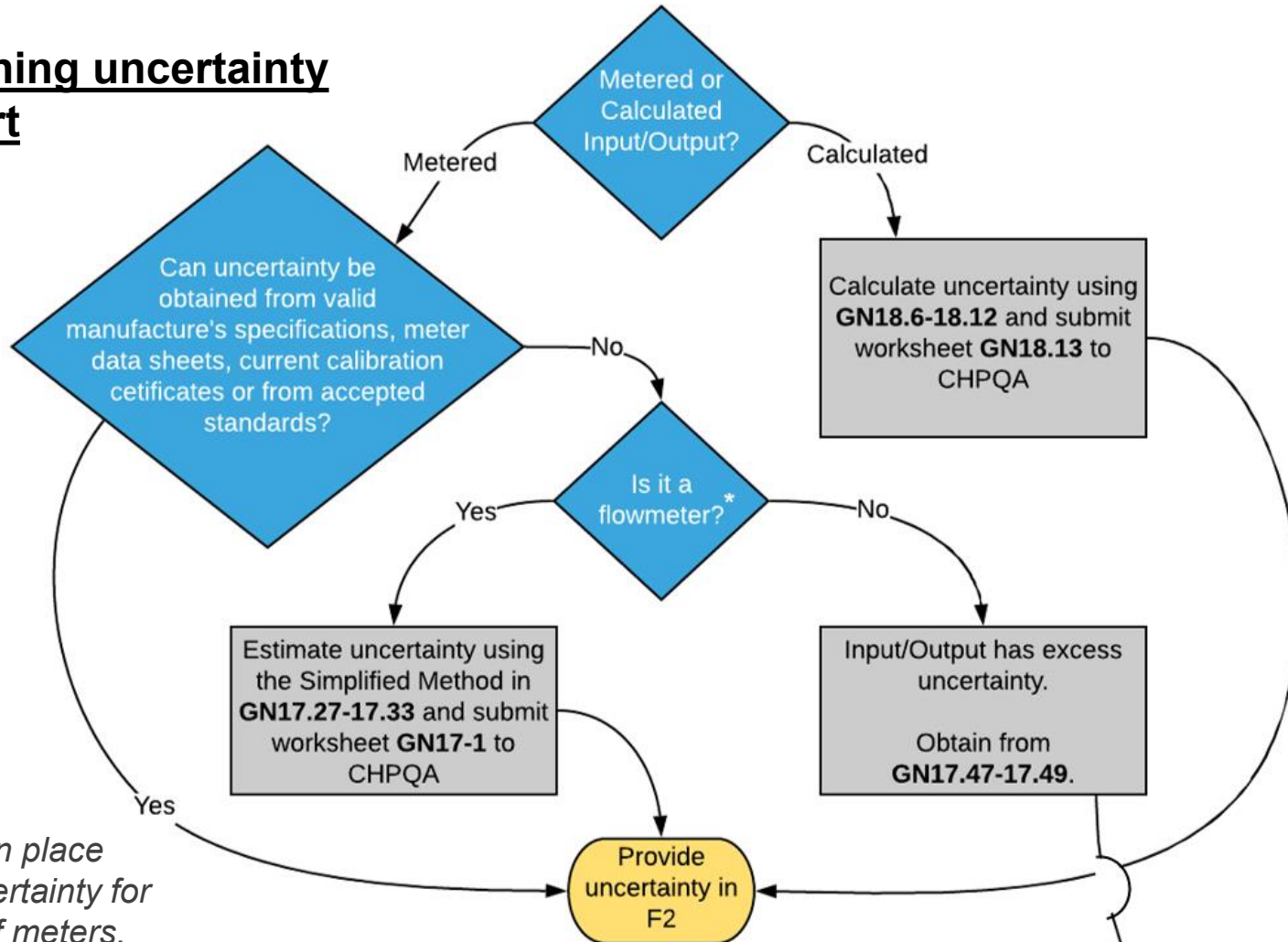
Determining Uncertainty Adjustment Factors (F_{OI} , F_{OP} and F_{OH})

Flowchart from the new Simple Guide to Uncertainty



Determining uncertainty

Determining uncertainty flowchart

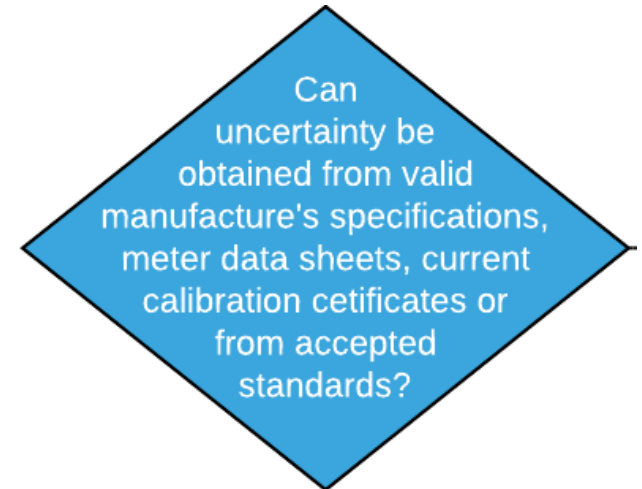


**No method in place estimate uncertainty for other types of meters.*



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

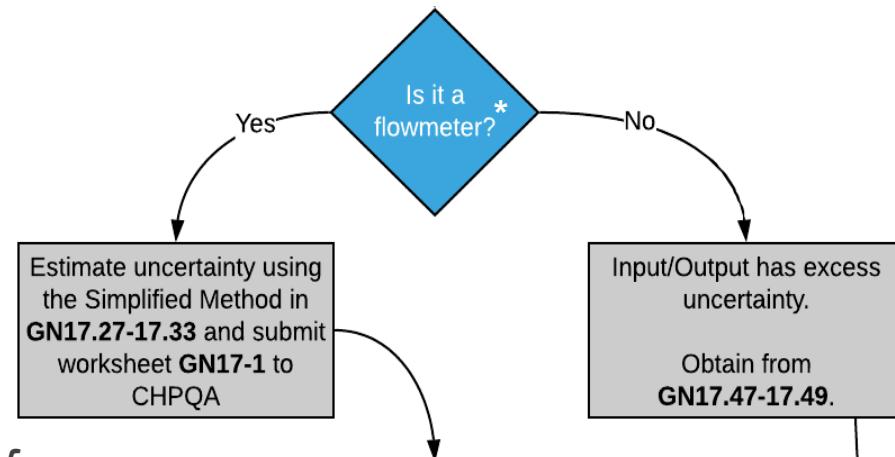




Determining uncertainty

- 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.*





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 U_e
≤ 5 years	0.0
> 5 – 7 years	3.0
> 7 – 10 years	7.0
> 10 years	10.0



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 unmetred 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

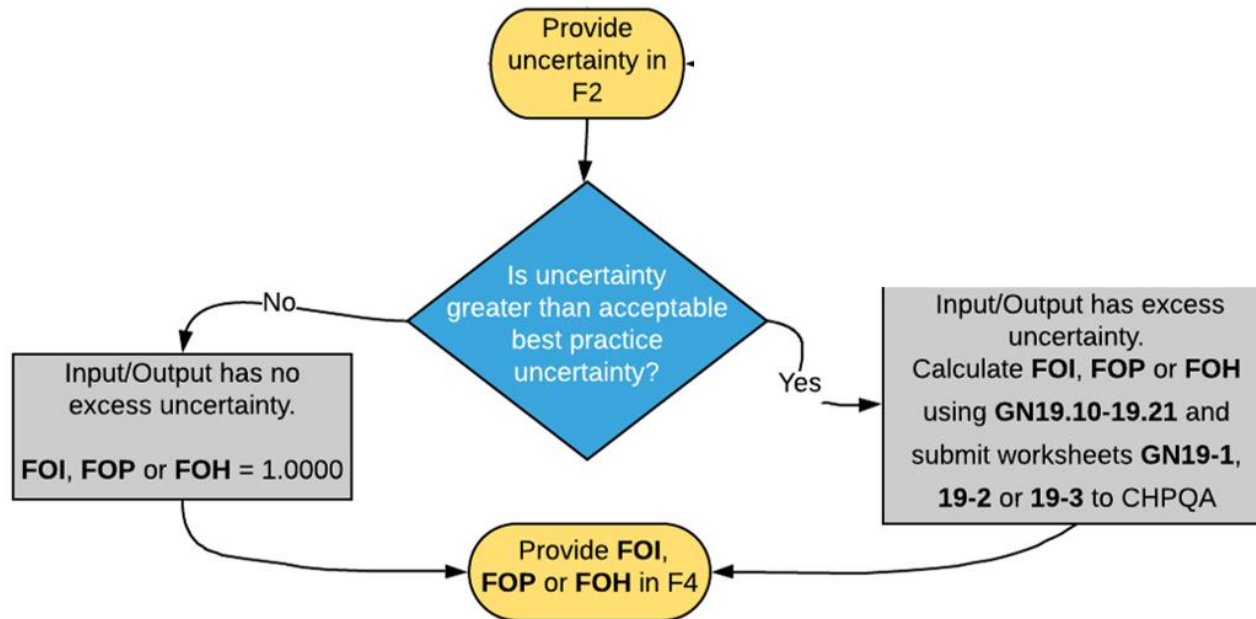
Tag prefix	Tag no.	User tag	Year installed	Metered service	Range	Outputs Units	Uncertainty +/-	
M	1	M1(FcQ)	2018	Fuel	80-1600	m3/hr	% 1.55	delete
Model type		Example Gas Turbine Meter	MPR meter	Yes	MPR no.	9339232669	Serial no.	1509112935
M	2	M2(EQ)	2018	Electricity	N/A	MWh	% 1.55	delete
Model type		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 $U_o > \text{UBP}$, then $\text{UX} = U_o - \text{UBP}$

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

Where 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:

$$F_{OI}, F_{OP} \text{ and } F_{OH} = 1.0000$$

- 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.

F_{OI} , F_{OP} or $F_{OH} = 1.0000$

Input/Output has excess
uncertainty.

Calculate **F_{OI} , F_{OP} or F_{OH}**
using **GN19.10-19.21** and
submit worksheets **GN19-1,**
19-2 or 19-3 to CHPQA



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:

Power Uncertainty Adjustment Factor FOP:

Heat Uncertainty Adjustment Factor FOH:

Power Efficiency = $100 \times (\text{CHP}_{TPO} \times F_{OP}) / (\text{CHP}_{TFI} \times F_{OI})$
 $\eta_{\text{POWER}} = 100 \times (18285 \times 1) / (104055 \times 1.0921) = 16.09 \%$

Heat Efficiency = $100 \times (\text{CHP}_{QHOX} \times F_{OH}) / (\text{CHP}_{TFI} \times F_{OI})$
 $\eta_{\text{HEAT}} = 100 \times (61258 \times 0.9012) / (104055 \times 1.0921) = 48.58 \%$

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.



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Thank You