

BCG 1.0A

Validation

Implementation -

ISO 13443 & ISO

6976

Validation of SAP QCI for
natural gas based on a global
natural gas quantity conversion
template

Notes:

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Introduction

This solution is a configuration & validation implementation based on:


Standard ISO 13443 First edition 1996-12-15 (Natural gas - Standard reference conditions)

and

Standard ISO 6976 Second edition 1995-12-01, corrected and reprinted 1996-02-01
(Natural gas – Calculation of calorific values, density, relative density and Wobbe index from composition)

The solution is part of the product Bulk Calculations Gas Version 1.0A (BCG 10A).

The solution runs only in an SAP ABAP environment in which IS-Oil has been implemented.

 *This validation implementation is not relevant if you utilize the QuantityWare MQCI natural gas conversion groups*

The solution can be accessed by the SAP Quantity Conversion Interface (QCI) and is controlled by the Conversion Groups provided within this configuration implementation.

1. Installation

The technical implementation is provided as a part of the initial BCG 10A installation SAINT package.

Please follow the QuantityWare SAINT Installation instructions for BCG 10A.

SAP Oil & Gas must be installed

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

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

On releases ERP 2005 (ERP 6.0) 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.

2. Basic definitions of natural gas quantities and behaviour

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 equilibrium with its vapour.

3. Components of the Installation

Within this implementation, we provide conversion groups and reading groups that calculate the base density & base heating value as well as quantity values (energies, masses and volumes at any desired reference condition set) for natural gas (**LOW PRESSURE**) at **ideal & real gas conditions using the SAP QCI**.

Customizing data:

SI system:

The conversion groups QV00 to QV1C are provided within BCG 1.0A using SI measurement units with standard reference pressure values p_1 and p_2 of 101,325 kPa,

$t_1/^\circ\text{C}$ = combustion reference temperature

$t_2/^\circ\text{C}$ = volumetric or metering reference temperature

Heating value types:

01: Energy / Volume

02: Energy / Mass

03: Energy / Mol

Heating value classes:

SD: Superior, dry

SW: Superior, wet

ID: Inferior, dry

IW: Inferior, wet

U.S. customary system:

The conversion groups QV20 to QV2K are provided using U.S. customary measurement units:

$t_1/^\circ\text{C}$ = combustion reference temperature = 60 °F

$t_2/^\circ\text{C}$ = volumetric or metering reference temperature 60°F

p_2/PSI = volumetric or metering reference pressure , variable (different in different U.S. states)

Heating value types:

01: Energy / Volume

02: Energy / Mass

03: Energy / Mol

Heating value classes:

SD: Superior,dry

SW: Superior, wet

ID: Inferior,dry

IW: Inferior,wet

Test tools:

Test report **/QTYW/VALIDATE_SAP_QCI_NATGAS** is delivered with BCG 1.0A. With this report and the configuration data described above, you can validate the SAP QCI for natural gas conversions as required by SAP (documented in the SAP IMG).

4. Formula and requirements

Implemented formula

This is an implementation of natural gas conversion groups which is based on ISO 13443: “Natural gas – Standard reference conditions” 1996-12-15.

The formulae utilized by the conversion groups are implemented within the SAP QCI, which allow conversions between different sets of standard (base) reference conditions. Although ISO 13443 defines a temperature value of 15 °C (288.15 K) and a pressure value of 101.325 kPa as standard reference conditions for measurements and calculations for real dry gas (natural gases, natural-gas substitutes, similar fluids in the gaseous state), it is recognized that in certain circumstances it may be impracticable or even forbidden to use these ISO standard reference conditions (e.g. forced by national legislation or contractual obligations). Thus, conversion formulae are provided in ISO 13443 which enable values of properties (relating to any known other reference conditions) to be converted to values for the ISO standard reference conditions. In addition to the formulae provided within ISO 13443, calculation formulas based on ISO 6976:1995 (E) are utilized by the SAP QCI.

With the global template and the test report described in this document, you can validate the SAP natural gas conversion formulae.

Implementation requirements

In order to use the SAP QCI conversion groups delivered with this package, you have to activate the SAP basic natural gas conversion routines in customizing: If not already activated, go to:

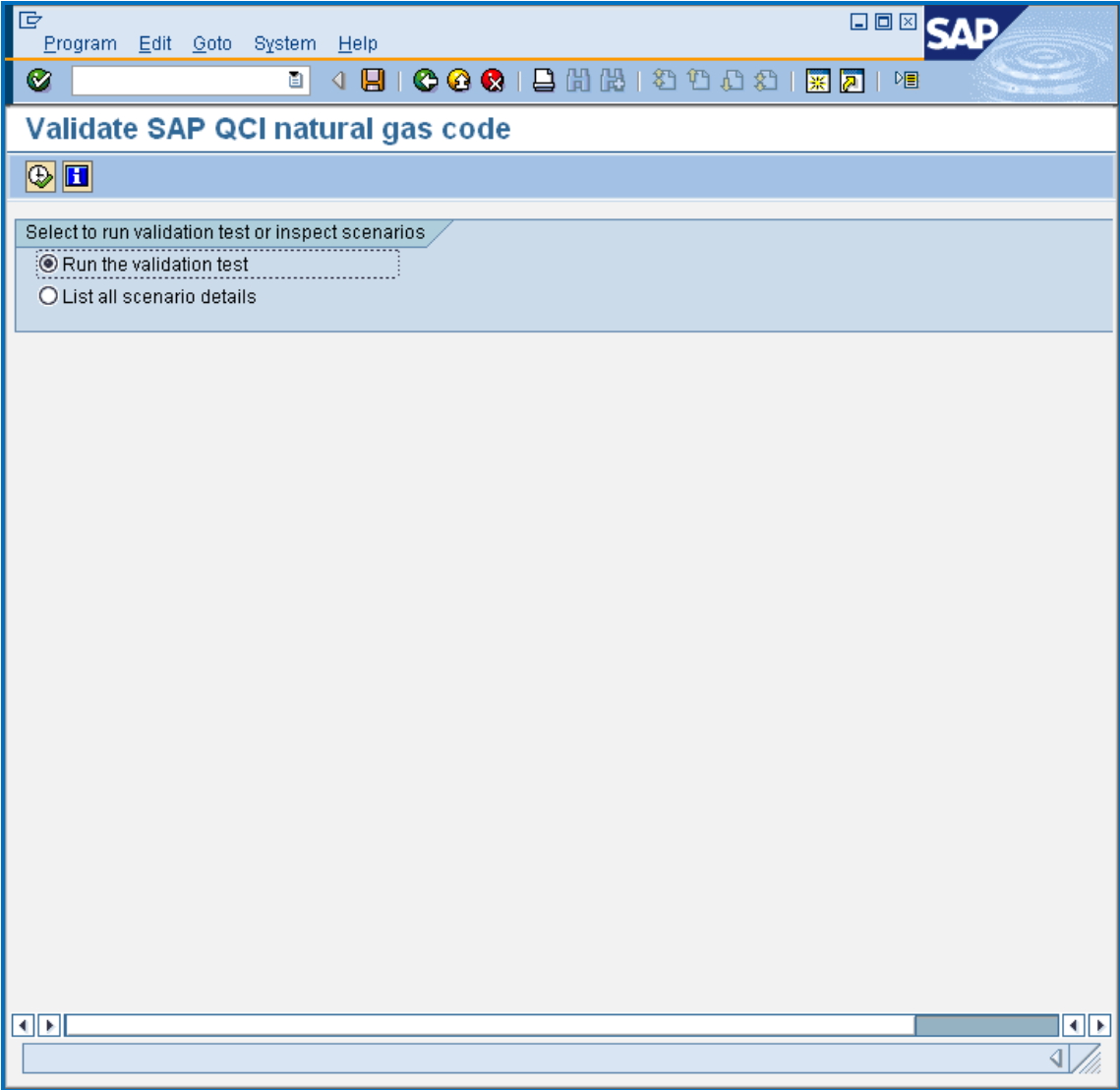
Industry Solution Oil & Gas (Downstream) → HPM (Hydrocarbon Product Management) → Petroleum Measurement Standards → Quantity Conversion Interface (QCI) Configuration → Activate SAP conversion routines for natural gas

Here, you can activate the SAP natural gas routines. Afterwards, run the validation and test report. If no errors are reported, productive usage of the SAP QCI with BCG 10A for natural gas is possible.

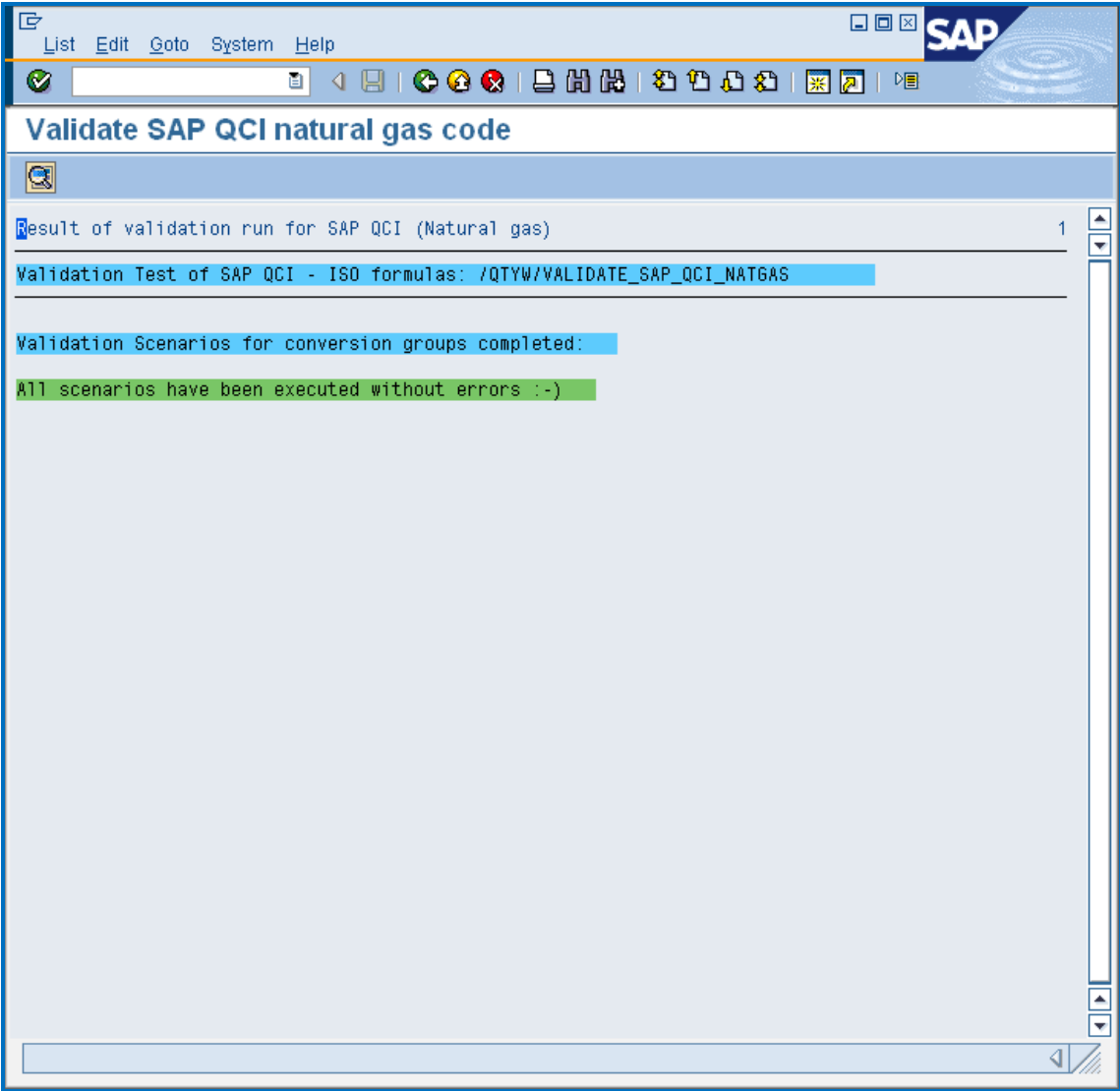
5. Installation & Validation Test

Included in the BCG 1.0A package are test & validation programs, accessible from the Gas Measurement Cockpit, that can be used to test the installation and also to validate the SAP QCI for natural gas conversions.

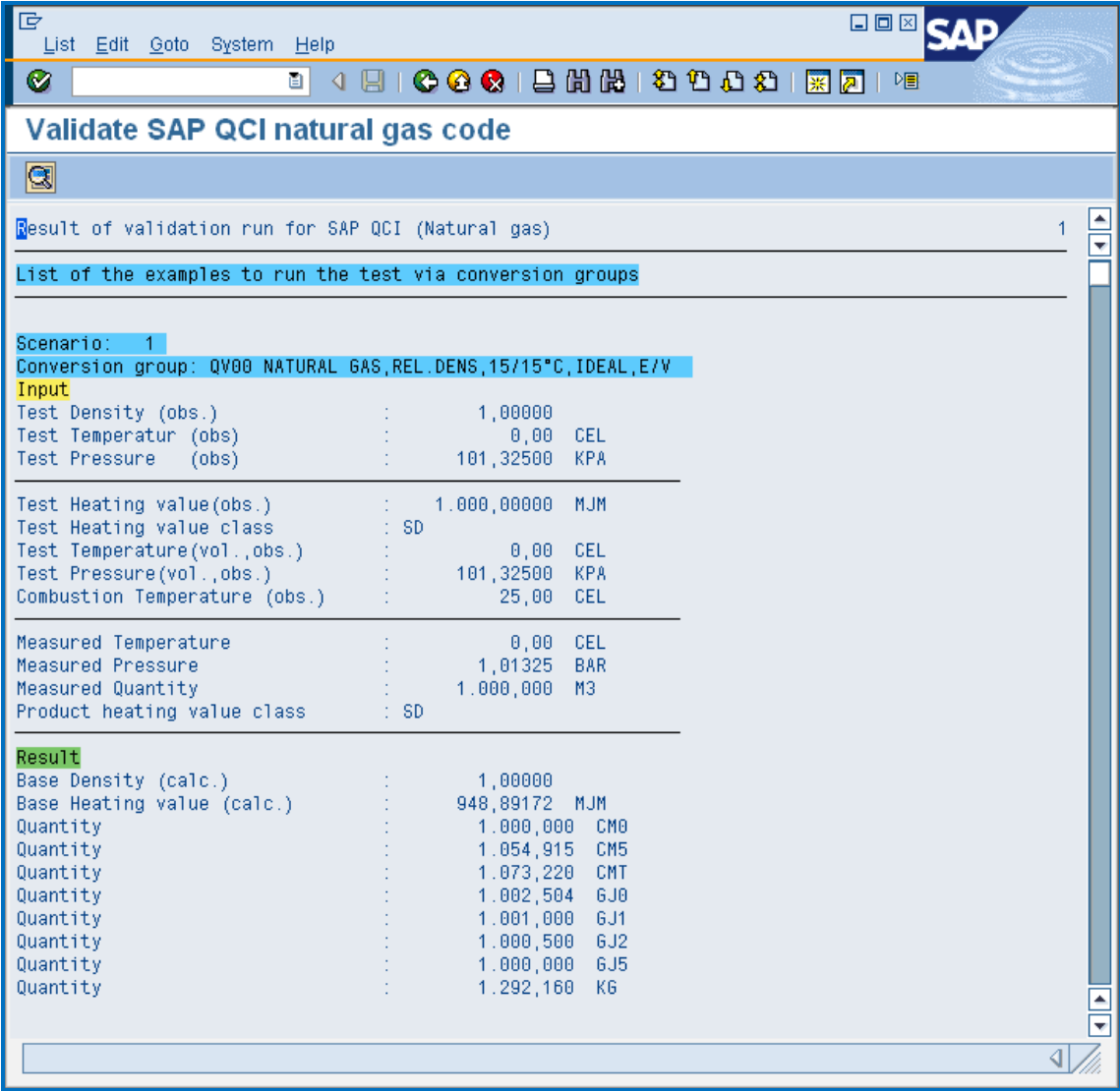
```
/QTYW/VALIDATE_SAP_QCI_NATGAS
```



Via the validation test, the configuration is checked and all 61 conversion scenarios are executed to validate the SAP QCI for natural gas. If the configuration check and validation is successful, the result will be displayed as shown as follows:



If you select the option: List all scenario details, the report lists all details for the scenarios:



Validate SAP QCI natural gas code

Result of validation run for SAP QCI (Natural gas) 1

List of the examples to run the test via conversion groups

Scenario: 1
 Conversion group: QV00 NATURAL GAS,REL.DENS,15/15°C,IDEAL,E/V

Input

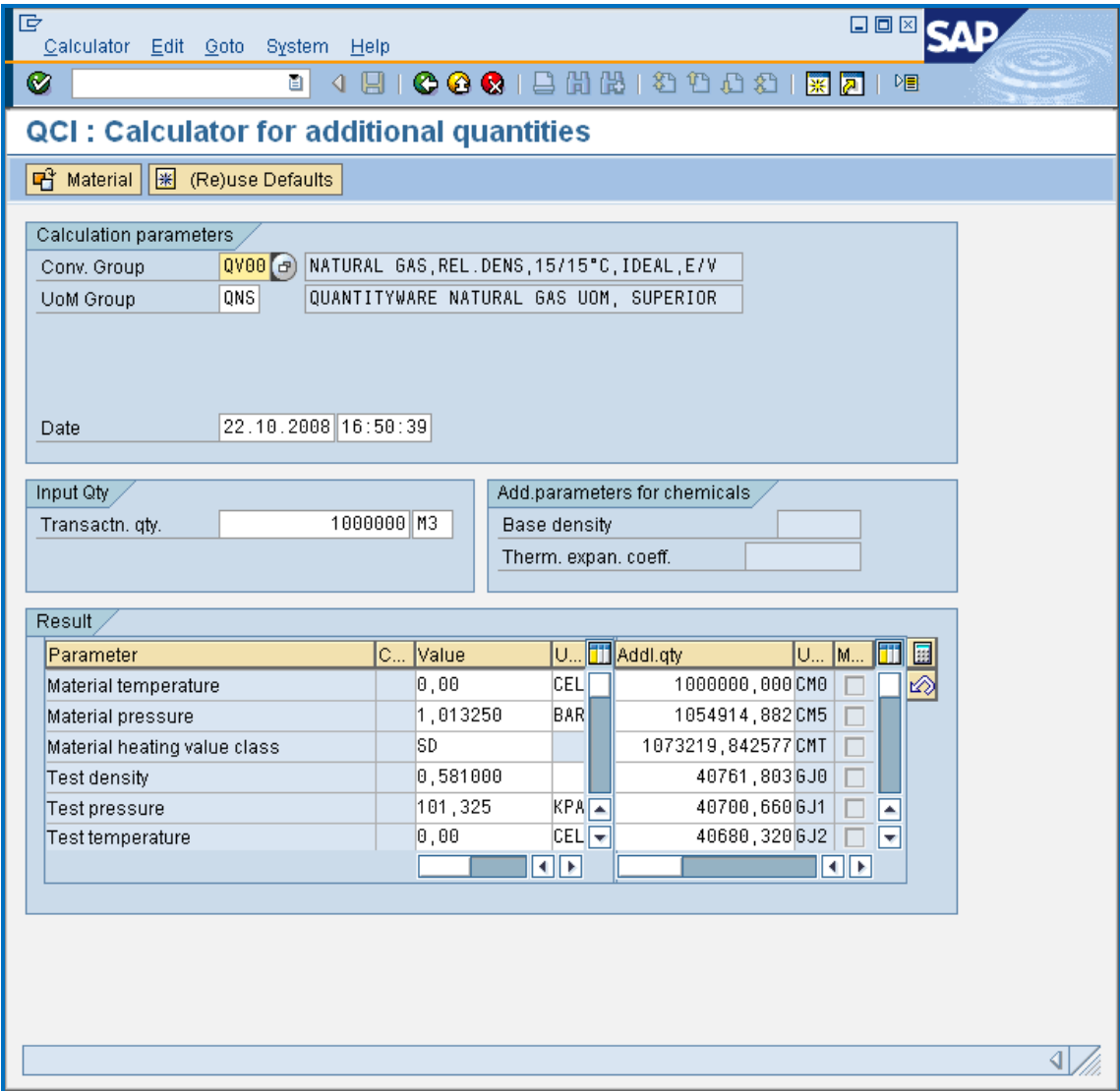
Test Density (obs.)	:	1,00000	
Test Temperatur (obs)	:	0,00	CEL
Test Pressure (obs)	:	101,32500	KPA
<hr/>			
Test Heating value(obs.)	:	1.000,00000	MJM
Test Heating value class	:	SD	
Test Temperature(vol.,obs.)	:	0,00	CEL
Test Pressure(vol.,obs.)	:	101,32500	KPA
Combustion Temperature (obs.)	:	25,00	CEL
<hr/>			
Measured Temperature	:	0,00	CEL
Measured Pressure	:	1,01325	BAR
Measured Quantity	:	1.000,000	M3
Product heating value class	:	SD	
<hr/>			

Result

Base Density (calc.)	:	1,00000	
Base Heating value (calc.)	:	948,89172	MJM
Quantity	:	1.000,000	CM0
Quantity	:	1.054,915	CM5
Quantity	:	1.073,220	CMT
Quantity	:	1.002,504	GJ0
Quantity	:	1.001,000	GJ1
Quantity	:	1.000,500	GJ2
Quantity	:	1.000,000	GJ5
Quantity	:	1.292,160	KG

6. Integration into SAP - QCI desktop calculator

This configuration and validation implementation (global template) is fully integrated into the QCI and thus into all logistics processes such as the SAP Trader's & Schedulers Workbench (TSW). The desktop calculator (transaction O3QCITEST), accessible from the Gas Measurement Cockpit, can be used to calculate natural gas quantities for all of the above defined conversion groups:



QCI : Calculator for additional quantities

Material (Re)use Defaults

Calculation parameters

Conv. Group: QV00 NATURAL GAS, REL. DENS, 15/15°C, IDEAL, E/V

UoM Group: QNS QUANTITYWARE NATURAL GAS UOM, SUPERIOR

Date: 22.10.2008 16:50:39

Input Qty

Transactn. qty.: 1000000 M3

Add parameters for chemicals

Base density:

Therm. expan. coeff.:

Result

Parameter	C...	Value	U...	Addl. qty	U...	M...
Material temperature		0,00	CEL	1000000,000	CM0	<input type="checkbox"/>
Material pressure		1,013250	BAR	1054914,882	CM5	<input type="checkbox"/>
Material heating value class		SD		1073219,842577	CMT	<input type="checkbox"/>
Test density		0,581000		40761,803	GJ0	<input type="checkbox"/>
Test pressure		101,325	KPA	40700,660	GJ1	<input type="checkbox"/>
Test temperature		0,00	CEL	40680,320	GJ2	<input type="checkbox"/>