

BCG 1.0A

Rounding procedures

Technical description and recommendations on rounding of natural gas Wobbe index, densities, heating values and related values

Notes

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Introduction

BCG covers quantity conversion solutions for:

- All natural gases, natural-gas substitutes and similar fluids that are present in the gaseous phase (state) at normal(standard) ISO conditions as specified in ISO 13443 First edition –1996-12-15. The standard conditions are 101,325 kPa and 15 °C. By this definition, LNG (liquefied natural gas) is also included in the product definition range.
- Liquid hydrocarbons (NGL/LPG) having a vapour pressure greater than atmospheric pressure at 15°C, in which the standard pressure shall be equilibrium pressure at 15°C. The standard conditions are 101,325 kPa and 15 °C.

For all products falling into one of these categories, QuantityWare now offers, or plans to offer implementations of quantity conversion standards, depending on the availability of national/international measurement standards and customer requirements. For a detailed list of standards supported with BCG 10A, please refer to the document “BCG 10A Supported standards”.

With BCG 1.0A, we deliver a complete solution which covers all quantity conversion and measurement requirements for the relevant supply chain management business processes of natural gas (low and high pressure regime), NGL and LNG. With the conversion groups (more than 330 conversion groups for natural gas, 80 for LNG) you are able to configure all your SAP Oil & Gas processes, such as inventory management, order-to-cash processes, procure-to-pay, as well as complex scheduling and transmission processes within the SAP Trader’s & Schedulers Workbench.

1. Installation

The technical implementation is provided as a part of a CSP package for BCG 10A.

Please follow the standard SAP instructions for importing service packages into your system via transaction SPAM, or the implementation on installation packages via transaction SAINT.

SAP Oil and Gas must be installed

QuantityWare BCG 10A must be installed.

Customizing settings, which are needed in every client in which this standard will be used, are included in the delivery package.

On releases based upon SAP 4.72 and below, the related customizing transport must be imported into all necessary clients, or distributed to them from client 000.

On releases based upon SAP ERP 2005 (ECC 6.00) or newer, BC Set /QTYW/BCG_10A must be activated in the relevant clients.

Please refer to the QuantityWare BCG 10A Installation Guide for more information.

▲ WARNING: *If you import the customizing template into a pre-existing client, any pre-existing entries listed within the template (transport or BC-Set) will be **OVERWRITTEN!***

2. Basic definitions of natural gas quantities and behavior

Besides serving as basic feedstock for the chemical industry, natural gas is predominantly used for heat production as a fuel in large industry sites and millions of households worldwide.

In order to define a trading value for natural gas and to ensure natural gas interchangeability, certain quantities that characterize natural gas must be defined and recorded in business transactions for various processes e.g. inventory management, quality assurance, pricing and excise duty payments. For a comprehensive list of such quantities we recommend ISO standard ISO 6976 as a reference.

With BCG 1.0A QuantityWare delivers conversion groups that are designed for all globally known standard reference conditions for natural gas in the gas phase (high and low pressure regime (CNG), as well as conversion groups for NGL (Natural Gas Liquids). With the release of BCG 1.0A, LNG (Liquefied Natural Gas) support is also in scope.

In order to aid the comprehension of this documentation, we cite the most important definitions from standard ISO 6976 & ISO 6578.

Common definitions:

Superior calorific value:

The amount of heat which would be released by the complete combustion in air of a specified quantity of gas, in such a way that the pressure p_1 at which the reaction takes place remains constant, and all the products of combustion are returned to the same specified temperature t_1 as that of the reactants, all of these products being in the gaseous state except for water formed by combustion, which is condensed to the liquid state at t_1 .

▲ A synonym for calorific value is the term **heating value**. Calorific values can be specified on a molar or mass basis. Then the calorific value depends on the combustion reference conditions t_1 and p_1 . More commonly, calorific values are determined based upon a volumetric basis ;in this instance, the calorific value needs to be specified with the combustion reference conditions t_1 and p_1 as well as the volumetric reference conditions t_2 and p_2 .

Inferior calorific value:

The amount of heat which would be released by the complete combustion in air of a specified quantity of gas, in such a way that the pressure p_1 at which the reaction takes place remains constant, and all the products of combustion are returned to the same specified temperature t_1 as that of the reactants, all of these products being in the gaseous state.

Density:

The density is the mass of a gas sample divided by its volume at specified conditions of pressure and temperature.

Relative density:

The density of a gas divided by the density of dry air of standard composition (see Annex B ISO 6976:1995 for a definition of dry air) at the same specified conditions of pressure and temperature.

Wobbe index:

The superior calorific value on a volumetric basis at specified reference conditions, divided by the square root of the relative density at the same specified metering reference conditions.

- ▲ *The Wobbe index is an important quality designation for natural gas, which is commonly used to determine trade prices and the interchangeability of natural gas.*
- ▲ *The SAP QCI does not calculate the Wobbe index for natural gas. BCG contains functions to perform these calculations within the delivered global templates.*

Gas interchangeability:

An important business requirement when trading natural gas is that natural gas combustion is kept at a defined quality levels that are e.g. required by burners. The Wobbe index (sometimes also referred to as Wobbe number) can serve as one important quality number to ensure interchangeability of natural gas batches with e.g. an apparent different composition.

Ideal gas and real gas:

An ideal gas is one that obeys the ideal gas law:

$$p \cdot V_m = R \cdot T \quad \dots(1)$$

where

p is the absolute pressure

T is the thermodynamic temperature

V_m is the volume per mole of gas

R is the molar gas constant, in coherent units.

No real gas obeys this law. For real gases, equation (1) must be rewritten as

$$p \cdot V_m = Z(T,p) \cdot R \cdot T \quad \dots(2)$$

where $Z(T,p)$ is a variable often close to unity, and is known as the compression factor.

Compression factor:

The actual (real) volume of a given mass of a gas at specified pressure and temperature divided by its volume, under the same conditions, as calculated by the ideal gas law.

Combustion reference conditions:

The specified temperature t_1 and pressure p_1 . These are the conditions at which the fuel (natural gas) is notionally burned.

Metering reference conditions:

The specified temperature t_2 and pressure p_2 . These are the conditions at which the amount of the fuel to be burned is notionally determined; there is no a priori reason for these to be the same as the combustion reference conditions.

▲ *A range of reference conditions is in use throughout the world. In order to ensure ease of trade, exact conversions of natural gas quantities between different sets of reference conditions is required, based on international standards. This range of different reference conditions is also one of the main reasons why natural gas quantity conversions are complex, even in the low pressure regime.*

Standard reference conditions of selected countries:

Country	t_1	p_1	t_2	p_2
Argentina	-	101,325 kPa	15 °C	101,325 kPa
Australia	15 °C	101,325 kPa	0 °C	101,325 kPa
Austria	25 °C	101,325 kPa	0 °C	101,325 kPa
Belgium	25 °C	101,325 kPa	0 °C	101,325 kPa
Brazil	-	101,325 kPa	0 °C	101,325 kPa
Canada	15 °C	101,325 kPa	15 °C	101,325 kPa
China	20 °C	101,325 kPa	20 °C	101,325 kPa
Czechoslovakia	25 °C	101,325 kPa	20 °C and 0 °C	101,325 kPa
Denmark	25 °C	101,325 kPa	0 °C	101,325 kPa
Egypt	-	101,325 kPa	15 °C	101,325 kPa
Finland	-	101,325 kPa	15 °C	101,325 kPa
France	0 °C	101,325 kPa	0 °C	101,325 kPa
Germany	25 °C	101,325 kPa	0 °C	101,325 kPa
Hong Kong	-	101,325 kPa	15 °C	101,325 kPa
Hungary	-	101,325 kPa	0 °C	101,325 kPa
India	-	101,325 kPa	0 °C	101,325 kPa
Indonesia	-	101,325 kPa	0 °C	101,325 kPa
Iran	-	101,325 kPa	15 °C	101,325 kPa
Ireland	15 °C	101,325 kPa	15 °C	101,325 kPa
Italy	25 °C	101,325 kPa	0 °C	101,325 kPa
Japan	0 °C	101,325 kPa	0 °C	101,325 kPa
Netherlands	25 °C	101,325 kPa	0 °C	101,325 kPa
New Zealand	-	101,325 kPa	15 °C	101,325 kPa
Norway	-	101,325 kPa	15 °C	101,325 kPa
Pakistan	-	101,325 kPa	15 °C	101,325 kPa
Romania	25 °C	101,325 kPa	15 °C and 0 °C	101,325 kPa
Russia	25 °C	101,325 kPa	20 °C and 0 °C	101,325 kPa
Spain	0 °C	101,325 kPa	0 °C	101,325 kPa
Sweden	-	101,325 kPa	0 °C	101,325 kPa
United Kingdom	15 °C	101,325 kPa	15 °C	101,325 kPa
USA	15 °C	101,325 kPa	15 °C	101,325 kPa
Yugoslavia	0 °C	101,325 kPa	0 °C	101,325 kPa

Source: ISO 13443 and ISO 12213.

On the other hand, ISO 6976 specifies six sets of reference conditions for heating values on a volumetric basis (Table 5 therein), which can be extracted from the above table, and one additional set (25/15) is apparently in usage in some countries. QuantityWare thus defines a global template for the SI system based on seven sets of combustion and metering reference conditions, plus an additional three sets of U.S. customary conditions.

Additional LNG specific definitions:

Liquefied natural gas (LNG):

Liquids composed predominantly of methane.

Orthobaric density:

The mass of the liquid occupying unit volume at a given temperature, the liquid being in the equilibrium with its vapour.

3. Accuracy aspects of natural gas property values

When calculating physical property values such as heating values, densities and Wobbe index, the precision of such values, which result from random errors in the analytical procedures to determine basic property data, may be expressed in terms of repeatability and/or reproducibility. Definitions of these terms can be found in EN ISO 6976:2005, chapter 9.

It is generally accepted that quoting figures with large numbers of decimals in business process relevant documents (i.e. pricing) is not realistic as such figures do not take into account the boundaries defined by examination of repeatability and/or reproducibility.

In other words, the number of significant figures which are given for the value of each property should reflect the expected accuracy of calculation of the property in question. Contracts between business partners may clearly specify the number of significant figures to be used for the measurement process.

ISO 6976 recommends that the expression of gas mixture calculation results, even in the case of a “perfect” analysis, is to be reported no better than the following levels of significance:

Calorific value (heating value) – molar basis:	0.01 kJ/mol
– mass basis:	0.01 MJ/kg
– volumetric basis:	0.01 MJ/ m ³
Relative density:	0.0001
Density:	0.001 kg/ m ³
Wobbe index:	0.01 MJ/ m ³

Attention must be paid to whether the analytical data justify quoting this level of significance; if not, the number of significant figures should be reduced accordingly.

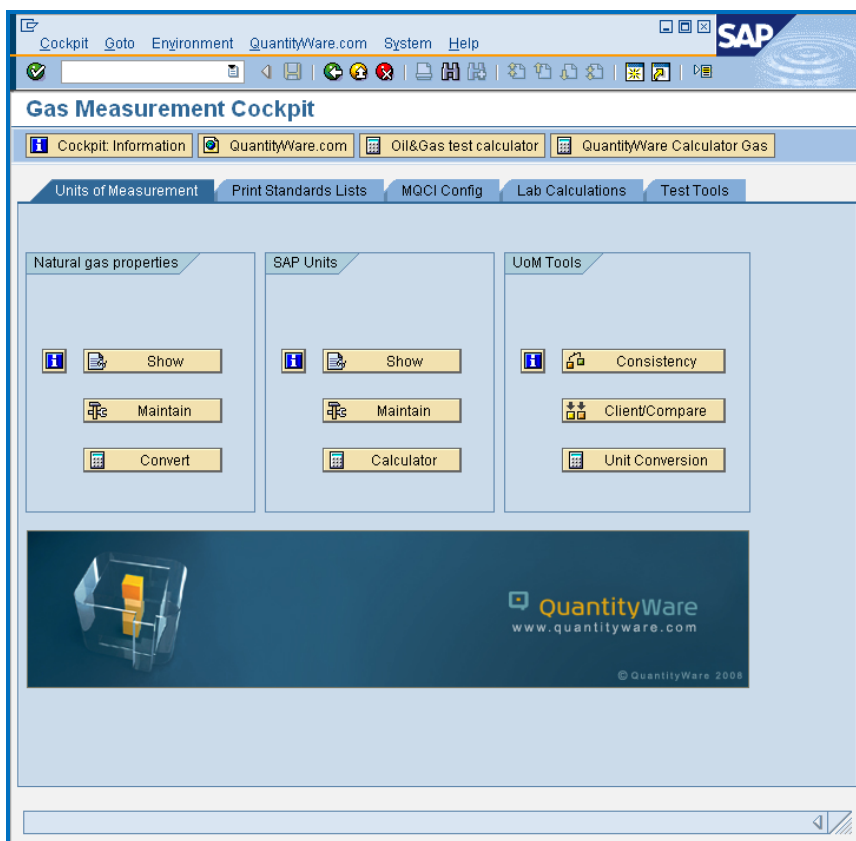
4. Rounding properties in BCG implementations – MQCI

For all MQCI implementations, two rules apply:

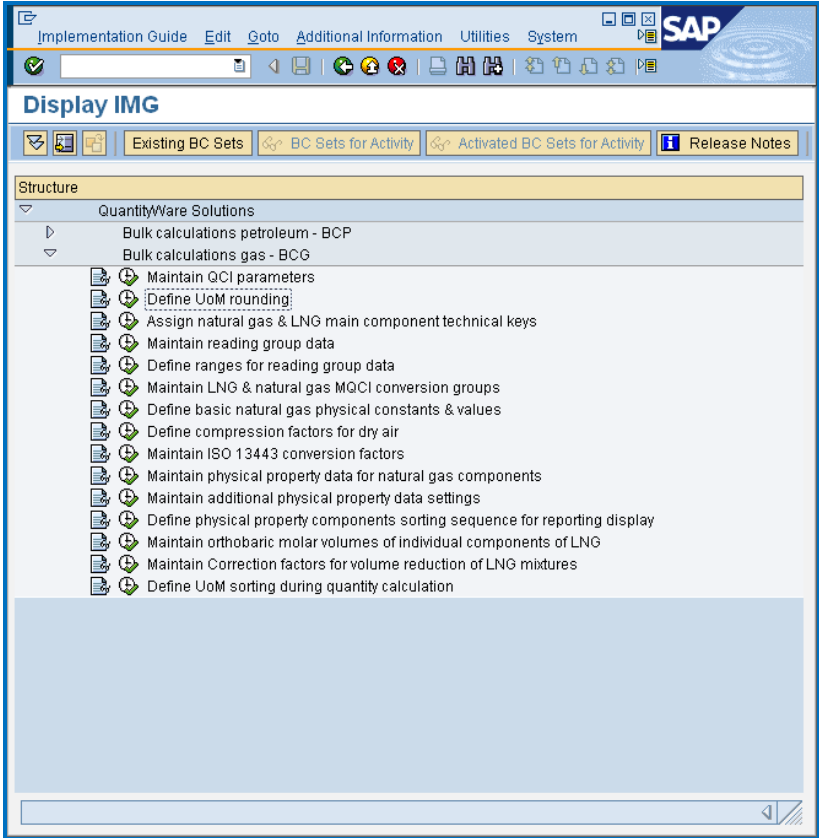
- The MQCI implementations for natural gas and LNG enable rounding via settings within the conversion group and physical property data set customizing. All rounding is based on the definitions of the relevant unit of measure, which is assigned in customizing.
- If a measurement standard specifies rounding, this rounding is implemented according to the standard.

4.1. Rounding settings for a unit of measure

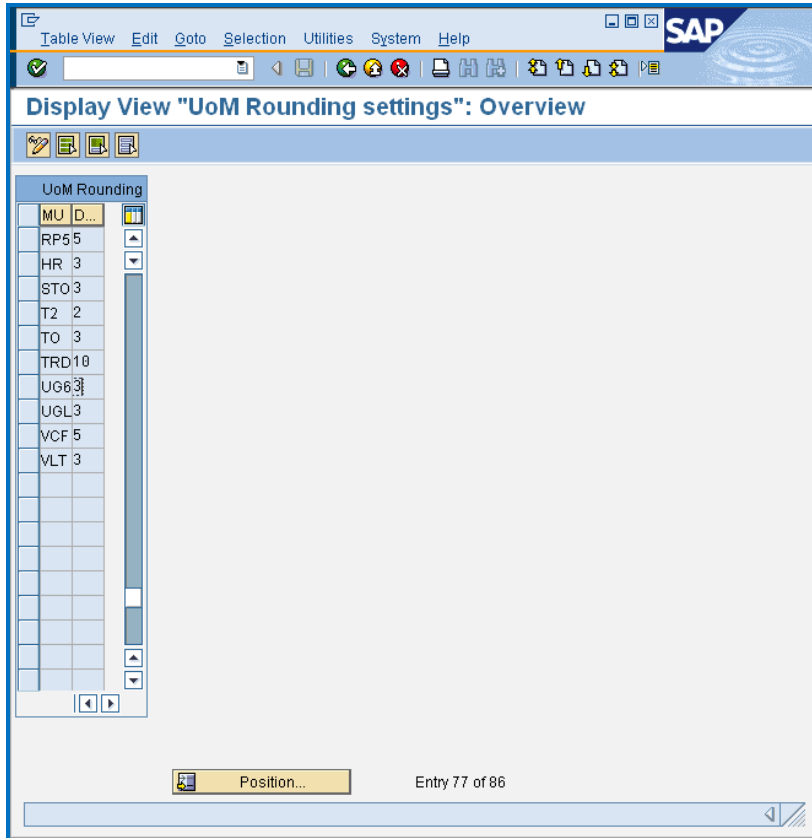
The rounding definition for a UoM has to be entered separately customizing for each unit of measure as shown below. You can access transaction /QTYW/UOM_ROUND from the Gas Measurement Cockpit:



Choose: Measurement Cockpit menu path: Goto -> QuantitWare IMG



Here you choose: "Define UoM rounding":



If you maintain a valid UoM and an entry in the field: “Decimal pl. rounding”, values such as heating values, densities and Wobbe index are rounded. Valid entries for “Decimal pl. rounding” are:

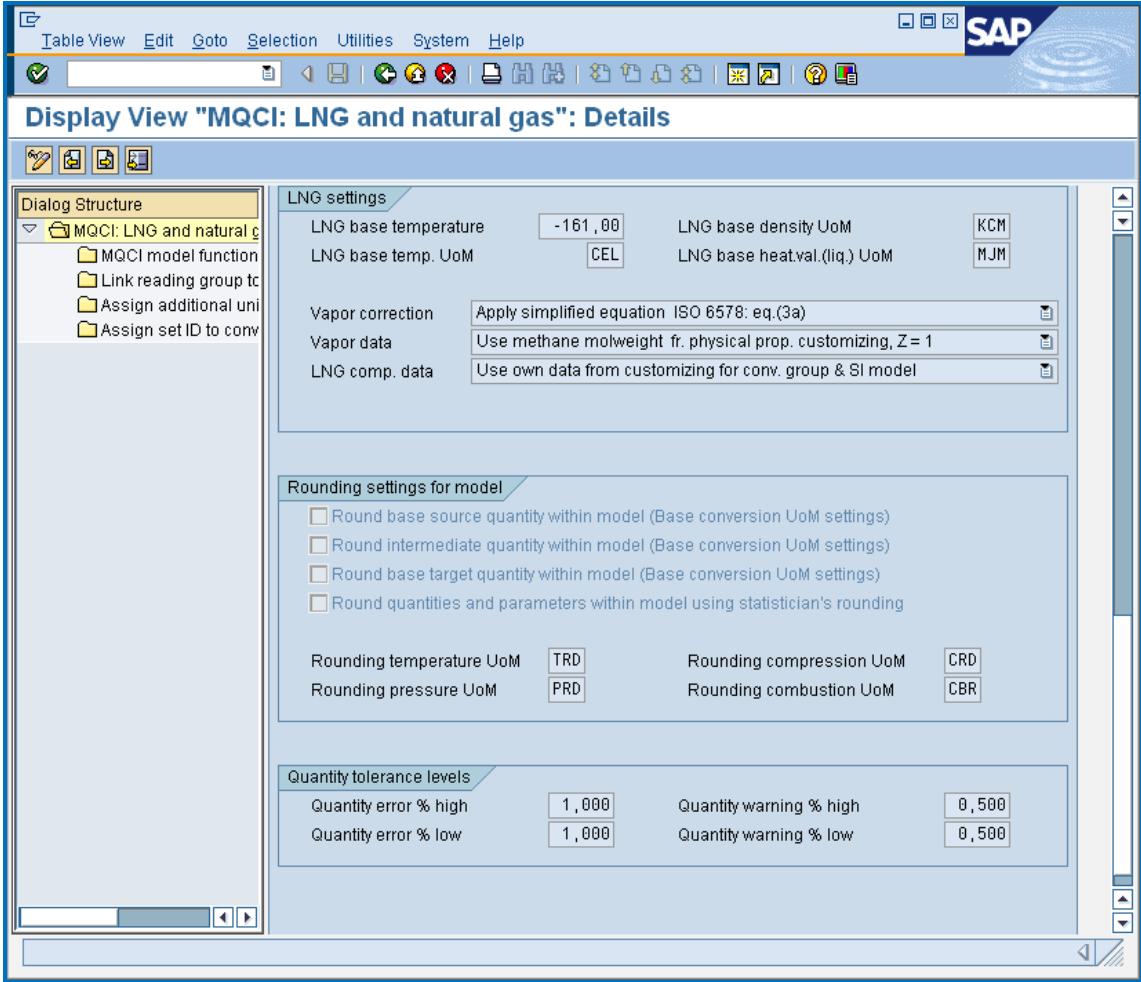
- Any number between 14 and 1 (rounding to the 14th up to the first decimal place after the period)
- Any number between 0 and -10 (rounding to the first (zero decimal rounding) up to the 10th digit before the period).
- UoM not maintained: no rounding for UoM values

▲ *Example 1: You set “Decimal places rounding for the unit MJM to 2. The system calculates a heating value of **42.227896789 MJM**. Rounding leads to a reported result of **42.23 MJM**.*

▲ *Example 2: You set “Decimal places rounding for the unit MJM to 1-. The system calculates a heating value of **42.227896789 MJM**. Rounding leads to a reported result of **42.00 MJM**.*

4.2. Conversion group rounding settings

In the conversion group, you define the base conversion units, which are utilized for intermediate rounding, if this is activated. Also, you define rounding UoM for temperature, pressure, and compression factors there as well.



4.3. Physical property data rounding settings

For each physical property data set, you define rounding settings and rounding UoM in customizing:

Table View Edit Goto Selection Utilities System Help SAP

Display View "Maintain rounding settings for fractions": Overview

Dialog Structure

- ▢ Declare summation factor definition
- ▢ Maintain rounding settings for fractions

Set	Short Description	R...	R...	R...	R...	Rounding ind. molar m
Q0	QW: GPA 2172-96, 60°F/14.696 PSI	RP4	RP5	RP5	RP1	Round individual p
Q1	QUANTITYWARE:25°C / 0°C ISO 6976 DATA					Round final sum ac
Q2	QUANTITYWARE:15°C / 15°C ISO 6976 DATA					Round final sum ac
Q3	QUANTITYWARE:0°C / 0°C ISO 6976 DATA					Round final sum ac
Q4	QUANTITYWARE:15°C / 0°C ISO 6976 DATA					Round final sum ac
Q5	QUANTITYWARE:20°C / 20°C ISO 6976 DATA					Round final sum ac
Q6	QUANTITYWARE:25°C / 20°C ISO 6976 DATA					Round final sum ac
Q7	QUANTITYWARE:25°C / 15°C ISO 6976 DATA					Round final sum ac
Q8	QUANTITYWARE: 15°C / 15°C ISO 6578 DATA					Round final sum ac
QA	QW: GPA 2145-03,REV.2, 60°F/14.696 PSI					Round final sum ac
QB	QW: GPA 2145-09 60°F/14.696 PSI	RP4	RP5	RP5	RP1	Round individual p
QC	QW: GPA 2145-09 15 °C/101.325 KPA	RP4	RP5	RP5	RP3	Round individual p
QD	QW: GPA 2145-03,REV.2,15°C/15°C/101,325					Round final sum ac
QE	QW: GPA 2145-09 BASED 60°F/15.025 PSI	RP4	RP5	RP5	RP1	Round individual p
QF	QW: GPA 2145-09 BASED 60°F/14.730 PSI	RP4	RP5	RP5	RP1	Round individual p
QG	QW: GPA 2145-09 BASED 60°F/14.650 PSI	RP4	RP5	RP5	RP1	Round individual p

Position... Entry 1 of 16

5. Rounding properties in BCG implementations – SAP QCI

5.1. Rounding of input data – SAP QCI

Within BCG **NO ROUNDING** of input data beyond the settings for data entry in the unit of measure definitions is performed

5.2. Intermediate rounding – SAP QCI

BCG implementations strictly follow all documented implementation guidelines for calculation procedures; this is also the case with respect to rounding, wherever such guidelines are available.

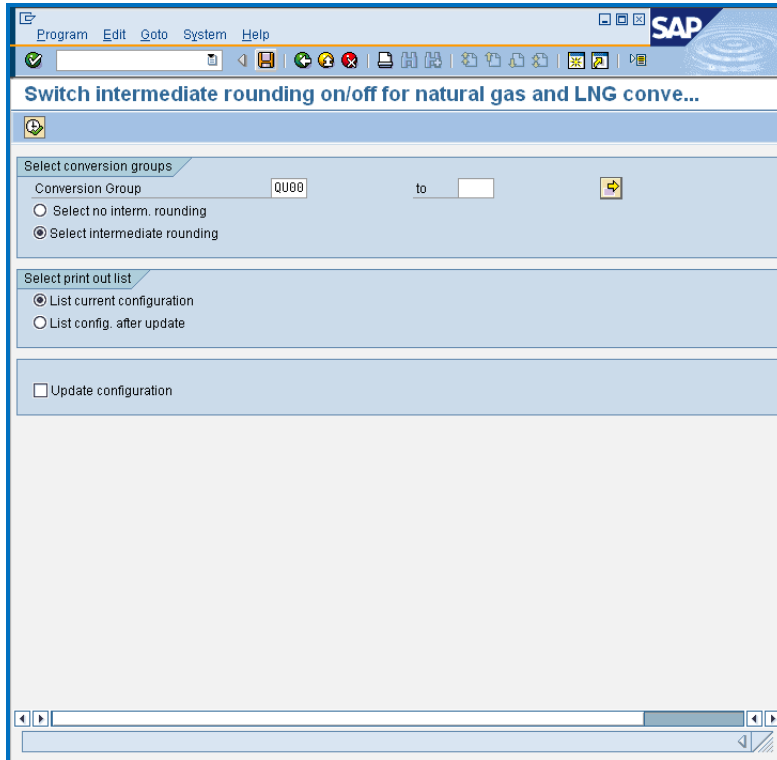
This is the case for the highly complex procedures defined in ISO 122213-2 & -3 (AGA8 and SGERG methods). Other calculation procedures are documented as purely mathematical procedures with no explicit statement on rounding of intermediate results.

▲ *BCG implementations for the SAP QCI avoid rounding within all procedures.*

▲ *However, three exceptions from this rule have to be noted:*

- When calculating the compression factor of dry air, the results are always rounded to 5 significant decimal places, as this is the level of accuracy of the data provided in ISO 6976.
- When calculating the heating values from physical properties data, where the component data is present as Energy/mol, the resulting heating values are rounded to the levels defined above, thus reproducing all example calculations defined in ISO 6976.
- When calculating the LNG density from composition, the resulting density in kg/ m³ is rounded to 0.1 kg/ m³, thus reproducing all data from the example calculations provided in ISO 6578.

It is possible to switch off heating values' rounding on a molar basis and the LNG density described above. Report /QTYW/ROUNDING_CONTROL should be used for this purpose.. Within this report, you can change the customizing settings of any natural gas conversion group. You have the following selection options:



You can enter any range of conversion groups for natural gas or LNG for which you require a configuration change.

Choose either “Select no intermediate rounding” or “Select intermediate rounding” (the QuantityWare default of the BCG template conversion groups). You can then run the report – it will output a list of the configuration before or after a possible update. In detail, one special function module is added or removed to the function module call sequence in customizing, i.e. function /QTYW/NO_FIXED_ROUNDING is being added to the function module sequence customizing, which prohibits intermediate rounding.

5.3. Rounding of calculation results – SAP QCI

BCP implementations for the SAP QCI do not round any final results. Instead, a special connector function is provided (/QTYW/ROUNDING_CONNECTOR), that is part of every BCG template conversion group configuration. Within this function, the rounding of final results can be performed, if the corresponding unit of measure is defined to be rounded. (E.g. recommended in ISO 6976 (see data above). The definition has to be entered separately in transaction /QTYW/UOM_ROUND for each unit of measure as described above.