



Bulk Calculations – Gas BCG 3.0

Documentation Reference Manual

Notes

The latest version of this documentation can be found in the QuantityWare [Knowledge Base](#). All documentation is kept current for the combinations of latest BCS release with the latest supported SAP Oil, Gas, & Energy release. For all currently supported combinations see [Note #000086 "Support and Release \(Lifecycle\) details" page 2, "Release Lifecycle"](#).

Your release level can be determined via:

```
"/o/QTYW/COCKPIT_GAS" -> "Cockpit" -> "Support Package Level"
```

Version History

Version	Date	Description
00	2017-03-31	Initial Release
01	2017-10-11	S/4HANA 1709 validity added
02	2019-02-17	S/4HANA 1809 validity added
03	2021-09-21	Modern QW document style applied; 30A CSP02 / 30B CSP01 changes
04	2023-11-01	30A CSP03 / 30B CSP02 changes

Contents

1. Introduction	6
2. Documentation Overview	7
3. BCG – Gas Measurement Cockpit	11
3.1. Introduction	11
3.2. Structure of the Gas Measurement Cockpit (GMC)	12
3.3. GMC Methodology	25
3.4. GMC Tab Strip Details	25
3.5. GMC Documentation	42
3.6. Summary	42
4. BCG – Test Scenarios	43
4.1. Introduction	43
4.2. Test Scenario – Delivery with BC Set	44
4.3. Test Scenario – Definition	44
4.4. Access to the Test Scenario Tool	45
4.5. Test Scenario Tool Activities	46
4.6. Summary	59
5. BCG – Configuration Template	60
5.1. Introduction	60
5.2. Unit of Measure Definitions	62
5.3. Conversion Group Configuration	63
5.4. QuantityWare IMG Access	67
5.5. Summary	67
6. BCG – QuantityWare MQCI	68
6.1. Introduction	68

6.2.	MQCI – SAP Integration.....	70
6.3.	MQCI Technical Integration Details	72
6.4.	MQCI Calculation Scenarios	74
6.5.	MQCI Calculation Models	79
6.6.	MQCI Quantity Value Calculation & Rounding.....	82
6.7.	MQCI Property Rounding.....	88
6.8.	MQCI and SAP QCI: Parameter Range Checks	89
6.9.	MQCI ASTM Table 1 – NGL/LPG.....	91
6.10.	MQCI Tolerance Group	93
6.11.	MQCI Advanced Configuration Options	96
6.12.	MQCI Support of CPL Calculations	101
6.13.	Summary	102
7.	BCG - Customizing Transactions.....	103
7.1.	Introduction	103
7.2.	QuantityWare Customizing Transactions.....	103
7.3.	Summary.....	105
8.	BCG - Natural Gas Component Physical Properties Data	106
8.1.	Introduction	106
8.2.	Physical Properties - Data Set Description.....	107
8.3.	Fundamental Constants and Properties of Dry Air	109
8.4.	Physical Property Data Validation.....	111
8.5.	Summary.....	111
9.	BCG - Natural Gas & LNG Measurement.....	112
9.1.	Introduction	112
9.2.	Basic Definitions - Natural Gas Quantities and Measurements.....	112
9.3.	Basic Measurement Principles	119

9.4.	Summary.....	122
10.	BCG - Gas Measurement Cockpit - Security	123
11.	BCG - Protection of Intellectual Property	125
12.	Abbreviations	127
13.	BCG - Documentation Rules.....	130
14.	BCG - Basic System Settings.....	131

1. Introduction

BCG (Bulk Calculations – Gas) is delivered within the Bulk Calculations - Solution (BCS) and activated with a usage key.

For BCG this document provides:

- An overview of all documentation delivered for BCG
- Links to related documents
- Detailed documentation for specific areas

Read this document and - depending on your project roles - the related documents carefully before you install QuantityWare BCG or start your BCG implementation project.

2. Documentation Overview

The following BCG documents are either published as a chapter of this document, or available as separate documents in the [Knowledge Base](#).

- **BCS Technical Installation Documentation:**

Audience: SAP basis experts performing the installation

Content: Describes the technical requirements and procedures to be followed during the technical installation of the BCS.

Publication: Separate document in the [Knowledge Base](#).

- **BCG - Project Assessment and Implementation Guidelines (PAIG):**

Audience: Project team lead responsible for BCG implementation & project members

Content: Describes a high-level project methodology which enables the successful design and configuration of quantity conversion solutions that run in an SAP Oil, Gas, & Energy ERP system, based upon business requirements.

Publication: Separate document in the [Knowledge Base](#).

- **BCG Test Manual:**

Audience: Project team responsible for BCG implementation

Content: Provides a sequence **of eight (8) test cases** which you may execute in your system (client 045 and your own development/test client) - during your 4 week test period - in order to define a production ready conversion group in your development/test client – including automated test cases - based on the BCG template configuration.

Publication: Separate document in the [Knowledge Base](#).

- **BCG - Gas Measurement Cockpit (GMC):**

Audience: BCG implementation project team-lead and project members, as well as petroleum measurement specialists wishing to use the GMC.

Content: Describes the GMCs methodology, structure, and content.

Publication: This document

- **BCG - Test Scenarios:**

Audience: BCG implementation project team-lead and project members, as well as petroleum measurement specialists wishing to use the GMC.

Content: Describes the theory behind and the definition of quantity conversion automated test scenarios.

Publication: This document

- **BCG - Configuration Template:**

Audience: BCG project implementation members.

Content: Lists all QuantityWare BCG template tables and the number of entries delivered. Explains how to access and analyze the data via the GMC.

Publication: This document

- **BCG - Supported Standards Manual:**

Audience: Project members implementing BCG and petroleum measurement specialists.

Content: Lists all measurement standards that are implemented with BCG and provides detailed installation test information.

Publication: Separate document in the [Knowledge Base](#).

- **BCG - QuantityWare MQCI:**

Audience: Project members implementing BCG

Content: Describes the functional possibilities of the QuantityWare Model based QCI (MQCI) in detail.

Publication: This document

- **BCG - Customizing:**

Audience: Project members implementing BCG

Content: Describes BCG customizing options which can be accessed from the GMC.

Publication: This document

- **BCG - Physical Property Data:**

Audience: Project members implementing BCG

Content: Describes the physical property data for BCG which can be accessed from the Gas Measurement Cockpit (GMC) in detail.

Publication: This document

- **BCG - Natural Gas & LNG Measurement:**

Audience: Project members implementing BCG.

Content: Describes the fundamentals of natural gas and LNG measurements with respect to quantity conversion calculations.

Publication: This document

- **BCG - Gas Measurement Cockpit - Security:**

Audience: Project members implementing BCG.

Content: Lists the QuantityWare single & composite roles delivered with BCS which can be assigned to GMC users.

Publication: This document

- **BCG - Protection of Intellectual Property:**

Audience: Project members implementing BCG.

Content: Describes the QuantityWare Intellectual Property security measures.

Publication: This document



In addition to the above listed documents, QuantityWare publishes BCG notes which are also an integral part of the BCG documentation, all available in the [Knowledge Base](#).

All code corrections published via note are included in the immediately following CSP.

For an overview of note validity, see section 6 of [Note 000067](#) – “Additional Installation Information”.

The associated files must be downloaded from the [QuantityWare Service Portal](#).

Finally, Consulting and Working Papers are published frequently, which are all as well available in the [Knowledge Base](#).

3. BCG – Gas Measurement Cockpit

3.1. Introduction

The software package BCG is one important part of the overall QuantityWare solution for the natural gas industries. The complete solution consists of:

- QuantityWare Software Package
- QuantityWare Training Services
- QuantityWare Support Services

The Gas Measurement Cockpit (GMC) is the single access point for measurement specialists and certified BCG consultants to the QuantityWare BCG solution. Here you design, monitor, maintain and enhance complex, measurement standard based quantity conversion implementations that run within the SAP Oil, Gas, & Energy ERP system. The Gas Measurement Cockpit (GMC) provides an easy-to-use user interface (UI), which is structured in a way such that measurement experts and technical consultants can organize their work efficiently.



After you log on to your SAP Oil, Gas, & Energy system, enter transaction code `/n/QTYW/COCKPIT_GAS` to launch the Gas Measurement Cockpit (GMC).

Make sure that the required authorization roles are assigned to your user.

The technical installation team must enter the BCG license via the GMC, too.

3.2. Structure of the Gas Measurement Cockpit (GMC)

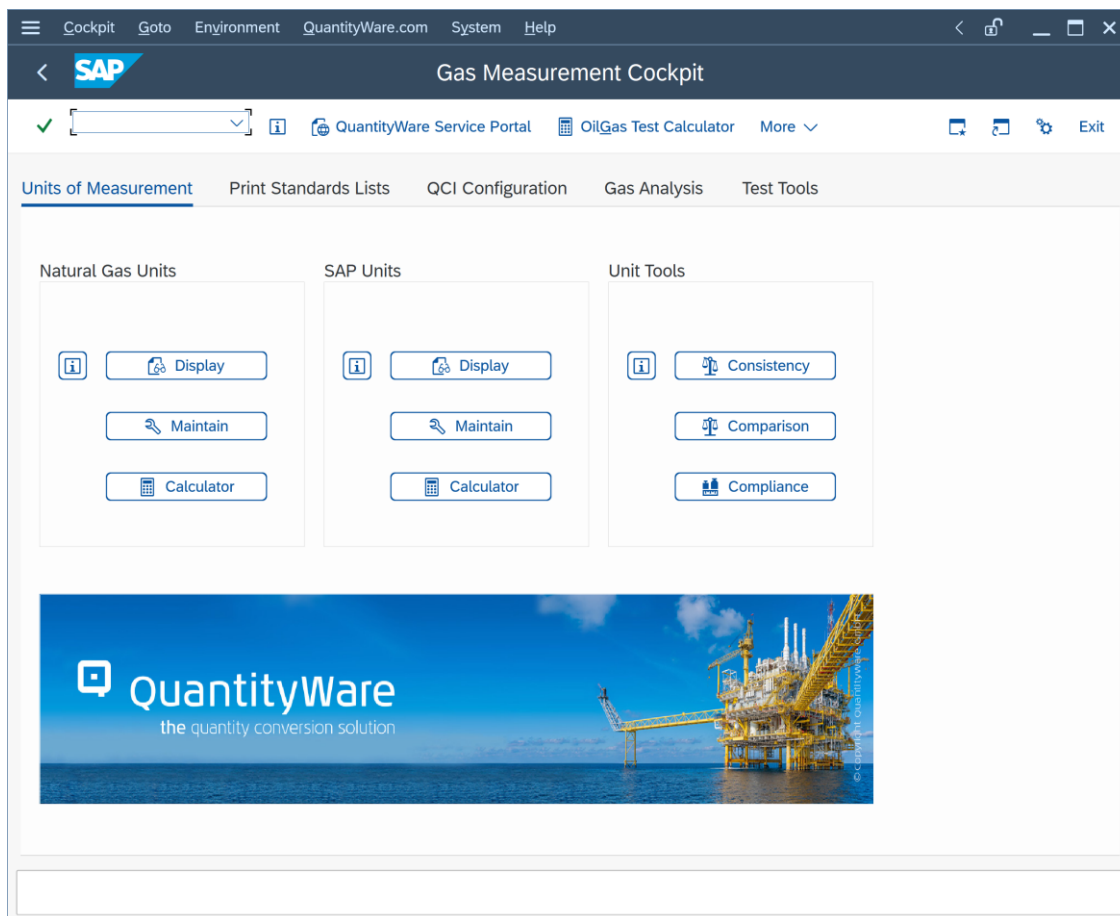
The GMC is structured with Tabs and Menus.

3.2.1. GMC Overview – Tabs

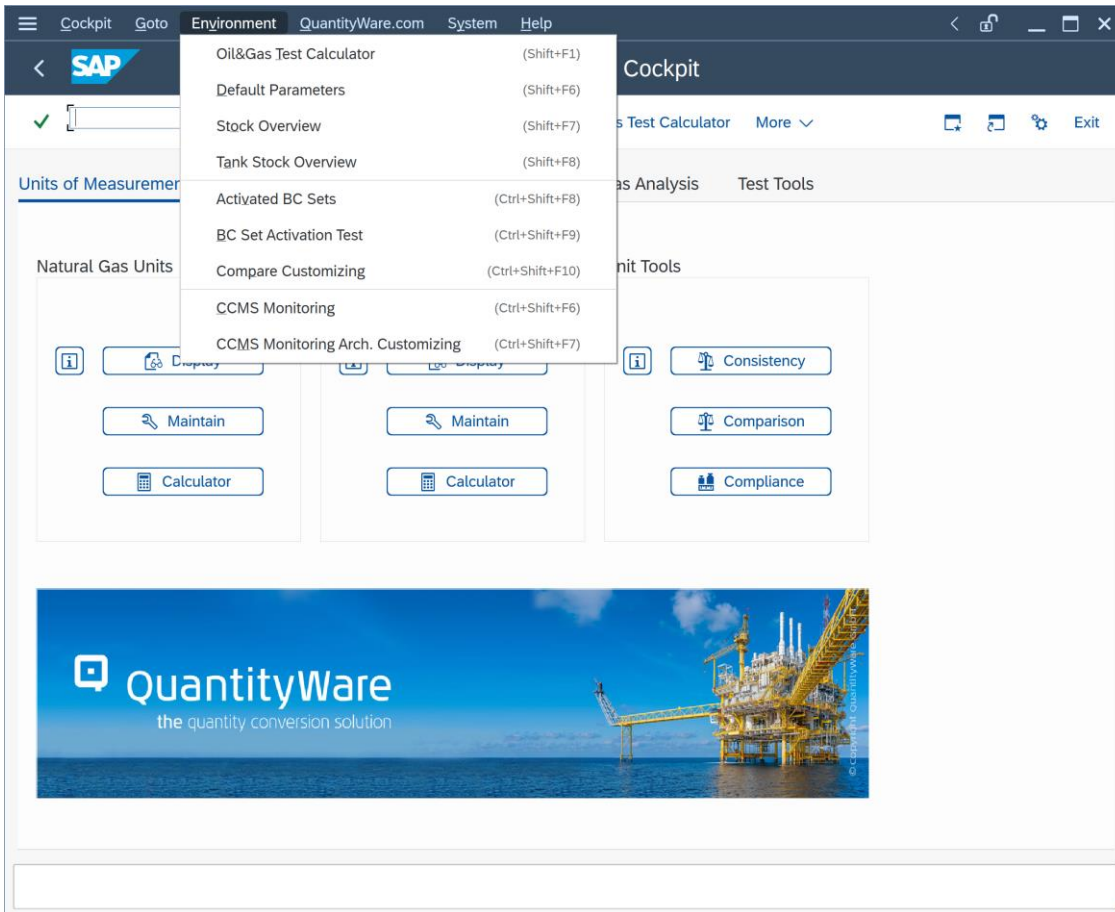
The Gas Measurement Cockpit provides five tab pages.

3.2.1.1. Units of Measurement

Here you define, create, change, display and monitor unit of measurement (UoM) settings. Detailed documentation of the UoM concepts is provided. You perform natural gas property conversions between different reference conditions, e.g., for heating values or densities. You also define the UoM compliance settings and prepare the UoM Compliance Analysis in this tab page. All calculations and results can be easily printed for further processing.

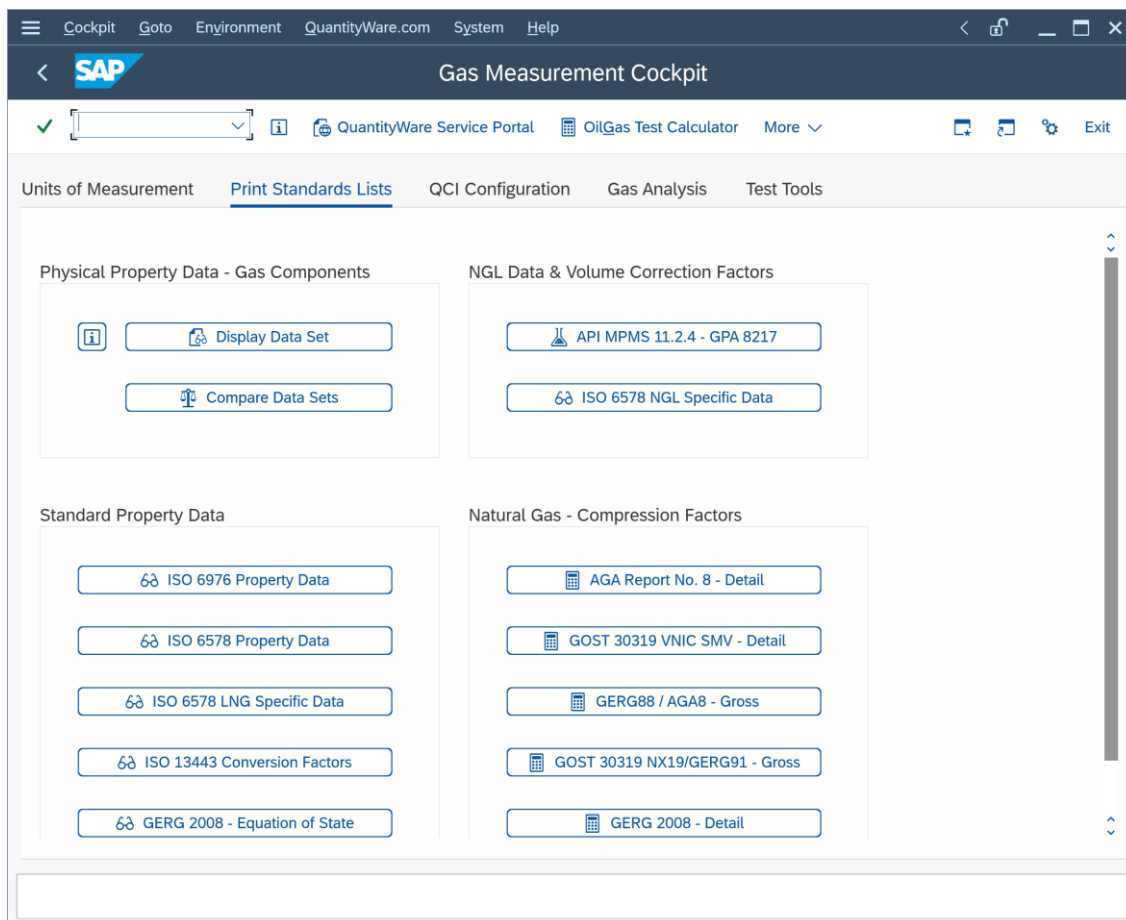


In your productive clients, you may disable access to configuration settings via customizing settings. Specifically, you may disable the maintenance access in this tab page (in addition to generally locking the transaction via SAP standard settings of customizing transactions), as well as direct customizing and technical tool access via the menu paths “Goto” and “Environment”:



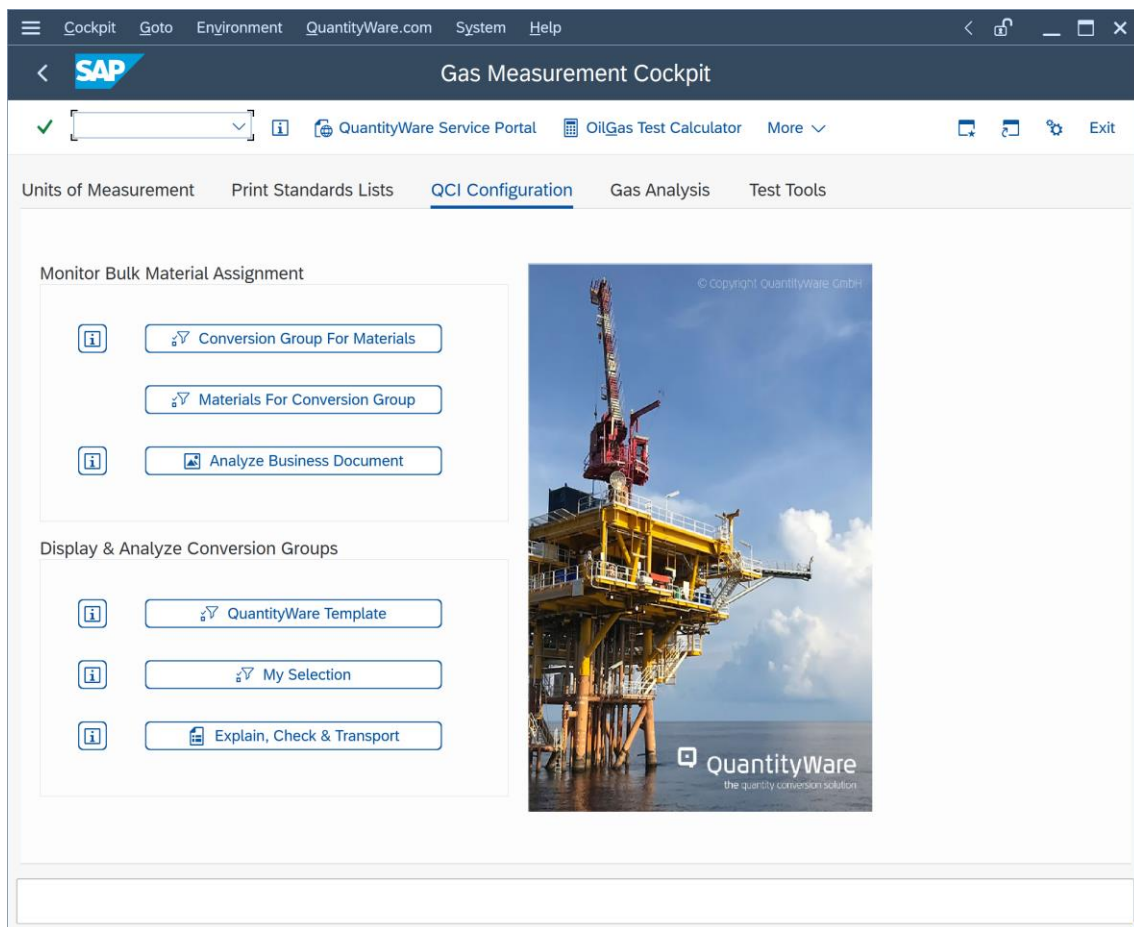
3.2.1.2. Print Standards Lists

Here you display and print lists of physical property data sets, compression factors and LNG specific data, as well as volume correction factors for NGL. Natural gas and LNG long term contracts specify detailed calculation procedures and property data to be utilized for custody transfer, which you monitor and verify here.



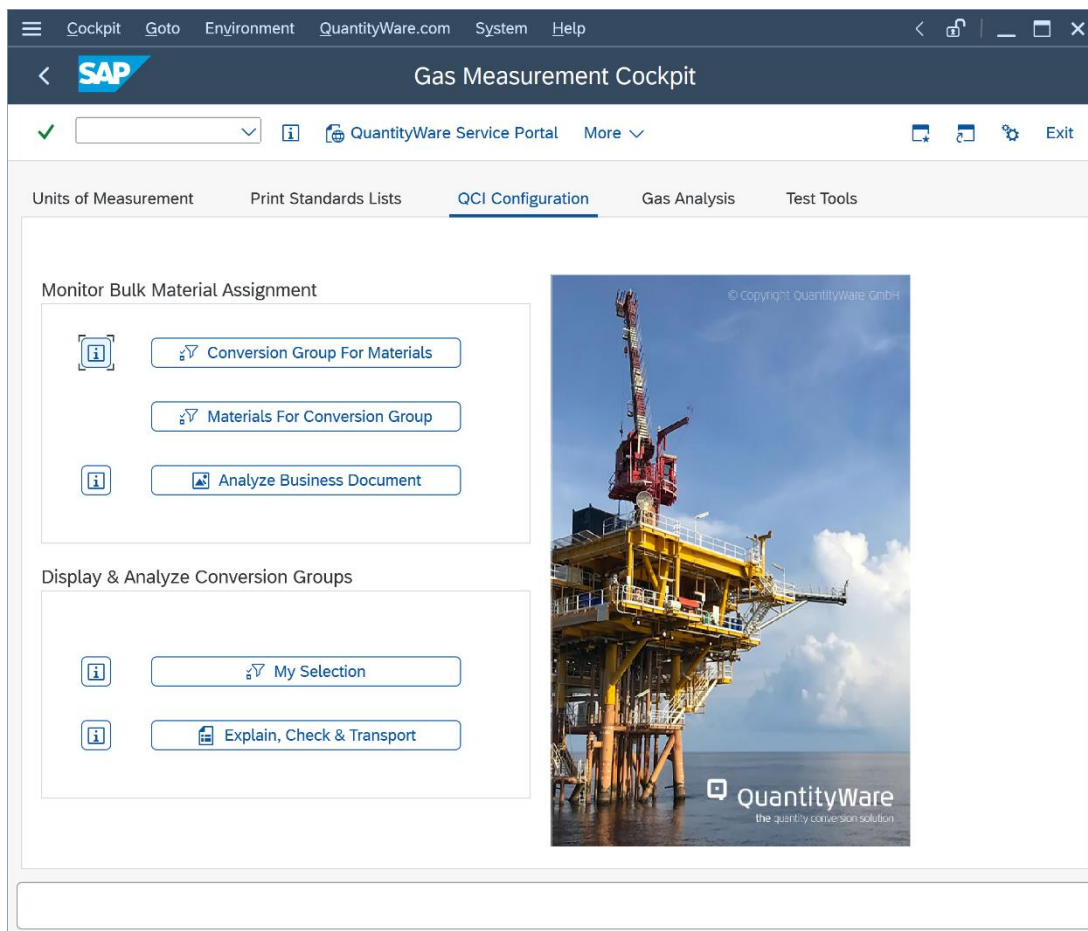
3.2.1.3. QCI Configuration (Template Client)

Here you display and monitor the QCI conversion group settings for various selection criteria and control the assignment of your conversion groups to your material/product master data. You can also “explain” a conversion group definition and print out audit reports for conversion groups. You may analyze business documents (material documents, physical inventory documents and deliveries) with respect to the additional quantity conversion values here.

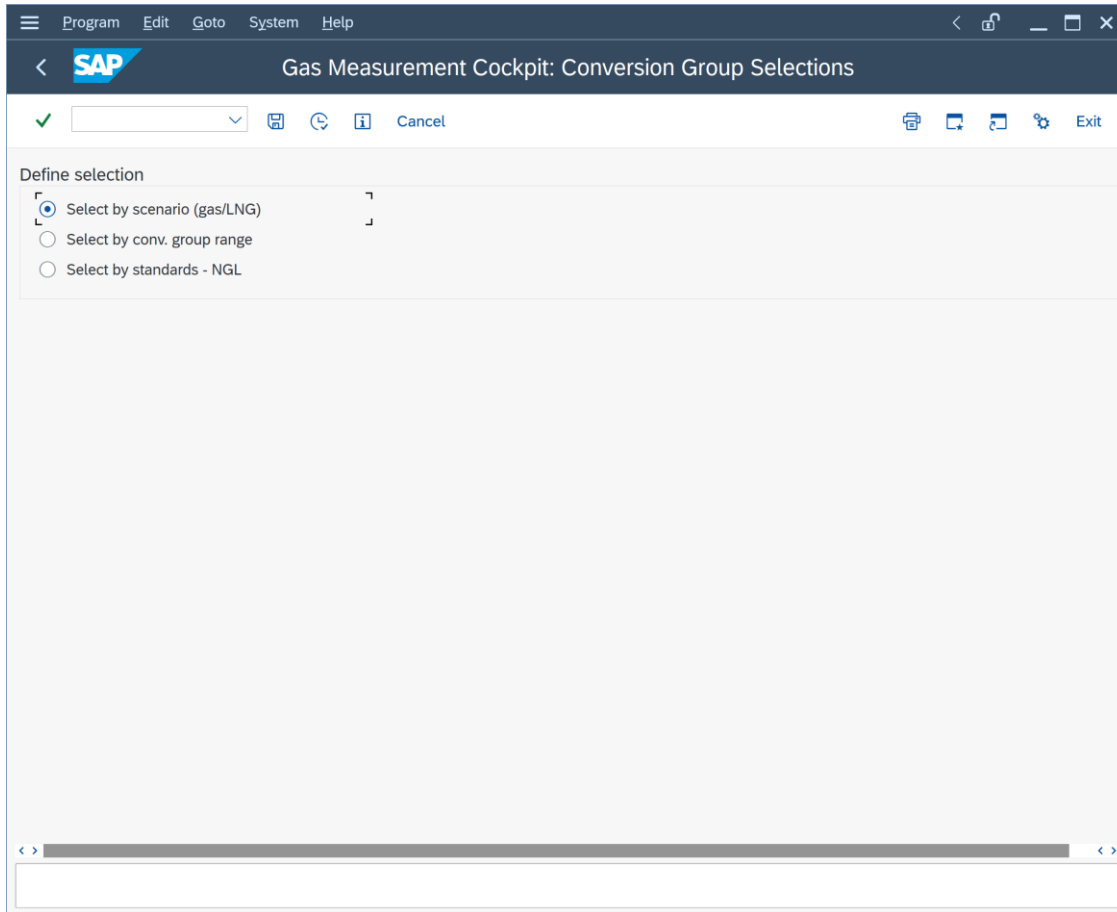


3.2.1.4. QCI Configuration

In clients where the QuantityWare template BC set "/QTYW/BCG_30X" (where "X" is the current valid installed QuantityWare BCS release – e.g., "30A" or "30B") is not activated, under "Display & Analyze Conversion Groups" the template selection push button "QuantityWare Template" is not available. The "Explain, Check and Transport" push button may also be configured to be invisible.



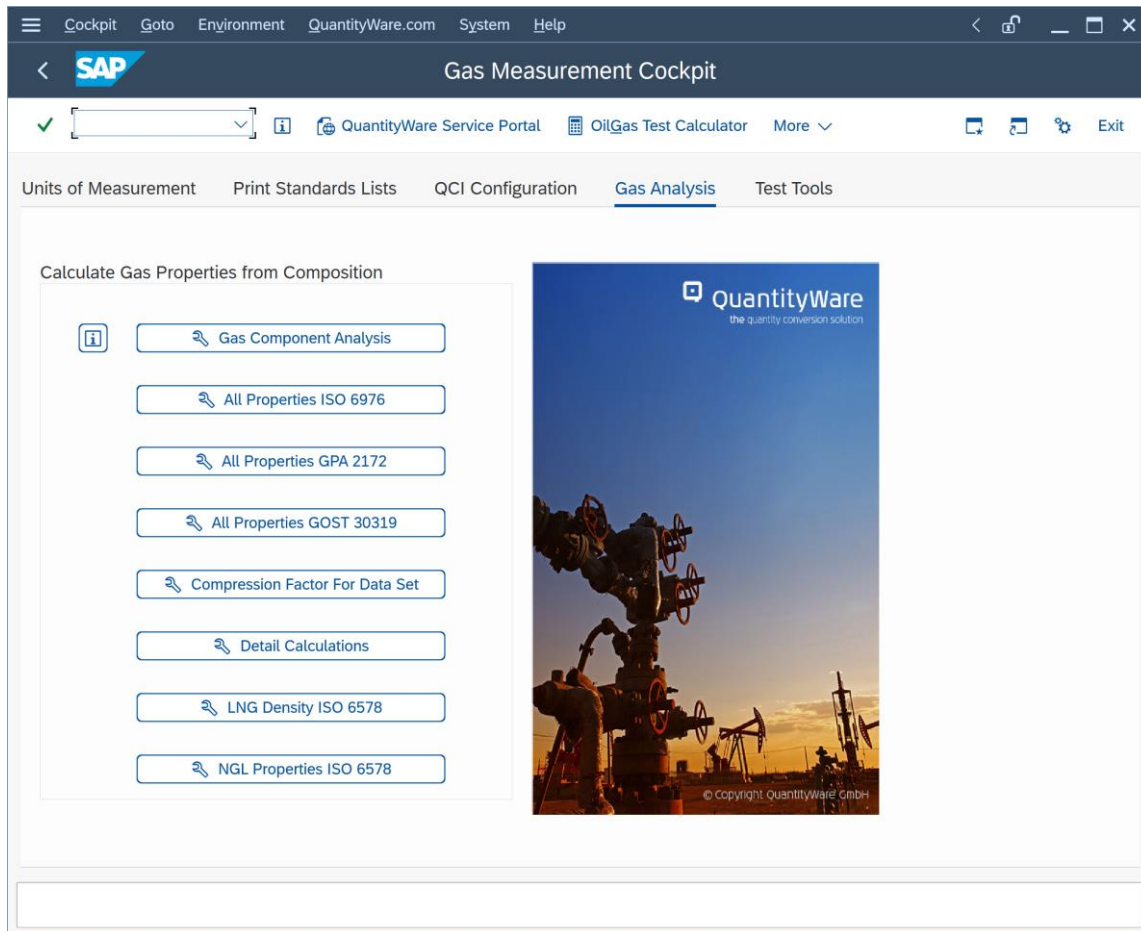
For BCG conversion groups, three different selection methods are available:



Natural gas, Hydrogen and LNG conversion groups may be selected by calculation scenario or by range; NGL/LPG conversion groups may be selected by range or by measurement standards.

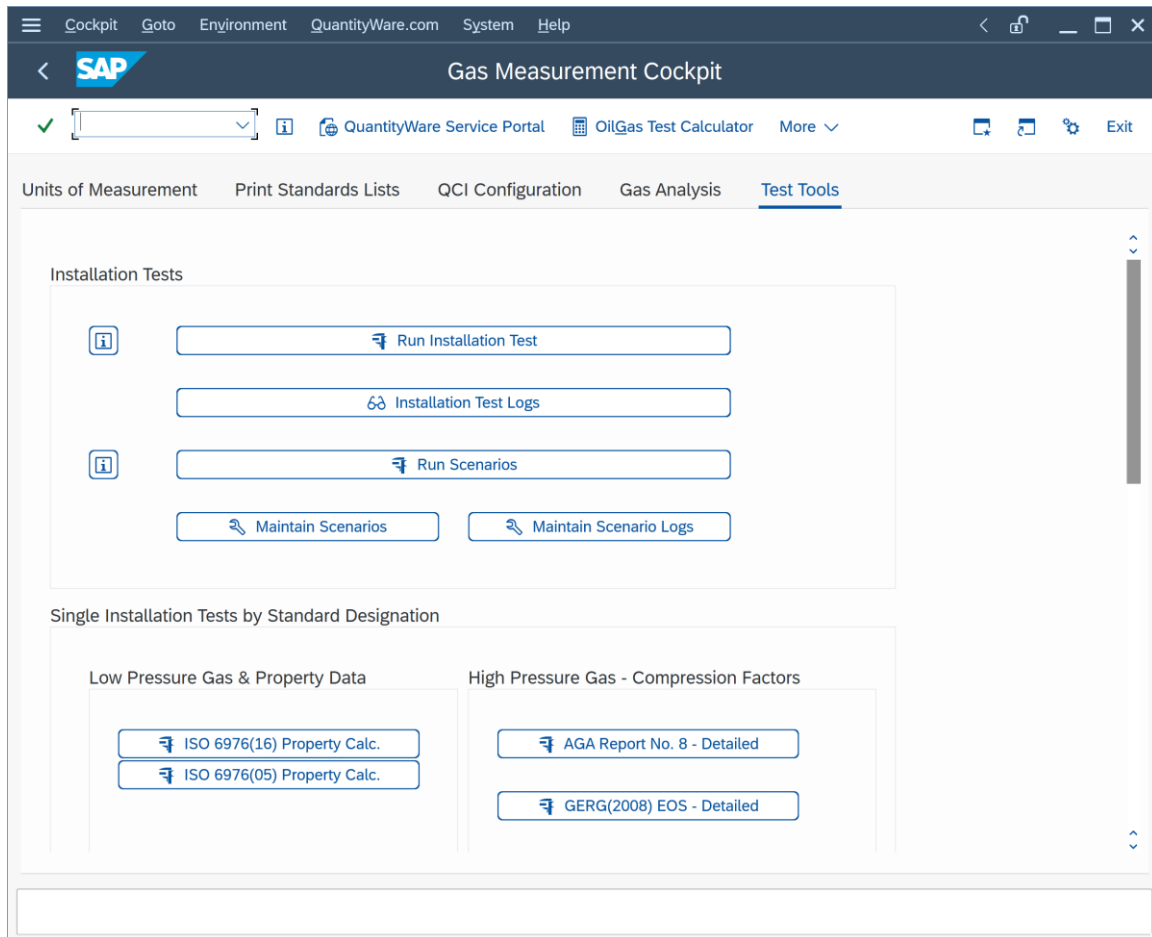
3.2.1.5. Gas Analysis

Here you perform natural gas, LNG and LPG/NGL property calculations based on various measurement standards and on laboratory data; you prepare quantity conversion default data for goods movement calculations, starting with a sophisticated gas component analyzer tool.



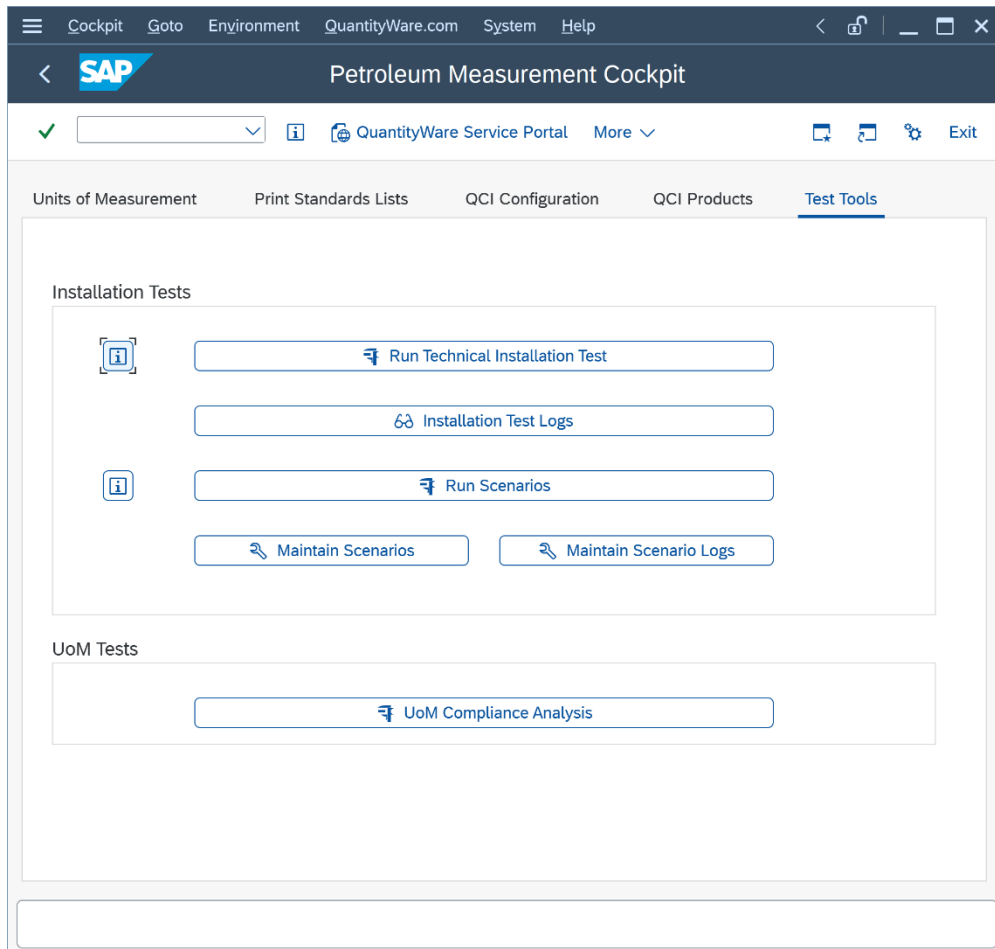
3.2.1.6. Test Tools (Template Client)

In template client 045 you execute the QuantityWare installation test (which includes QuantityWare Test Scenarios) to ensure the correctness of the quantity conversion implementations in your system.



3.2.1.7. Test Tools

In all other relevant clients, where the QuantityWare BC set is not activated, you execute your own UoM Compliance Analysis test via this tab page, as well as your own test scenarios, which are defined during the BCG implementation project. The Technical Installation Test can be executed there as well.



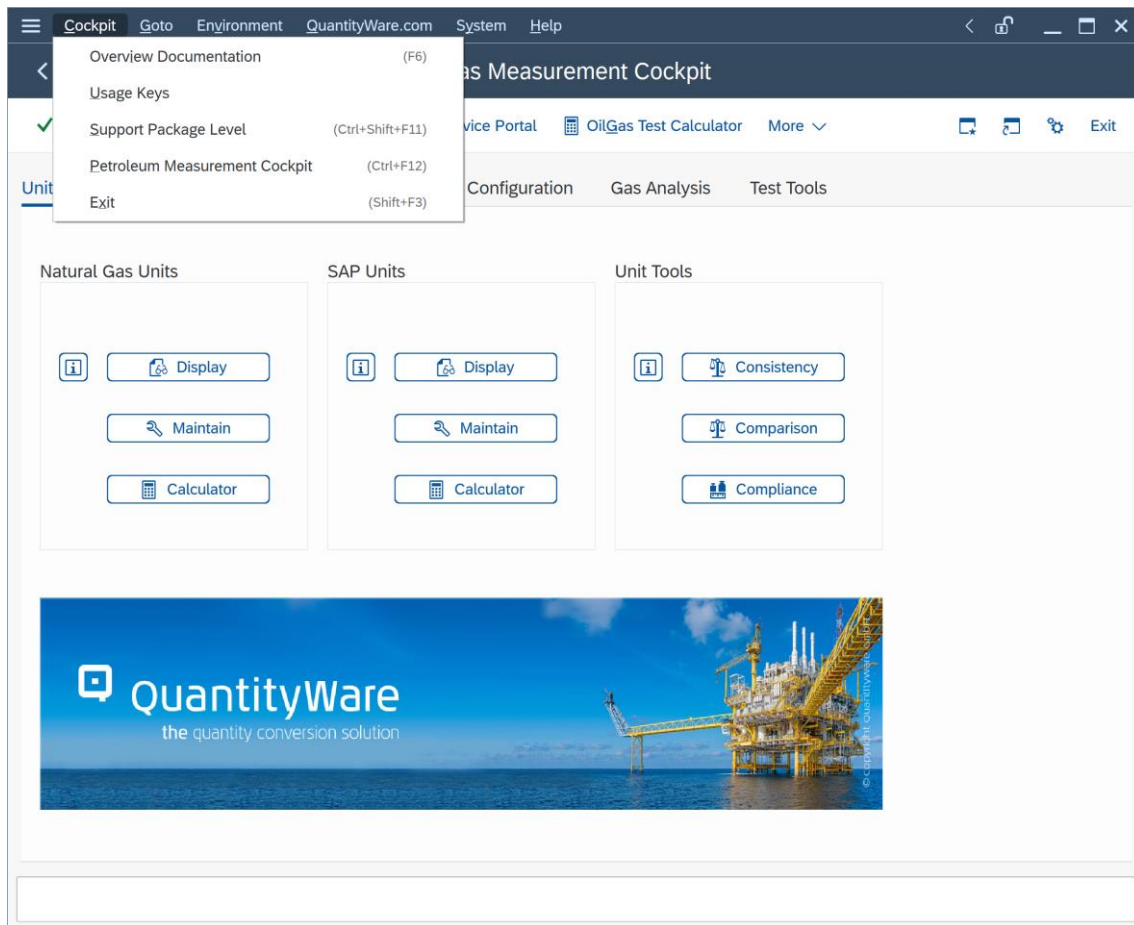
The tab page that is active when you leave the GMC transaction will be the one you see when you next use the GMC.

3.2.2. BCG Overview – Menus

From the BCG menu, you have access via the following menu points to relevant transactions and information resources:

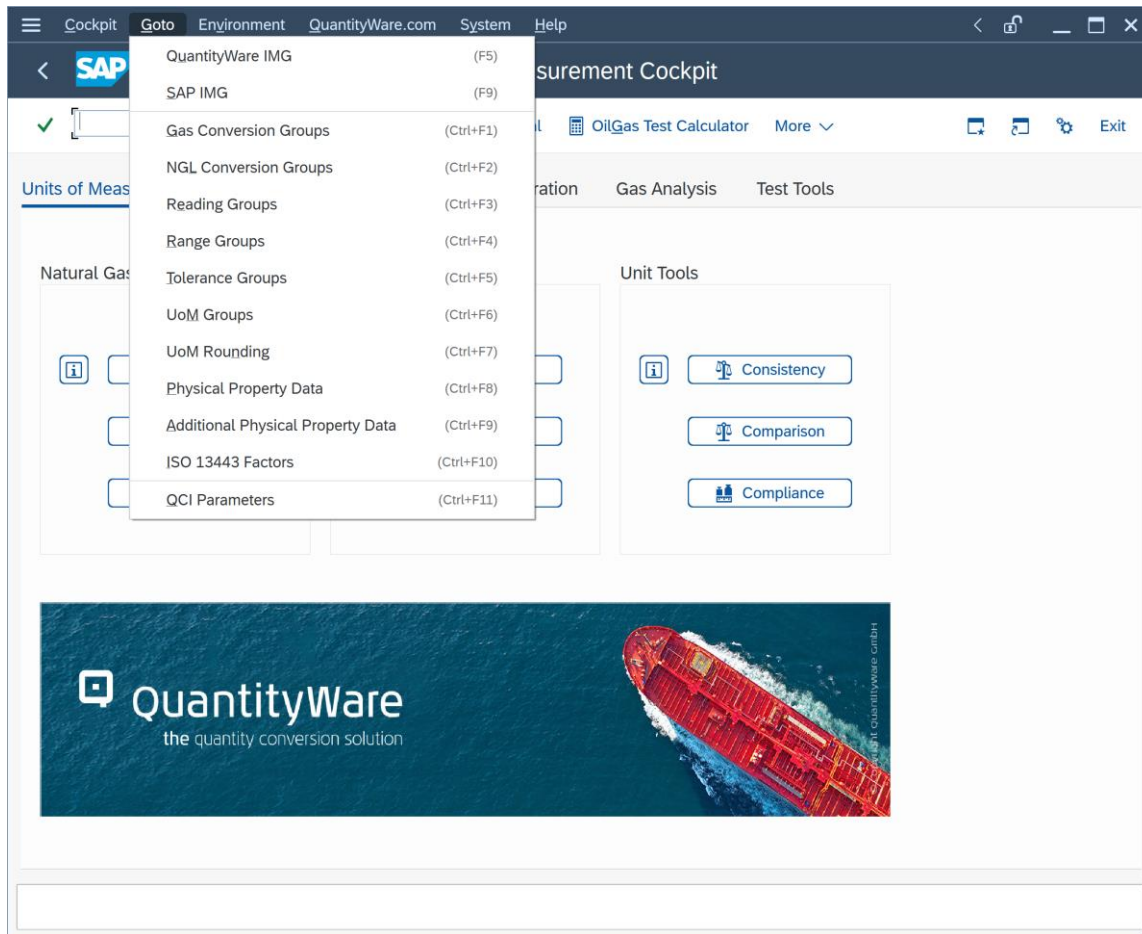
3.2.2.1. Cockpit

Enter or check the QuantityWare BCG usage key, read the detailed online documentation, determine the QuantityWare support package level, or navigate to the Petroleum Measurement Cockpit:



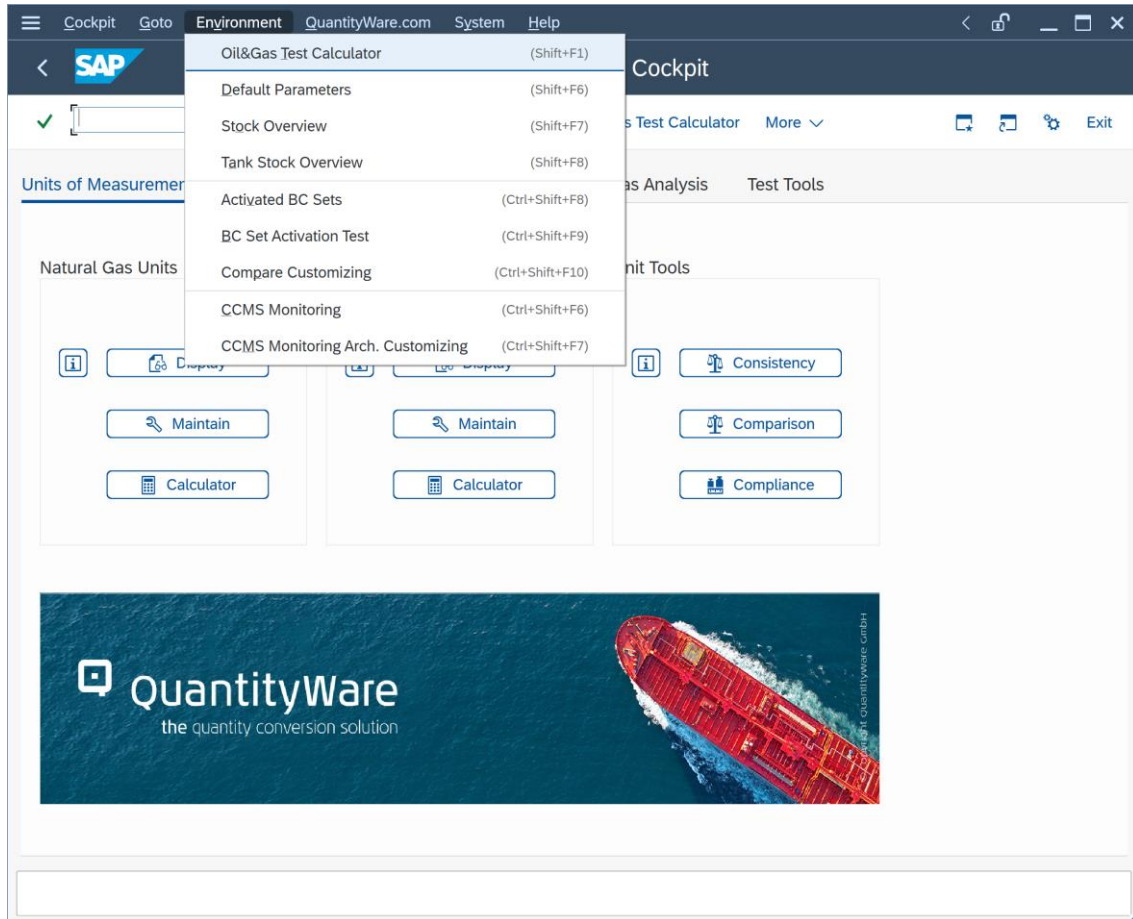
3.2.2.2. Goto

You navigate to all QuantityWare customizing transactions (direct or via SAP IMG) and create or change data if the client settings allow this; fast access to most important customizing transactions is also available:



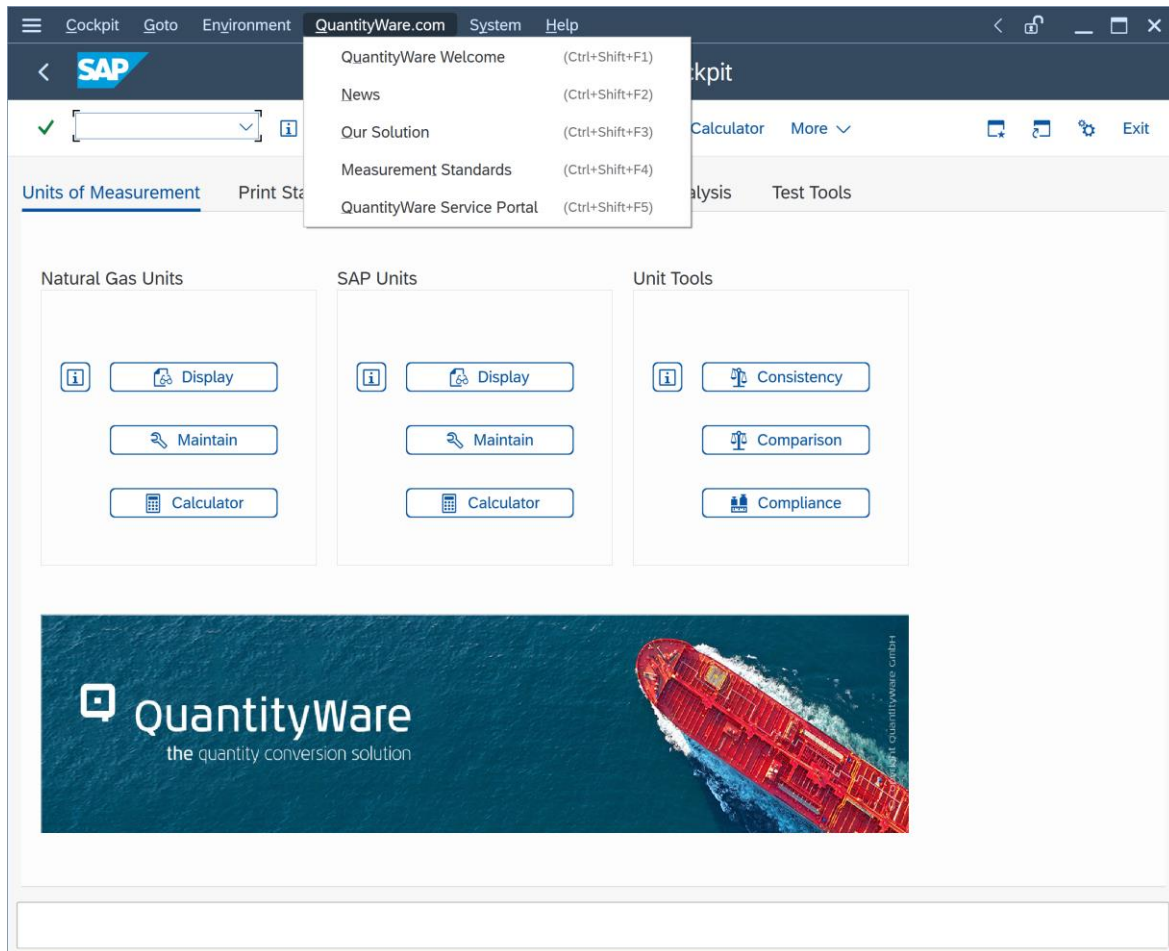
3.2.2.3. Environment

Navigate to related applications like the Oil & Gas Test calculator or the tank management transaction:



3.2.2.4. QuantityWare.com

Navigate to the most relevant QuantityWare website pages and to the QuantityWare Service Portal site:



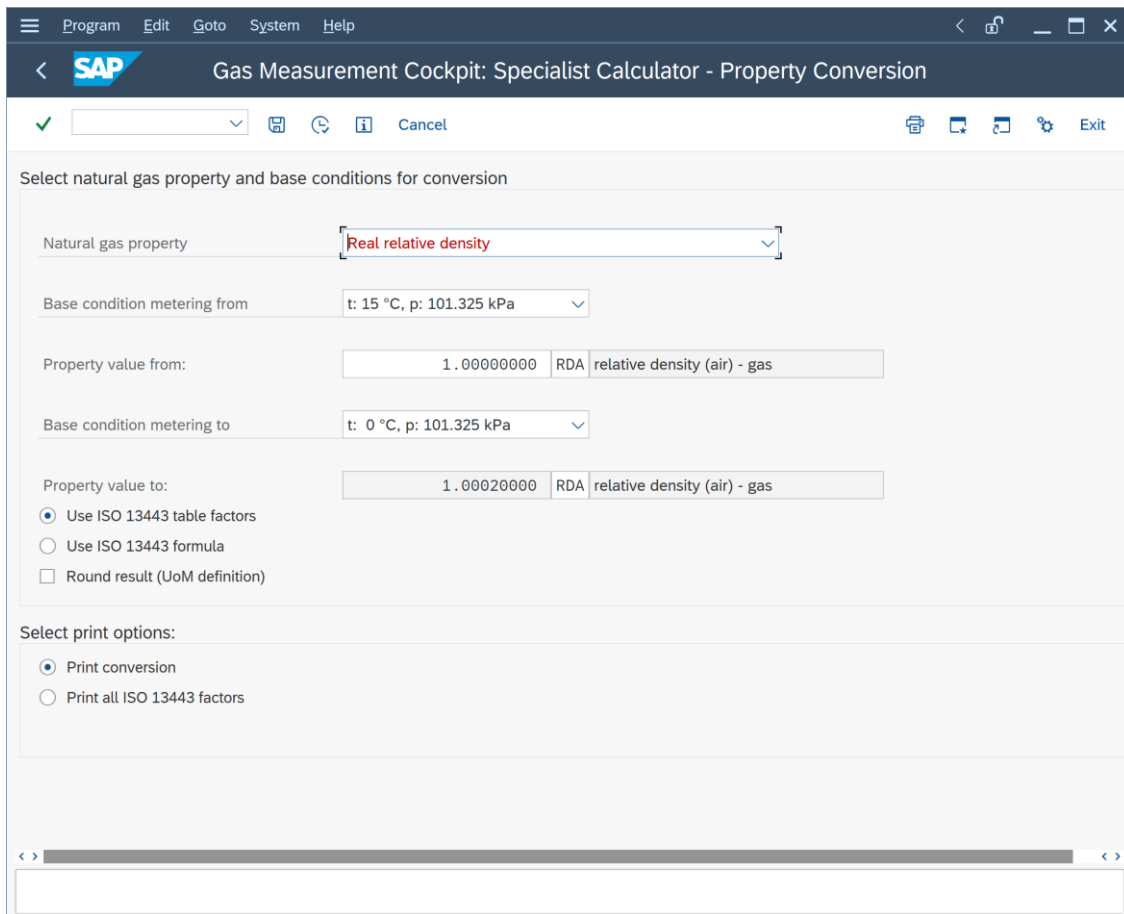
3.3. GMC Methodology

The five tab strips are organized so that they group complex implementation project sub tasks into “task packages”, as well as organizing regular monitoring and error analysis tasks in a structured way. The QuantityWare Project Assessment and Implementation Guidelines (PAIG) methodology provides the underlying design logic for the GMC. For more details, read the separate PAIG documentation for BCG.

3.4. GMC Tab Strip Details

3.4.1. Units of Measurement

Correct UoM definitions and intra-conversion factors are the basis of all quantity conversions. You need to ensure that all UoM are correctly defined. For example, you frequently need to control whether heating values that you report are accurate, or data from business partners is consistent with your data. The Natural Gas Specialist Calculator supports property conversion calculations based on ISO 13443 conversion factors or formulas for all known natural gas properties and base conditions:



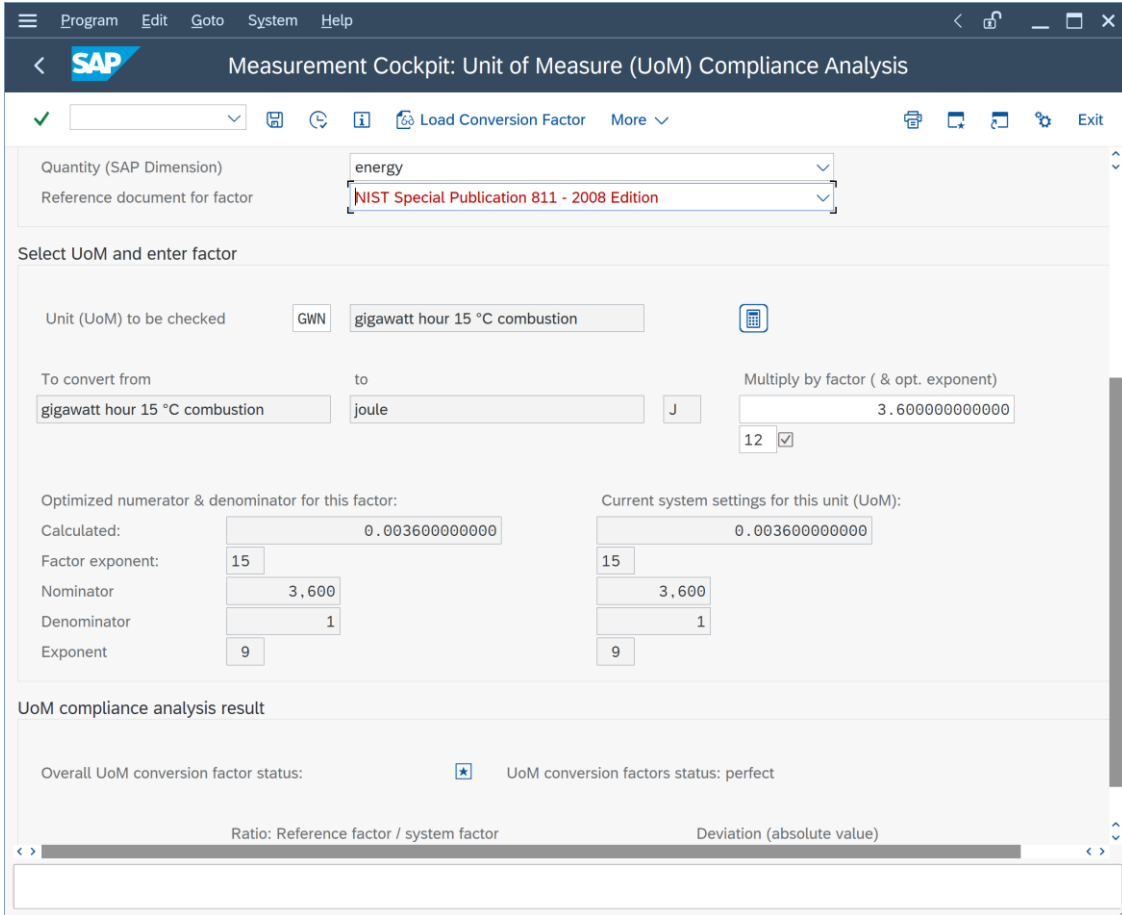
You also need to monitor all UoM for your natural gas properties and stock keeping quantities, thus the GMC provides a sophisticated UoM comparison tool which you utilize to compare UoM definitions that are delivered in BC sets with UoM definitions in your system clients.

SAP Gas Measurement Cockpit: Display Natural Gas Property Units of Measure

Display Natural Gas Property Units for Dimension

No Dimension	OG ISO	P	Measurement unit text	One UoM	=	Factor	SI UoM conversion
7 energy	OG GV		gigajoule - 15 °C comb.,sup.	1 GJ1	=	1,000,000,000.0000000000	J UoM Conversion
8 energy	OG GV		gigajoule - 20 °C comb., sup.	1 GJ2	=	1,000,000,000.0000000000	J UoM Conversion
9 energy	OG GV		gigajoule - 25 °C comb.,sup.	1 GJ5	=	1,000,000,000.0000000000	J UoM Conversion
10 energy	GV	X	gigajoule	1 GJL	=	1,000,000,000.0000000000	J UoM Conversion
11 energy	GWH	X	gigawatt hour	1 GWH	=	3,600,000,000.0000000000	J UoM Conversion
12 energy	OG		gigawatt hour 15 °C combustion	1 GWN	=	3,600,000,000.0000000000	J UoM Conversion
13 energy	JOU	X	joule	1 J	=	1.0000000000	J UoM Conversion
14 energy	KJQ	X	kilojoule	1 KJ	=	1,000.0000000000	J UoM Conversion
15 energy	KWH	X	kilowatt hour	1 KWH	=	3,600,000.0000000000	J UoM Conversion
16 energy	OG KWH		kilowatt hour -15 °C c.,inf.	1 KWI	=	3,600,000.0000000000	J UoM Conversion
17 energy	OG KWH		kilowatt hour -15 °C c.,sup.	1 KWN	=	3,600,000.0000000000	J UoM Conversion
18 energy	OG BZ		million Btu(IT) - 60 °F c.,s.	1 MBD	=	1,055,055,852.6200000000	J UoM Conversion
19 energy	OG BZ		million Btu(IT) - 60 °F c.,i.	1 MBI	=	1,055,055,852.6200000000	J UoM Conversion
20 energy	BZ		million Btu (IT)	1 MBT	=	1,055,055,852.6200000000	J UoM Conversion
21 energy	BZ	X	million Btu(IT)	1 MBU	=	1,055,055,852.6200000000	J UoM Conversion

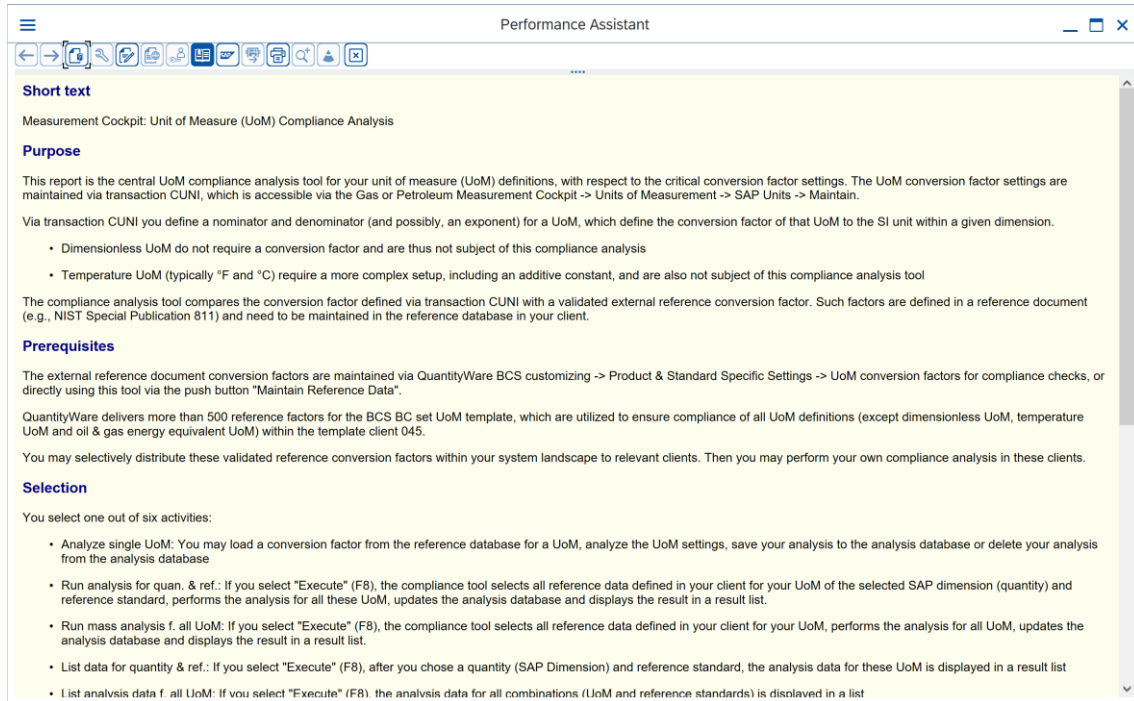
The UoM compliance analysis is also available in this tab page:



The screenshot shows the SAP Measurement Cockpit interface for Unit of Measure (UoM) Compliance Analysis. The window title is "Measurement Cockpit: Unit of Measure (UoM) Compliance Analysis". The interface includes a menu bar with "Program", "Edit", "Goto", "System", and "Help". Below the menu bar, there is a navigation bar with a back arrow, the SAP logo, and the title. A toolbar contains icons for a checkmark, a dropdown menu, a refresh icon, a help icon, a "Load Conversion Factor" button, and a "More" dropdown menu. The main content area is divided into several sections:

- Quantity (SAP Dimension):** A dropdown menu showing "energy".
- Reference document for factor:** A dropdown menu showing "NIST Special Publication 811 - 2008 Edition".
- Select UoM and enter factor:**
 - Unit (UoM) to be checked:** A dropdown menu showing "GWN" and a text input field containing "gigawatt hour 15 °C combustion".
 - To convert from:** A dropdown menu showing "gigawatt hour 15 °C combustion".
 - to:** A dropdown menu showing "joule".
 - Multiply by factor (& opt. exponent):** A text input field containing "3.600000000000" and a dropdown menu showing "12" with a checked checkbox.
- Optimized numerator & denominator for this factor:**
 - Calculated:** A text input field containing "0.003600000000".
 - Factor exponent:** A text input field containing "15".
 - Nominator:** A text input field containing "3,600".
 - Denominator:** A text input field containing "1".
 - Exponent:** A text input field containing "9".
- Current system settings for this unit (UoM):**
 - Calculated:** A text input field containing "0.003600000000".
 - Factor exponent:** A text input field containing "15".
 - Nominator:** A text input field containing "3,600".
 - Denominator:** A text input field containing "1".
 - Exponent:** A text input field containing "9".
- UoM compliance analysis result:**
 - Overall UoM conversion factor status:** A dropdown menu showing a checkmark icon.
 - UoM conversion factors status:** A text label showing "perfect".
 - Ratio: Reference factor / system factor:** A text input field.
 - Deviation (absolute value):** A text input field.

The online documentation provides a detailed explanation how to prepare the UoM compliance analysis:



Performance Assistant

Short text

Measurement Cockpit: Unit of Measure (UoM) Compliance Analysis

Purpose

This report is the central UoM compliance analysis tool for your unit of measure (UoM) definitions, with respect to the critical conversion factor settings. The UoM conversion factor settings are maintained via transaction CUNI, which is accessible via the Gas or Petroleum Measurement Cockpit -> Units of Measurement -> SAP Units -> Maintain.

Via transaction CUNI you define a nominator and denominator (and possibly, an exponent) for a UoM, which define the conversion factor of that UoM to the SI unit within a given dimension.

- Dimensionless UoM do not require a conversion factor and are thus not subject of this compliance analysis
- Temperature UoM (typically °F and °C) require a more complex setup, including an additive constant, and are also not subject of this compliance analysis tool

The compliance analysis tool compares the conversion factor defined via transaction CUNI with a validated external reference conversion factor. Such factors are defined in a reference document (e.g., NIST Special Publication 811) and need to be maintained in the reference database in your client.

Prerequisites

The external reference document conversion factors are maintained via QuantityWare BCS customizing -> Product & Standard Specific Settings -> UoM conversion factors for compliance checks, or directly using this tool via the push button "Maintain Reference Data".

QuantityWare delivers more than 500 reference factors for the BCS BC set UoM template, which are utilized to ensure compliance of all UoM definitions (except dimensionless UoM, temperature UoM and oil & gas energy equivalent UoM) within the template client 045.

You may selectively distribute these validated reference conversion factors within your system landscape to relevant clients. Then you may perform your own compliance analysis in these clients.

Selection

You select one out of six activities:

- Analyze single UoM: You may load a conversion factor from the reference database for a UoM, analyze the UoM settings, save your analysis to the analysis database or delete your analysis from the analysis database
- Run analysis for quan. & ref.: If you select "Execute" (F8), the compliance tool selects all reference data defined in your client for your UoM of the selected SAP dimension (quantity) and reference standard, performs the analysis for all these UoM, updates the analysis database and displays the result in a result list.
- Run mass analysis f. all UoM: If you select "Execute" (F8), the compliance tool selects all reference data defined in your client for your UoM, performs the analysis for all UoM, updates the analysis database and displays the result in a result list.
- List data for quantity & ref.: If you select "Execute" (F8), after you chose a quantity (SAP Dimension) and reference standard, the analysis data for these UoM is displayed in a result list
- List analysis data f. all UoM: If you select "Execute" (F8), the analysis data for all combinations (UoM and reference standards) is displayed in a list

3.4.2. Print Standards Lists

When either adding a new product line or changing conversions for existing products, the “second task package” is the definition of the correct measurement standard, or several standards, as well as specific rules which may apply for different countries/business contracts. You need to compare legacy system results with available standards - a process which is usually considerably easier when ranges of complex correction factors can be printed. During general operations, you may also need to explain your conversion results to an independent inspector and thus need to print the relevant data. Basically, five different types of standards are relevant for your gas quantity conversion configuration:

- Standards defining the detailed calculation model
- Standards defining correction and conversion factors due to pressure and temperature on product volumes and energies and all properties (heating values, densities, Wobbe index ...)
- Standards defining calculations of densities and heating values from composition
- Standards defining physical property data
- Standards defining the conversion factors between UoM of one dimension

Physical property data varies with time and standard source and is essential for calculations of heating values, Wobbe index and densities; thus a good overview and subsequently correct assignment to a conversion group is crucial.

SAP Gas Measurement Cockpit: Print Physical Properties of Hydrocarbons

Physical Property Data Sets - Natural Gas Components

Select Set ID -> display Set components
Select column 3 ... -> display Set header data

Set ID	Description	B. Tmp. HV	Base temp	Unit	Unit description	B.Press.HV	B.Press.VL	Unit	Unit description
QS	QW: 15 °C / 15 °C ISO 6578:2017 LNG	15.00	15.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
QT	QW: 15 °C / 15 °C ISO 6578:2017 NGL/LPG	288.150	288.150	K	Kelvin	101.325	101.325	KPA	kilopascal
QX	QW: 15 °C / 101.325 KPA GPA 2145:16 H2	15.00	15.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
QY	QW: 60 °F / 14.696 PSI GPA 2145:16 H2	60.00	60.00	FAH	degree Fahrenheit	14.696	14.696	PSI	pound-force per square In
R1	QW: 25 °C / 0 °C ISO 6976:16	25.00	0.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
R2	QW: 15 °C / 15 °C ISO 6976:16	15.00	15.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
R3	QW: 0 °C / 0 °C ISO 6976:16	0.00	0.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
R4	QW: 15 °C / 0 °C ISO 6976:16	15.00	0.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
R5	QW: 20 °C / 20 °C ISO 6976:16	20.00	20.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
R6	QW: 25 °C / 20 °C ISO 6976:16	25.00	20.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
R7	QW: 25 °C / 15 °C ISO 6976:16	25.00	15.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
R8	QW: 60 °F / 101.325 KPA ISO 6976:16	60.00	60.00	FAH	degree Fahrenheit	101.325	101.325	KPA	kilopascal
R9	QW: 60 °F / 14.696 PSI ISO 6976:16	60.00	60.00	FAH	degree Fahrenheit	14.696	14.696	PSI	pound-force per square In
RA	QW: 60 °F / 14.696 PSI ISO 6976:16	60.00	60.00	FAH	degree Fahrenheit	14.696	14.696	PSI	pound-force per square In

SAP Gas Measurement Cockpit: Print Physical Properties of Hydrocarbons

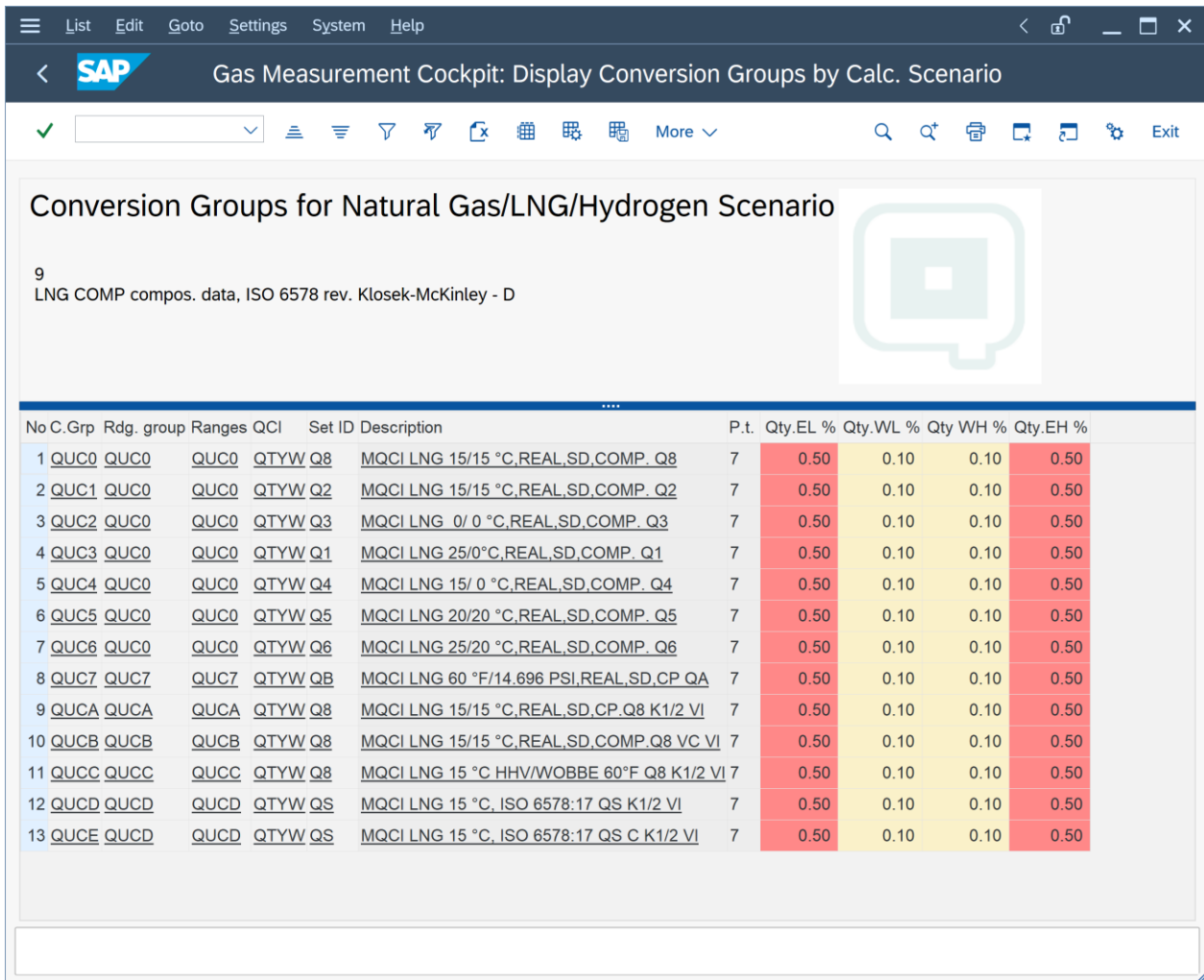
Physical Property Set - Component Properties

Set-ID: R8 - QW: 60 °F / 101.325 KPA ISO 6976:16
Component: METHANE - methane
Set is maintained with summation factors ISO 6976 def.

Parameter	Value	Unit	Unit description	Conditions
Molar mass	16.0424600	KKM	kilogram per kilomole	
Summation factor	0.0443700			at: 60.00 FAH , 101.325 ...
Heating value, superior, fuel as id. gas	891.4600000	KJL	kilojoule per mole	at: 60.00 FAH, ideal reac...

3.4.3. QCI Configuration

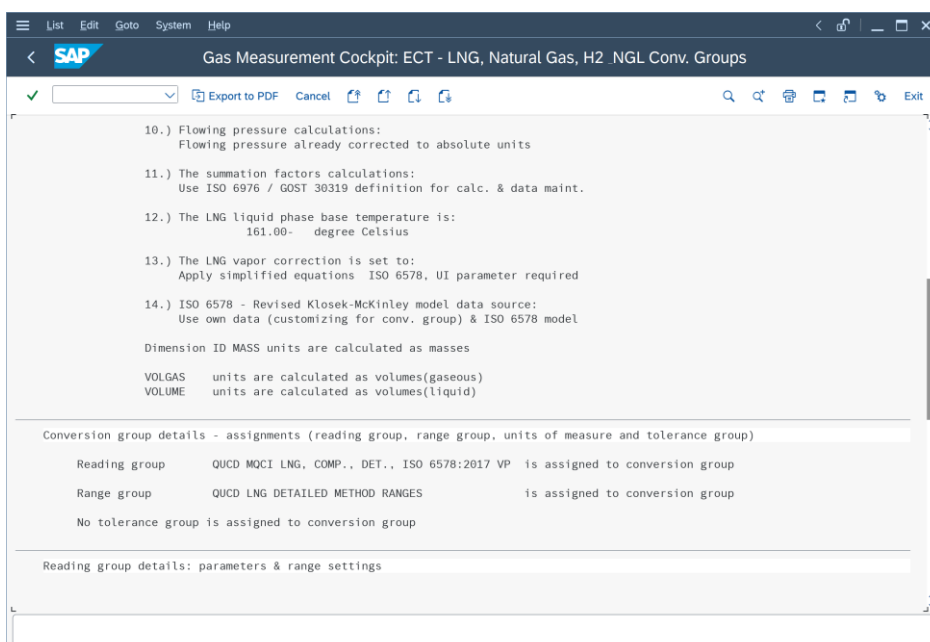
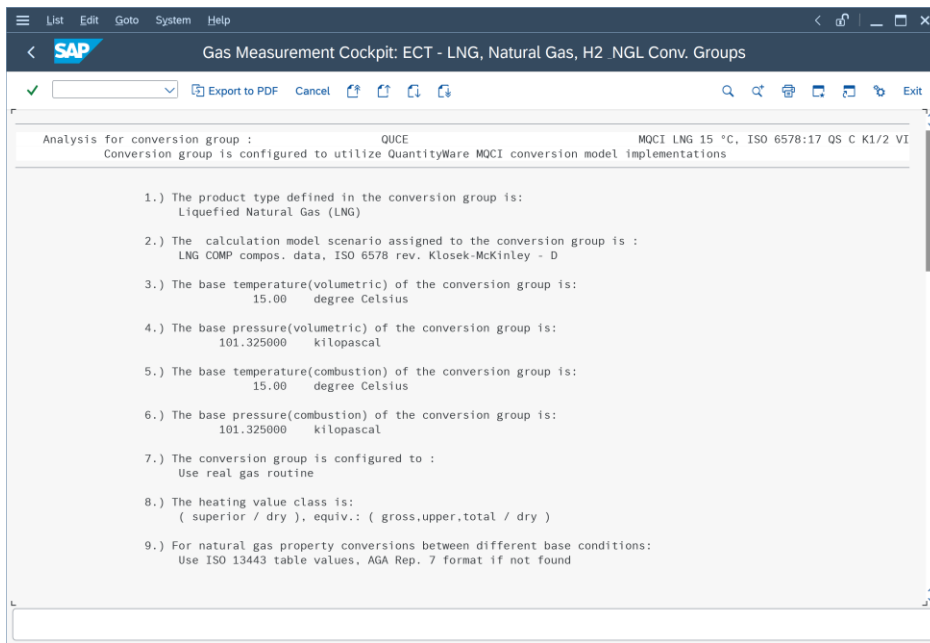
The third and most complex task package is to decide which conversion group needs to be assigned to your materials at which plant. You obtain an overview of the QuantityWare delivered conversion groups, organized via product groups, and inspect and cross-check the settings.



The screenshot shows the SAP interface for 'Gas Measurement Cockpit: Display Conversion Groups by Calc. Scenario'. The main title is 'Conversion Groups for Natural Gas/LNG/Hydrogen Scenario'. Below the title, there is a sub-header '9 LNG COMP compos. data, ISO 6578 rev. Klosek-McKinley - D'. The main content is a table with 13 rows of conversion groups. The table has columns for No C.Grp, Rdg. group, Ranges, QCI, Set ID, Description, P.t., Qty.EL %, Qty.WL %, Qty.WH %, and Qty.EH %.

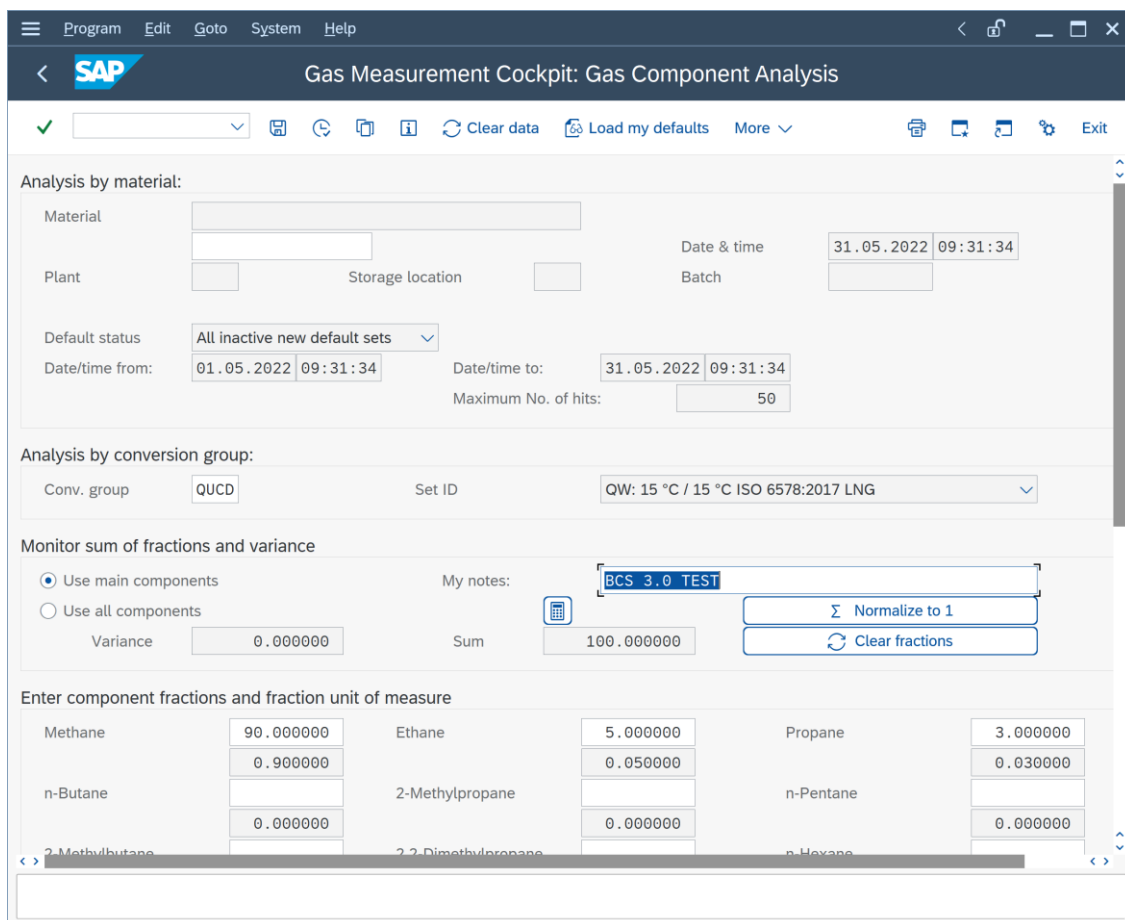
No C.Grp	Rdg. group	Ranges	QCI	Set ID	Description	P.t.	Qty.EL %	Qty.WL %	Qty.WH %	Qty.EH %
1	QUC0	QUC0	QUC0	QTYW Q8	MQCI LNG 15/15 °C.REAL.SD.COMP. Q8	7	0.50	0.10	0.10	0.50
2	QUC1	QUC0	QUC0	QTYW Q2	MQCI LNG 15/15 °C.REAL.SD.COMP. Q2	7	0.50	0.10	0.10	0.50
3	QUC2	QUC0	QUC0	QTYW Q3	MQCI LNG 0/ 0 °C.REAL.SD.COMP. Q3	7	0.50	0.10	0.10	0.50
4	QUC3	QUC0	QUC0	QTYW Q1	MQCI LNG 25/0°C.REAL.SD.COMP. Q1	7	0.50	0.10	0.10	0.50
5	QUC4	QUC0	QUC0	QTYW Q4	MQCI LNG 15/ 0 °C.REAL.SD.COMP. Q4	7	0.50	0.10	0.10	0.50
6	QUC5	QUC0	QUC0	QTYW Q5	MQCI LNG 20/20 °C.REAL.SD.COMP. Q5	7	0.50	0.10	0.10	0.50
7	QUC6	QUC0	QUC0	QTYW Q6	MQCI LNG 25/20 °C.REAL.SD.COMP. Q6	7	0.50	0.10	0.10	0.50
8	QUC7	QUC7	QUC7	QTYW QB	MQCI LNG 60 °F/14.696 PSI.REAL.SD.CP QA	7	0.50	0.10	0.10	0.50
9	QUCA	QUCA	QUCA	QTYW Q8	MQCI LNG 15/15 °C.REAL.SD.CP.Q8 K1/2 VI	7	0.50	0.10	0.10	0.50
10	QUCB	QUCB	QUCB	QTYW Q8	MQCI LNG 15/15 °C.REAL.SD.COMP.Q8 VC VI	7	0.50	0.10	0.10	0.50
11	QUCC	QUCC	QUCC	QTYW Q8	MQCI LNG 15 °C HHV/WOBBE 60°F Q8 K1/2 VI	7	0.50	0.10	0.10	0.50
12	QUCD	QUCD	QUCD	QTYW QS	MQCI LNG 15 °C, ISO 6578:17 QS K1/2 VI	7	0.50	0.10	0.10	0.50
13	QUCE	QUCD	QUCD	QTYW QS	MQCI LNG 15 °C, ISO 6578:17 QS C K1/2 VI	7	0.50	0.10	0.10	0.50

In this example, you display all LNG conversion groups delivered with the QuantityWare BCG template that are configured for the detailed LNG calculation scenario – where the molar composition data and the LNG liquid temperature are the main input data, and all properties are being calculated based on that data. From this list, you can directly navigate to all detailed conversion group settings or print a conversion group explanation statement by clicking on the description of a conversion group:



3.4.4. Gas Analysis

The basis of all natural gas property calculations is the molar composition of a natural gas or LNG. Here you enter any molar composition - or analyze composition data from SAP standard movement default tables - and perform calculations using laboratory data. All data can be printed out in detail, ensuring maximum calculation transparency and accuracy:



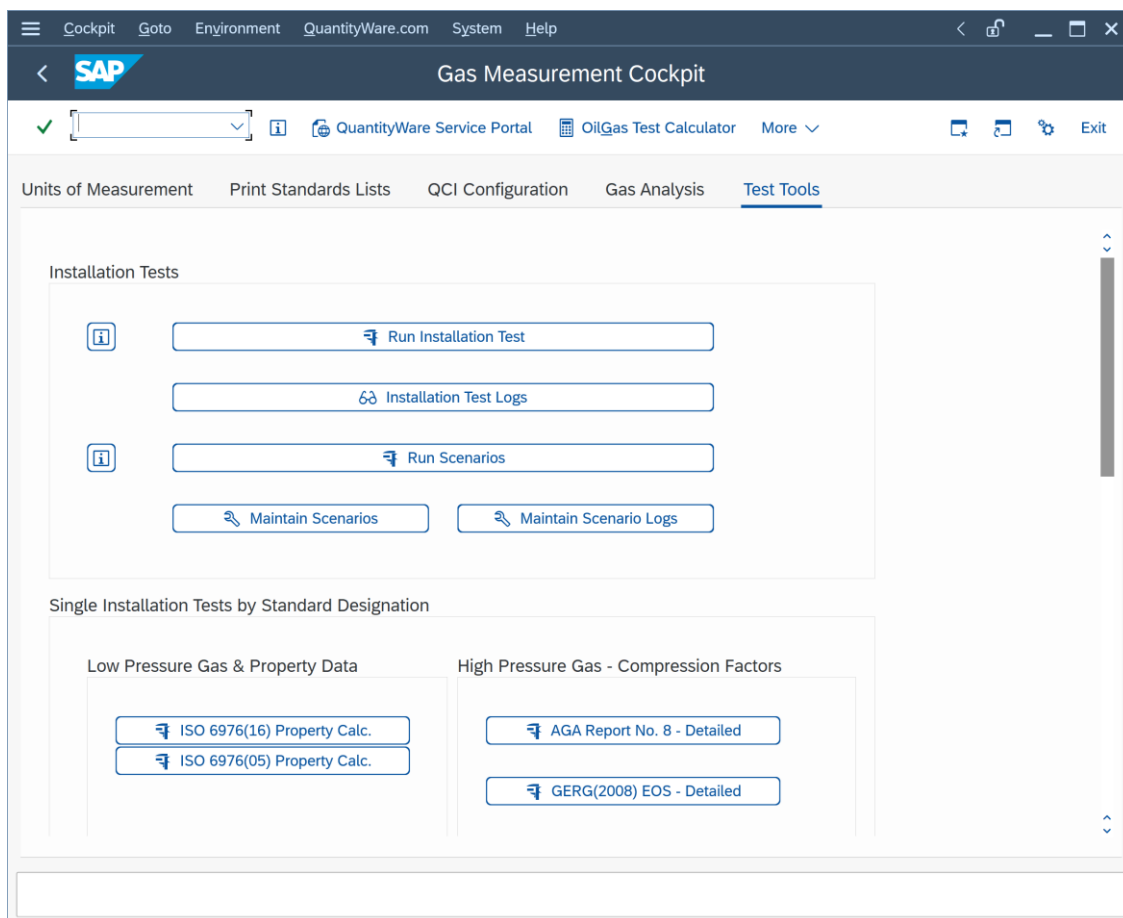
The screenshot shows the SAP Gas Measurement Cockpit interface for Gas Component Analysis. The window title is "SAP Gas Measurement Cockpit: Gas Component Analysis". The interface is divided into several sections:

- Analysis by material:** Includes fields for Material, Plant, Storage location, Date & time (31.05.2022 09:31:34), Batch, Default status (All inactive new default sets), Date/time from (01.05.2022 09:31:34), Date/time to (31.05.2022 09:31:34), and Maximum No. of hits (50).
- Analysis by conversion group:** Includes Conv. group (QUCD) and Set ID (QW: 15 °C / 15 °C ISO 6578:2017 LNG).
- Monitor sum of fractions and variance:** Includes radio buttons for "Use main components" (selected) and "Use all components". A "My notes" field contains "BCS 3.0 TEST". The Variance is 0.000000 and the Sum is 100.000000. Buttons for "Σ Normalize to 1" and "Clear fractions" are present.
- Enter component fractions and fraction unit of measure:** A table for entering component fractions:

Component	Fraction	Component	Fraction	Component	Fraction
Methane	90.000000	Ethane	5.000000	Propane	3.000000
	0.900000		0.050000		0.030000
n-Butane	0.000000	2-Methylpropane	0.000000	n-Pentane	0.000000
2-Methylbutane		2,2-Dimethylpropane		n-Hexane	

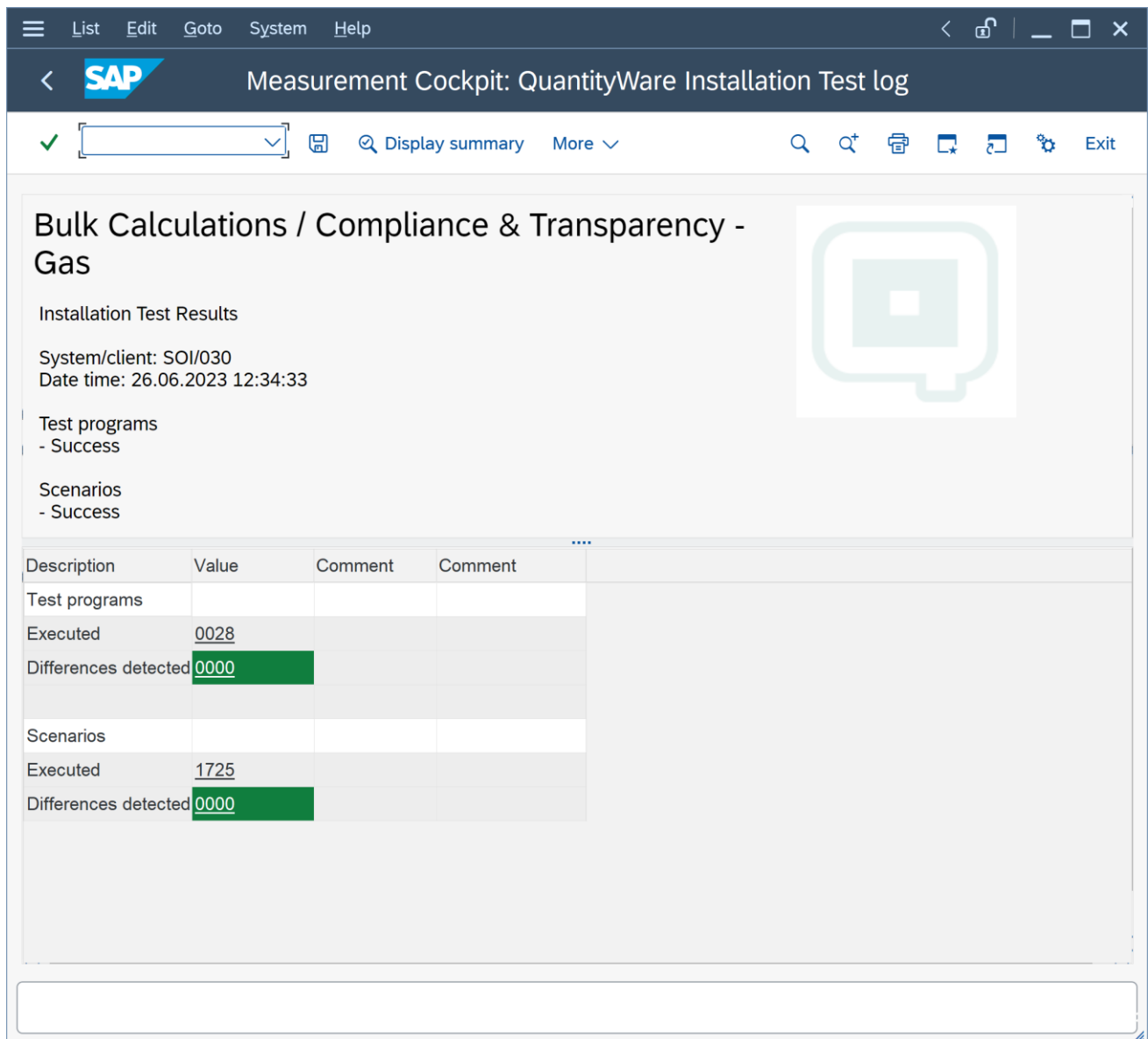
3.4.5. Test Tools

All UoM and quantity conversion settings need rigorous testing and quality control. The QuantityWare installation test needs to be executed from here. You also configure and run your own test scenarios with full logging and execution control to ensure full compliance for your implementation. Via this tab strip you access all QuantityWare test tools that are delivered with BCG:



From this tab, you either:

In client 045 - run the QuantityWare installation test with one click and obtain the test result within seconds



The screenshot shows the SAP Measurement Cockpit interface. The title bar reads "Measurement Cockpit: QuantityWare Installation Test log". The main content area displays the following information:

Bulk Calculations / Compliance & Transparency - Gas

Installation Test Results

System/client: SOI/030
Date time: 26.06.2023 12:34:33

Test programs
- Success

Scenarios
- Success

Description	Value	Comment	Comment
Test programs			
Executed	0028		
Differences detected	0000		
Scenarios			
Executed	1725		
Differences detected	0000		

- In your other clients - You run the Technical Installation Test, or utilize the QuantityWare Test Scenario Tool (Run Scenarios, Maintain Scenarios, Maintain Scenario Logs) to define your own test scenarios based on your requirements.
- Run the UoM compliance analysis in any client

Measurement Cockpit: Unit of Measure (UoM) Compliance Analysis

Display Unit of Measure Compliance Analysis Data

All UoM analysis data in system/client: SOI 030

No	Dimension text	UoM	Measurement unit text	SI	Standard	Ref./An.	Ref.Std.Factor	l/s	Cal.Denom.	Cal.Num. Exp	Sys.Denom.	Sys.Num. Exp	System Factor	l/s
134	energy	GJ2	gigajoule - 20 °C comb., sup.	J	1	oo	1,000,000,000.000	0	1	1	9	1	1,000,000,000.000	0
135		GJ5	gigajoule - 25 °C comb., sup.	J	1	oo	1,000,000,000.000	0	1	1	9	1	1,000,000,000.000	0
136		GJL	gigajoule	J	1	oo	1,000,000,000.000	0	1	1	9	1	1,000,000,000.000	0
201		G...	gigawatt hour	J	1	oo	0.0036000000000	15	1	3,600	9	1	0.0036000000000	15
202		G...	gigawatt hour 15 °C combustion	J	1	oo	0.0036000000000	15	1	3,600	9	1	0.0036000000000	15
231		J	joule	J	1	oo	1,000	0	1	1	0	1	1,000	0
258		KJ	kilojoule	J	1	oo	1,000	0	1	1,000	0	1	1,000	0
280		KW...	kilowatt hour	J	1	oo	3,600,000.000	0	1	3,600,000	0	1	3,600,000.000	0
281		KW...	kilowatt hour	J	2	oo	3,600,000.000	0	1	3,600,000	0	1	3,600,000.000	0
282		KWI	kilowatt hour -15 °C c.,inf.	J	1	oo	3,600,000.000	0	1	3,600,000	0	1	3,600,000.000	0
284		KW...	kilowatt hour -15 °C c.,sup.	J	1	oo	3,600,000.000	0	1	3,600,000	0	1	3,600,000.000	0
366		MBD	million Btu(IT) - 60 °F c.,s.	J	1	oo	1,055,055,852.620	0	481,031,239	507,514,824	9	481,031,239	1,055,055,852.620	0
368		MBI	million Btu(IT) - 60 °F c.,i.	J	1	oo	1,055,055,852.620	0	481,031,239	507,514,824	9	481,031,239	1,055,055,852.620	0
372		MBT	million Btu (IT)	J	1	oo	1,055,055,852.620	0	481,031,239	507,514,824	9	481,031,239	1,055,055,852.620	0
373		MBU	million Btu(IT)	J	1	oo	1,055,055,852.620	0	481,031,239	507,514,824	9	481,031,239	1,055,055,852.620	0

The UoM compliance analysis in client 045 is executed automatically once you execute the installation test and the result of the analysis is stored in your database. QuantityWare delivers validated UoM conversion factors which are utilized for the analysis and which you may also copy for your own analysis e.g., in your productive system and client.

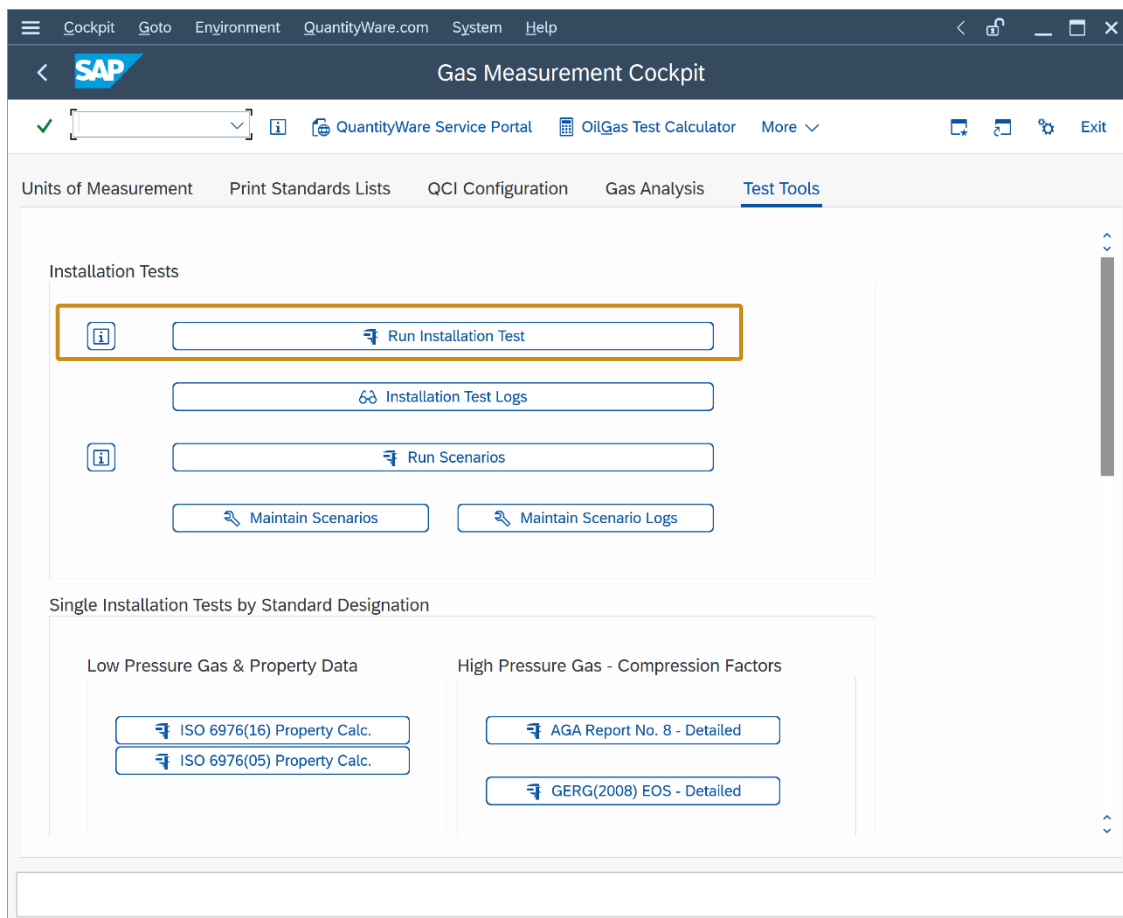
3.4.5.1. BCG Installation Test

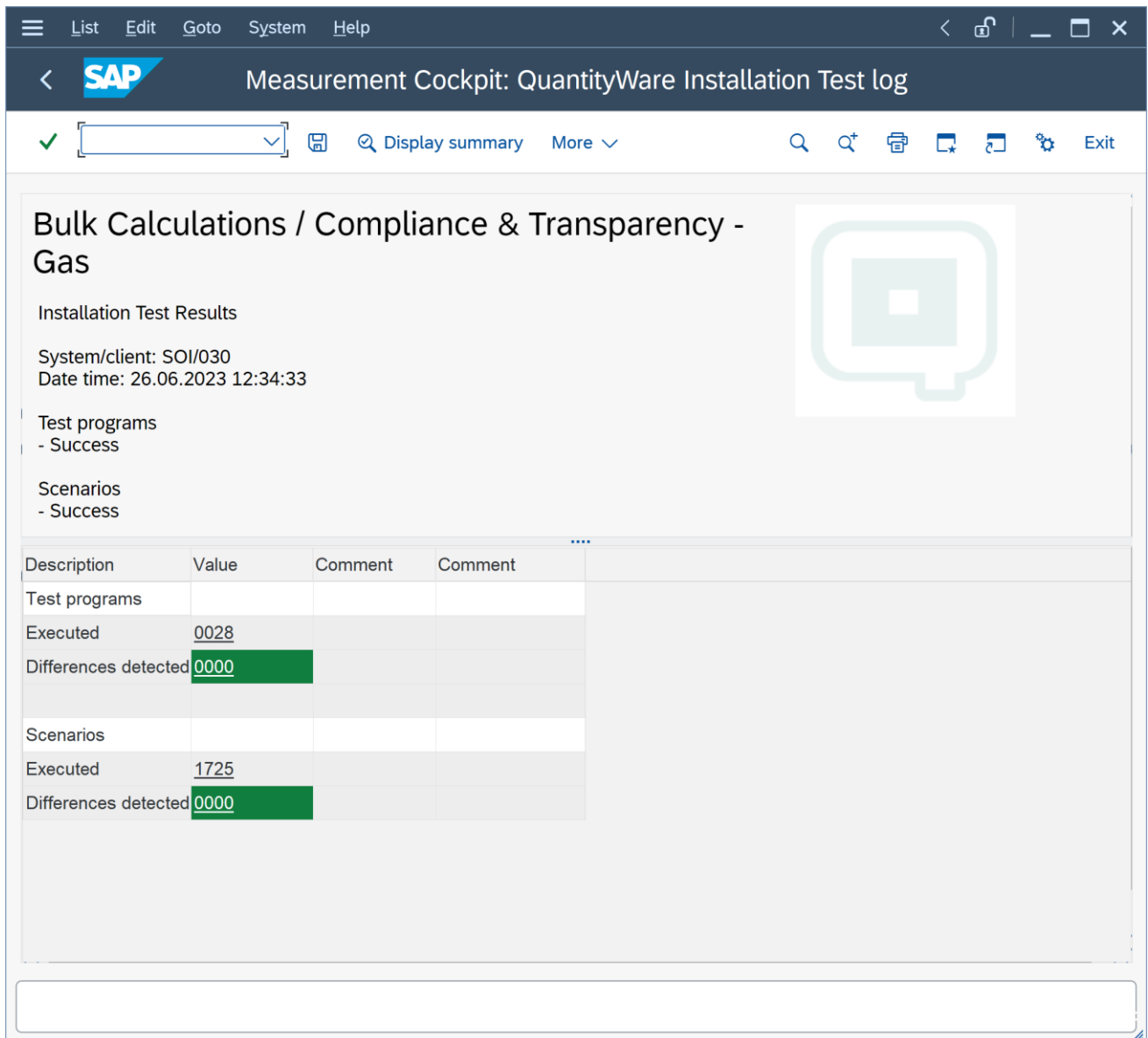
The BCG Installation Test must be executed in one dedicated system per system landscape and client 045 (recommended client number if available).

The BCG Installation Test requires that the appropriate BCG BC set is activated in that client. The BCG BC Set contains a rich configuration template (only client dependent data) on which the installation test performs massive tests in conjunction with the ABAP repository installation.

This configuration template is subsequently utilized by certified BCG consultants who select the required configuration objects (UoM definitions, conversion groups, reading groups ...) following the BCG PAIG methodology.

The BCG Installation Test is executed from the Gas Measurement Cockpit (GMC), tab strip "Test Tools" with one single click on push button "Run Installation Test":





The screenshot shows the SAP Measurement Cockpit interface for the 'QuantityWare Installation Test log'. The title bar includes 'SAP' and 'Measurement Cockpit: QuantityWare Installation Test log'. The main content area is titled 'Bulk Calculations / Compliance & Transparency - Gas' and displays 'Installation Test Results' for 'System/client: SOI/030' on 'Date time: 26.06.2023 12:34:33'. It reports 'Test programs - Success' and 'Scenarios - Success'. A table below provides a detailed breakdown of the test results.

Description	Value	Comment	Comment
Test programs			
Executed	0028		
Differences detected	0000		
Scenarios			
Executed	1725		
Differences detected	0000		

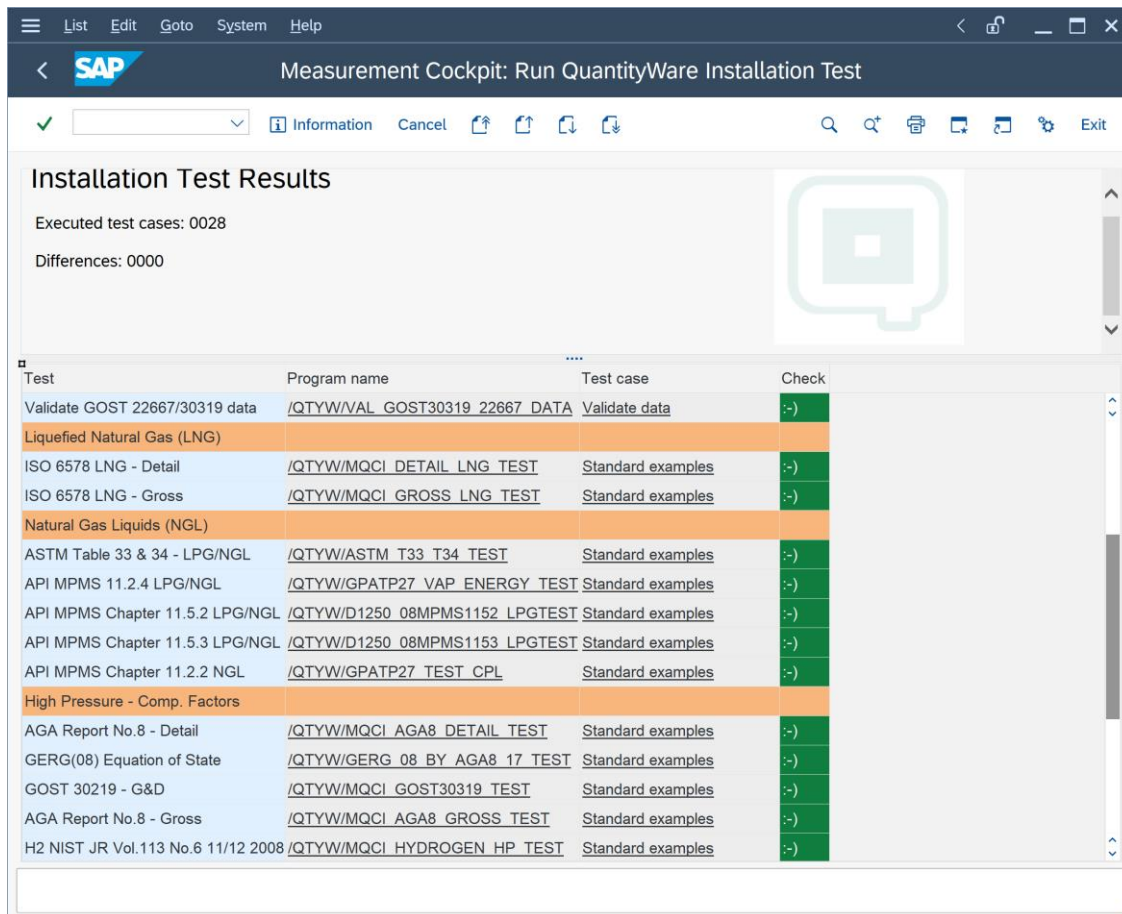
Two types of tests are executed during the installation test:

28 Test Programs

1 725 Test Scenarios

These results are also written to the installation test log database for later reference.

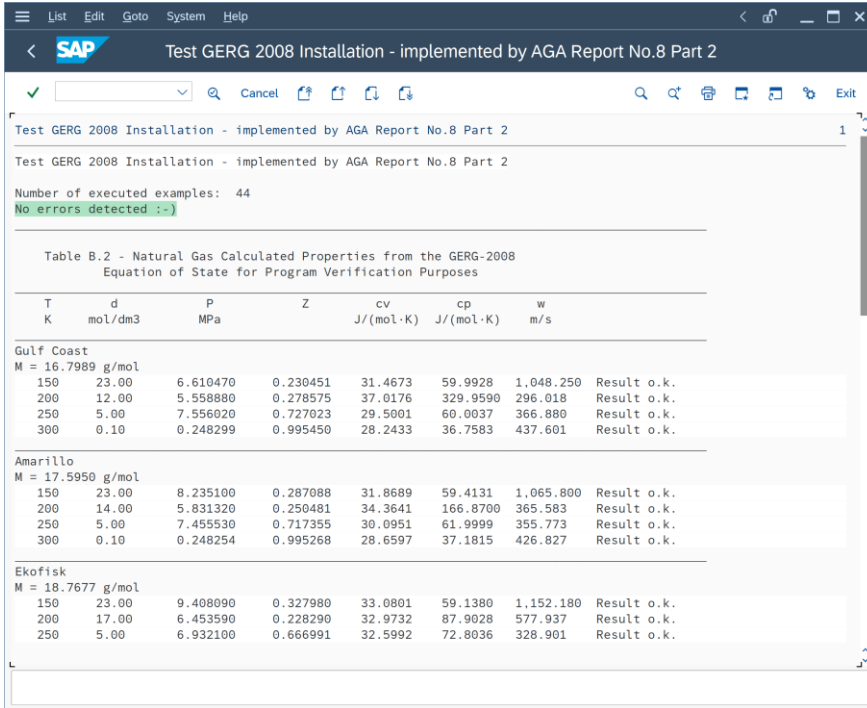
You navigate to the test details (either from this result list or the log database result list) by simply clicking a result line. If you select the test programs, a comprehensive list with all executed test programs and the relevant test cases is displayed:



Test	Program name	Test case	Check
Validate GOST 22667/30319 data	/QTYW/VAL_GOST30319_22667_DATA	Validate data	:-)
Liquefied Natural Gas (LNG)			
ISO 6578 LNG - Detail	/QTYW/MQCI_DETAIL_LNG_TEST	Standard examples	:-)
ISO 6578 LNG - Gross	/QTYW/MQCI_GROSS_LNG_TEST	Standard examples	:-)
Natural Gas Liquids (NGL)			
ASTM Table 33 & 34 - LPG/NGL	/QTYW/ASTM_T33_T34_TEST	Standard examples	:-)
API MPMS 11.2.4 LPG/NGL	/QTYW/GPATP27_VAP_ENERGY_TEST	Standard examples	:-)
API MPMS Chapter 11.5.2 LPG/NGL	/QTYW/D1250_08MPMS1152_LPGTEST	Standard examples	:-)
API MPMS Chapter 11.5.3 LPG/NGL	/QTYW/D1250_08MPMS1153_LPGTEST	Standard examples	:-)
API MPMS Chapter 11.2.2 NGL	/QTYW/GPATP27_TEST_CPL	Standard examples	:-)
High Pressure - Comp. Factors			
AGA Report No.8 - Detail	/QTYW/MQCI_AGA8_DETAIL_TEST	Standard examples	:-)
GERG(08) Equation of State	/QTYW/GERG_08_BY_AGA8_17_TEST	Standard examples	:-)
GOST 30219 - G&D	/QTYW/MQCI_GOST30319_TEST	Standard examples	:-)
AGA Report No.8 - Gross	/QTYW/MQCI_AGA8_GROSS_TEST	Standard examples	:-)
H2 NIST JR Vol.113 No.6 11/12 2008	/QTYW/MQCI_HYDROGEN_HP_TEST	Standard examples	:-)

The test programs contain one test case. The test case “Standard examples” ensures that all measurement standard examples (expected results) for CTPL / Compression factor standards, that are defined in a measurement standard, are reproduced exactly. Test case “Validate Data” ensures that physical property data sets are consistent.

You navigate to all test details from this overview list - test case: "Standard examples", e.g.:



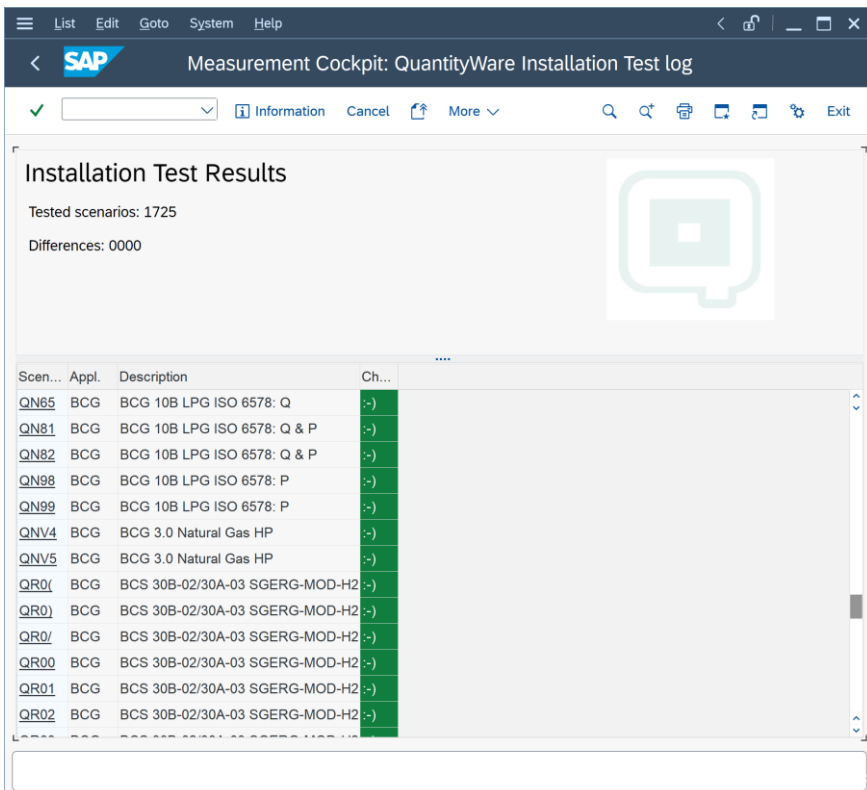
Test GERG 2008 Installation - implemented by AGA Report No.8 Part 2

Number of executed examples: 44
No errors detected :-)

Table B.2 - Natural Gas Calculated Properties from the GERG-2008 Equation of State for Program Verification Purposes

T K	d mol/dm ³	P MPa	Z	cv J/(mol·K)	cp J/(mol·K)	w m/s	
Gulf Coast							
M = 16.7989 g/mol							
150	23.00	6.610470	0.230451	31.4673	59.9928	1.048.250	Result o.k.
200	12.00	5.558880	0.278575	37.0176	329.9590	296.018	Result o.k.
250	5.00	7.556020	0.727023	29.5001	60.0037	366.880	Result o.k.
300	0.10	0.248299	0.995450	28.2433	36.7583	437.601	Result o.k.
Amarillo							
M = 17.5950 g/mol							
150	23.00	8.235100	0.287088	31.8689	59.4131	1.065.800	Result o.k.
200	14.00	5.831320	0.250481	34.3641	166.8700	365.583	Result o.k.
250	5.00	7.455530	0.717355	30.0951	61.9999	355.773	Result o.k.
300	0.10	0.248254	0.995268	28.6597	37.1815	426.827	Result o.k.
Ekofisk							
M = 18.7677 g/mol							
150	23.00	9.408090	0.327980	33.0801	59.1380	1.152.180	Result o.k.
200	17.00	6.453590	0.228290	32.9732	87.9028	577.937	Result o.k.
250	5.00	6.932100	0.666991	32.5992	72.8036	328.901	Result o.k.

If you select the test scenarios, a comprehensive list with all executed 1 725 test scenarios is displayed:



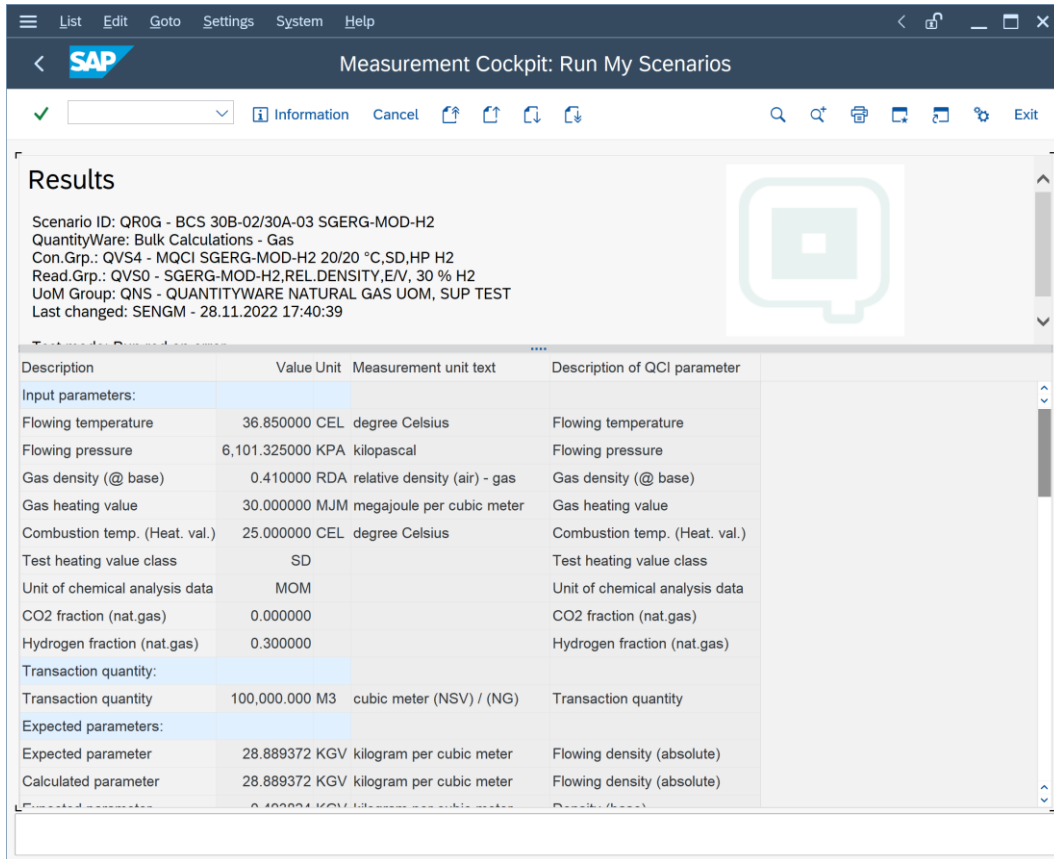
Measurement Cockpit: QuantityWare Installation Test log

Installation Test Results

Tested scenarios: 1725
Differences: 0000

Scen...	Appl.	Description	Ch...
QN65	BCG	BCG 10B LPG ISO 6578: Q	o.k.
QN81	BCG	BCG 10B LPG ISO 6578: Q & P	o.k.
QN82	BCG	BCG 10B LPG ISO 6578: Q & P	o.k.
QN98	BCG	BCG 10B LPG ISO 6578: P	o.k.
QN99	BCG	BCG 10B LPG ISO 6578: P	o.k.
QNV4	BCG	BCG 3.0 Natural Gas HP	o.k.
QNV5	BCG	BCG 3.0 Natural Gas HP	o.k.
QR0	BCG	BCS 30B-02/30A-03 SGERG-MOD-H2	o.k.
QR01	BCG	BCS 30B-02/30A-03 SGERG-MOD-H2	o.k.
QR02	BCG	BCS 30B-02/30A-03 SGERG-MOD-H2	o.k.
QR03	BCG	BCS 30B-02/30A-03 SGERG-MOD-H2	o.k.
QR04	BCG	BCS 30B-02/30A-03 SGERG-MOD-H2	o.k.
QR05	BCG	BCS 30B-02/30A-03 SGERG-MOD-H2	o.k.
QR06	BCG	BCS 30B-02/30A-03 SGERG-MOD-H2	o.k.
QR07	BCG	BCS 30B-02/30A-03 SGERG-MOD-H2	o.k.
QR08	BCG	BCS 30B-02/30A-03 SGERG-MOD-H2	o.k.
QR09	BCG	BCS 30B-02/30A-03 SGERG-MOD-H2	o.k.
QR10	BCG	BCS 30B-02/30A-03 SGERG-MOD-H2	o.k.
QR11	BCG	BCS 30B-02/30A-03 SGERG-MOD-H2	o.k.
QR12	BCG	BCS 30B-02/30A-03 SGERG-MOD-H2	o.k.
QR13	BCG	BCS 30B-02/30A-03 SGERG-MOD-H2	o.k.
QR14	BCG	BCS 30B-02/30A-03 SGERG-MOD-H2	o.k.
QR15	BCG	BCS 30B-02/30A-03 SGERG-MOD-H2	o.k.
QR16	BCG	BCS 30B-02/30A-03 SGERG-MOD-H2	o.k.
QR17	BCG	BCS 30B-02/30A-03 SGERG-MOD-H2	o.k.
QR18	BCG	BCS 30B-02/30A-03 SGERG-MOD-H2	o.k.
QR19	BCG	BCS 30B-02/30A-03 SGERG-MOD-H2	o.k.
QR20	BCG	BCS 30B-02/30A-03 SGERG-MOD-H2	o.k.

By clicking on a scenario ID, you display all test scenario details:



The screenshot shows the SAP Measurement Cockpit interface for running scenarios. The main content area displays the following details for a scenario:

- Scenario ID: QR0G - BCS 30B-02/30A-03 SGERG-MOD-H2
- QuantityWare: Bulk Calculations - Gas
- Con.Grp.: QVS4 - MQCI SGERG-MOD-H2 20/20 °C,SD,HP H2
- Read.Grp.: QVS0 - SGERG-MOD-H2,REL.DENSITY,E/V, 30 % H2
- UoM Group: QNS - QUANTITYWARE NATURAL GAS UOM, SUP TEST
- Last changed: SENGM - 28.11.2022 17:40:39

Below the details is a table with the following columns: Description, Value, Unit, Measurement unit text, and Description of QCI parameter.

Description	Value	Unit	Measurement unit text	Description of QCI parameter
Input parameters:				
Flowing temperature	36.850000	CEL	degree Celsius	Flowing temperature
Flowing pressure	6,101.325000	KPA	kilopascal	Flowing pressure
Gas density (@ base)	0.410000	RDA	relative density (air) - gas	Gas density (@ base)
Gas heating value	30.000000	MJM	megajoule per cubic meter	Gas heating value
Combustion temp. (Heat. val.)	25.000000	CEL	degree Celsius	Combustion temp. (Heat. val.)
Test heating value class	SD			Test heating value class
Unit of chemical analysis data	MOM			Unit of chemical analysis data
CO2 fraction (nat.gas)	0.000000			CO2 fraction (nat.gas)
Hydrogen fraction (nat.gas)	0.300000			Hydrogen fraction (nat.gas)
Transaction quantity:				
Transaction quantity	100,000.000	M3	cubic meter (NSV) / (NG)	Transaction quantity
Expected parameters:				
Expected parameter	28.889372	KGV	kilogram per cubic meter	Flowing density (absolute)
Calculated parameter	28.889372	KGV	kilogram per cubic meter	Flowing density (absolute)



QuantityWare recommends that you develop your own customer specific test scenarios (Maintain Scenarios) that contain your manually calculated results (cross checked by at least two experts) and check the system calculation against these results; in this manner, customer specific quantity conversion configuration can always be validated in your clients with one click. Thus, a high degree of automation is ensured, as well as system compatibility with your measurement standards during productive usage.

The QuantityWare Test Scenario Tool does not require any programming skills, you simply define your expected results for a chosen conversion group and the defined input parameters.

3.5. GMC Documentation

Detailed online documentation is available within the GMC, which explains all measurement concepts and all available tools.

3.6. Summary

The GMC provides an easy-to-use, structured, single point of access to all parties responsible for the configuration, control and development of quantity conversion policy and implementation. The GMCs functionality brings Transparency and enables the definition and realization of GRC-promoting procedures for the “bottom-line” of an energy companies’ business – bulk product movements.

4. BCG – Test Scenarios

4.1. Introduction

An important aspect in the definition and configuration of complex quantity conversion calculations is to ensure that the calculation results are reproducible, stable and based on e.g., contractual agreements between business partners, measurement standards and governmental requirements.

QuantityWare delivers a rich configuration template for BCG that contains all customizing configuration required to access all gas measurement standard implementations.

After installing BCG in your system, you must test the basic configuration implementation delivered with the BC set in client 045 (recommended client) where you have activated the relevant QuantityWare BC set. You run the implementation and installation from the GMC Test Tool tab with one click. The GMC is part of BCG and provides the central user interface for Gas Measurement Experts and Consultants to BCG.

After defining your relevant conversion groups based on copies from the QuantityWare configuration template, as well as all conversion model settings (e.g., unit of measure rounding, input parameters, range checks etc.), you need to cross-check the calculation results with an independent calculation procedure. Ultimately, this needs to be a semi-manual process (typically using a spreadsheet and a pocket calculator, or results from a legacy system).

QuantityWare delivers a test scenario tool for the definition of your own test scenarios for your configuration settings (e.g., conversion group and related settings) in your system. This test scenario tool can be accessed via the GMC as well. This chapter describes how to use the test scenario tool.

In your DEV or QA system, you define test scenarios based on your company specific conversion group configurations which can then be run at any time in the system. After definition and testing, transport the test scenarios from your DEV or QA system to all relevant systems in your landscape including your production system. A log can be written to the database for each test scenario run, providing a protocol of the test results for later auditing. You should also save a snapshot of each test scenario during a scenario run to the database. Such a snapshot can be written to the database if a scenario runs without error. The snapshot contains all relevant configuration data (conversion group and UoM customizing settings) and the test scenario data. If a scenario runs into an error, you simply compare the snapshot data with the then current system data to determine if a change of the scenario or the related configuration has caused the error.

Per test scenario, you may create exactly one snapshot. Once you have created your own test scenarios, you should run these tests and write the results including a snapshot to the log tables at least after:

- You install a new BCG support package (CSP) or note
- You install an SAP Oil, Gas, & Energy ERP related note or package

Tests can also be scheduled regularly or executed irregularly to ensure that configuration is consistent.

4.2. Test Scenario – Delivery with BC Set



With BCG, QuantityWare delivers **1 725** test scenarios as part of the BC set template, which you access in your BCG template client 045 where the BC set has been activated

These test scenarios are delivered for two reasons:

1. To provide an additional high precision test matrix which extends the standard QuantityWare BCG installation test. All scenarios are designed to run without errors within the QuantityWare BCG client 045, where the BC set has been activated
2. Provide examples for consultants implementing BCG to ease definition of customer specific test scenarios

4.3. Test Scenario – Definition

A QuantityWare test scenario is an automated, conversion group based calculation, where the calculation parameters (Scenario ID, conversion group with reading group and unit of measure (UoM) group) and the expected calculation results (quantity values and parameters) are pre-defined.

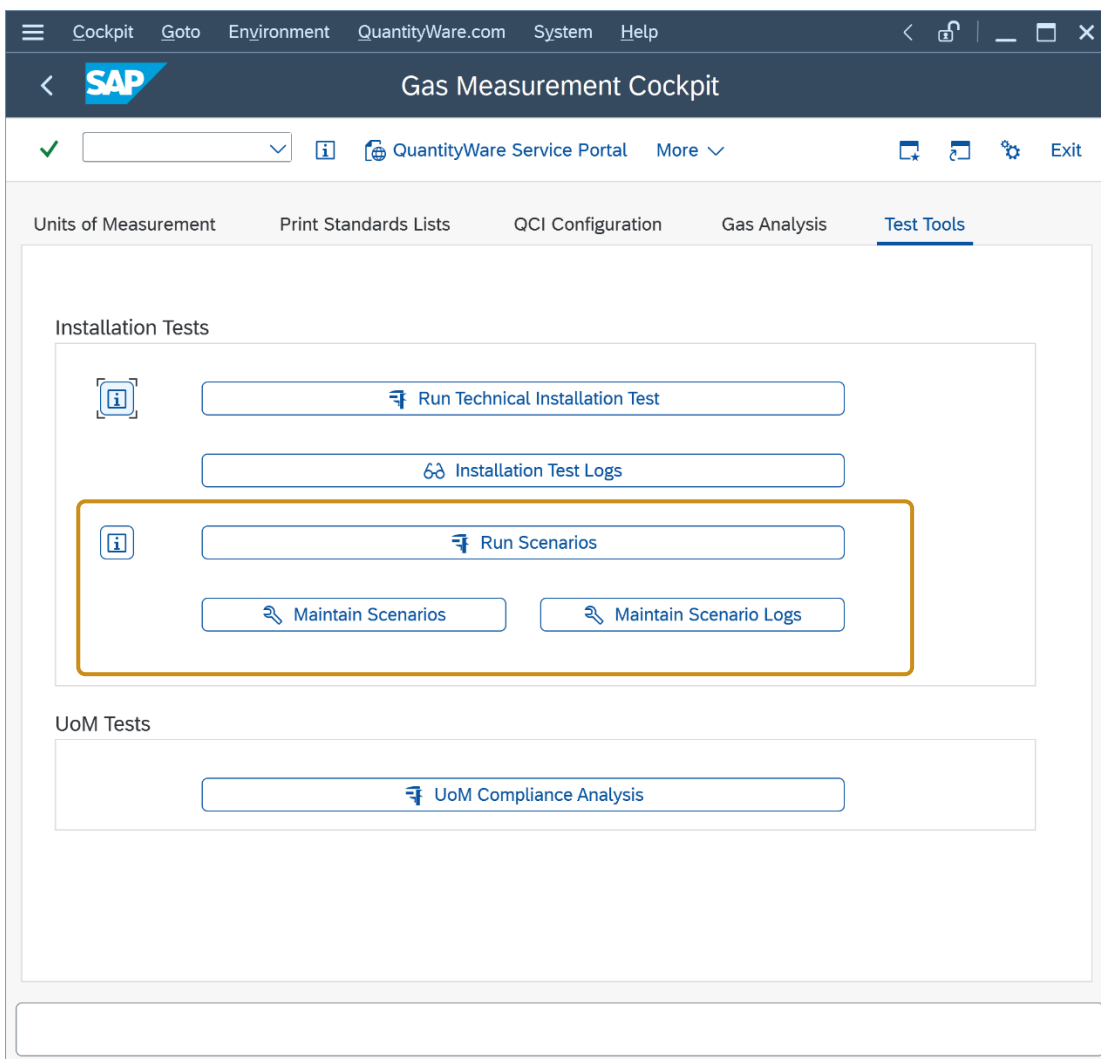
During a test scenario run, which you may start at any point in time, the system calculates the actual results (quantity values and parameters) and compares these actual results with your expected results defined in the test scenario. If all expected and actual results match, the scenario has been executed without error and reports the status “green - o.k.”; otherwise, the differences are reported as “red - not o.k.” and marked as such in the details list which is printed for each scenario.



You also have the option to define a test scenario such that it runs “green – o.k.” **if a pre-defined error message is encountered**. This way, you can (e.g.) automatically test that parameter range limits are correctly defined or that quantity deviations are within the specified limits.

4.4. Access to the Test Scenario Tool

The Test Scenario Tool is accessed via the GMC, tab strip “Test Tools”:



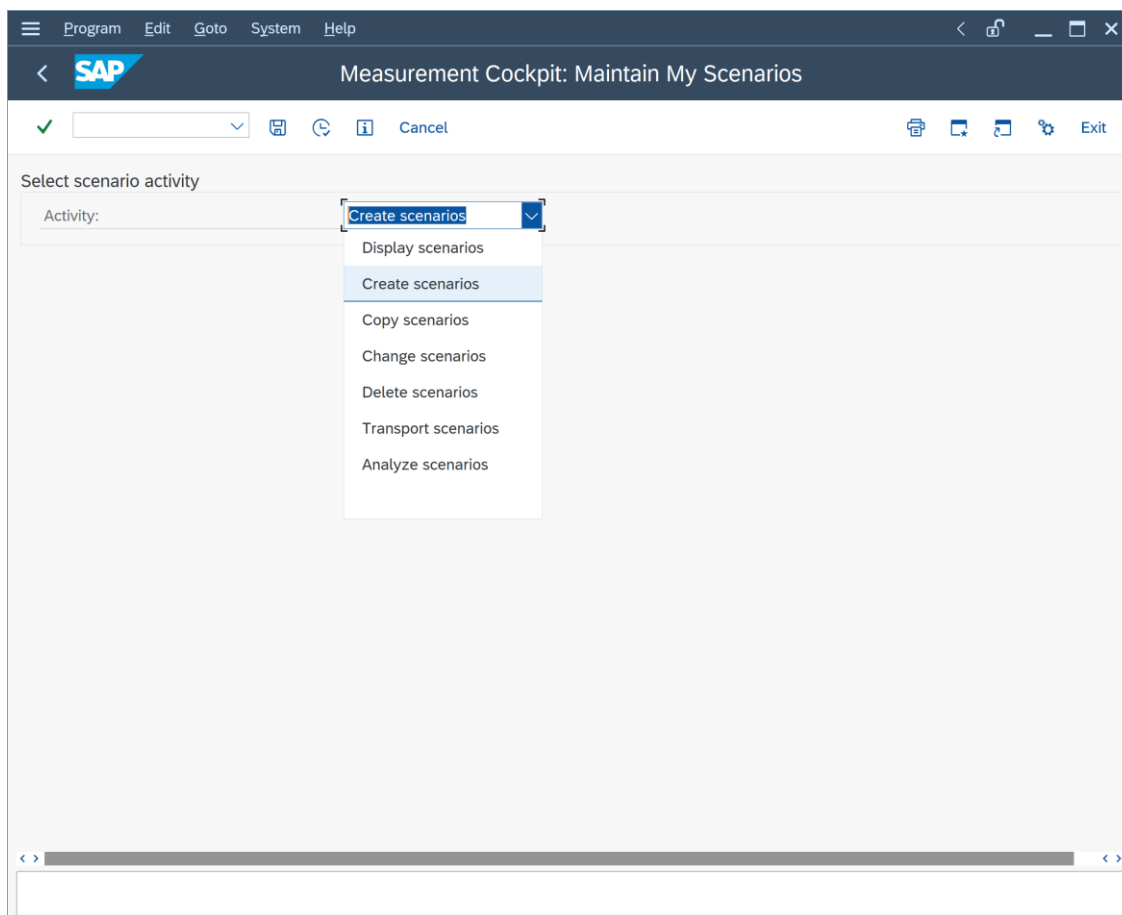
Three push buttons are available. “**Run Scenarios**”, “**Maintain Scenarios**” and “**Maintain Scenario Logs**”.

4.5. Test Scenario Tool Activities

All test scenarios can be transported to any required system and client within your system landscape. Test scenario definition typically takes place in your quality assurance system, after all Z* conversion groups have been configured as required and manual calculations are in accordance with the expected results. Test Scenario execution and log analysis typically takes place in your quality assurance and production system.

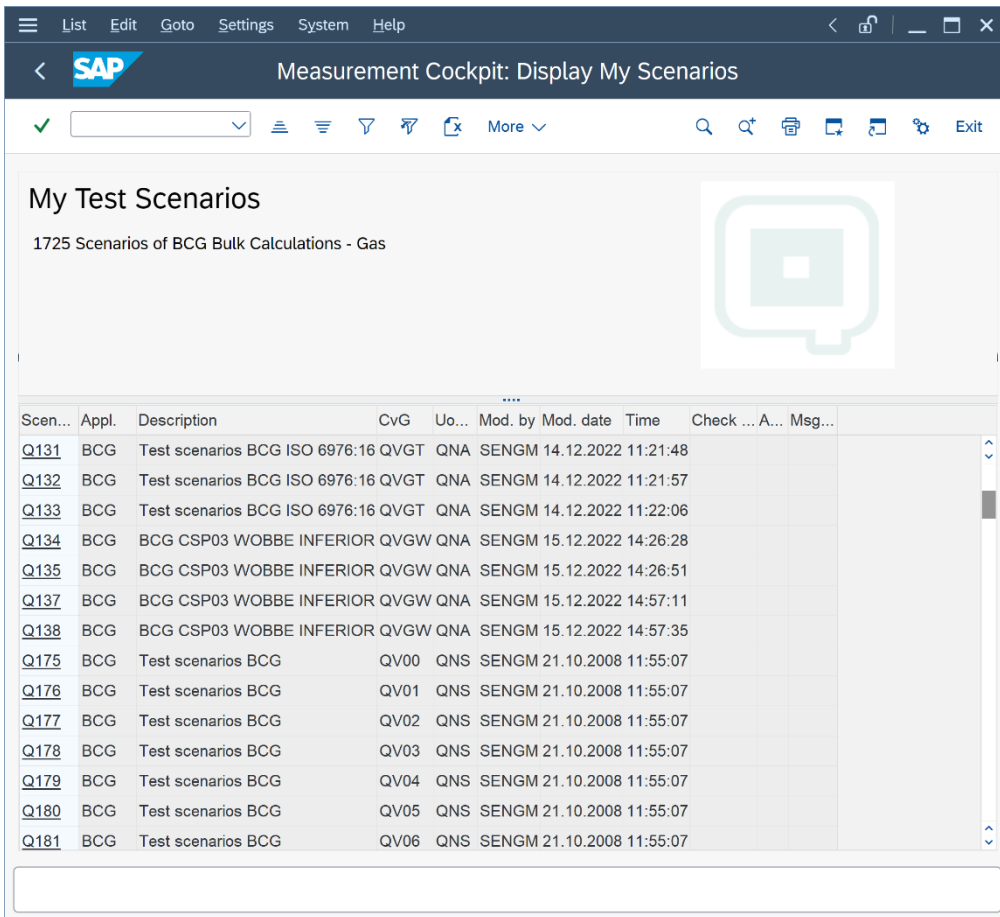
4.5.1. Maintaining Test Scenarios

If you select the “**Maintain Scenarios**” push button, you have the following options in the field “**Activity**”:



4.5.1.1. Display Scenarios

If you select this activity, you select a range of scenarios that will be displayed or display all scenarios for a conversion group:



The screenshot shows the SAP Measurement Cockpit interface for displaying scenarios. The title bar reads "Measurement Cockpit: Display My Scenarios". Below the title bar, there is a search bar and various action icons. The main content area is titled "My Test Scenarios" and displays "1725 Scenarios of BCG Bulk Calculations - Gas". A table of scenarios is visible below, with columns for Scenario ID, Application, Description, Conversion Group (CvG), Unit (Uo...), Modified by (Mod. by), Modified Date (Mod. date), Time, Check, and Message (Msg...).

Scen...	Appl.	Description	CvG	Uo...	Mod. by	Mod. date	Time	Check ...	A...	Msg...
Q131	BCG	Test scenarios BCG ISO 6976:16 QVGT	QNA	SENGM	14.12.2022	11:21:48				
Q132	BCG	Test scenarios BCG ISO 6976:16 QVGT	QNA	SENGM	14.12.2022	11:21:57				
Q133	BCG	Test scenarios BCG ISO 6976:16 QVGT	QNA	SENGM	14.12.2022	11:22:06				
Q134	BCG	BCG CSP03 WOBBE INFERIOR QVGW	QNA	SENGM	15.12.2022	14:26:28				
Q135	BCG	BCG CSP03 WOBBE INFERIOR QVGW	QNA	SENGM	15.12.2022	14:26:51				
Q137	BCG	BCG CSP03 WOBBE INFERIOR QVGW	QNA	SENGM	15.12.2022	14:57:11				
Q138	BCG	BCG CSP03 WOBBE INFERIOR QVGW	QNA	SENGM	15.12.2022	14:57:35				
Q175	BCG	Test scenarios BCG	QV00	QNS	SENGM	21.10.2008	11:55:07			
Q176	BCG	Test scenarios BCG	QV01	QNS	SENGM	21.10.2008	11:55:07			
Q177	BCG	Test scenarios BCG	QV02	QNS	SENGM	21.10.2008	11:55:07			
Q178	BCG	Test scenarios BCG	QV03	QNS	SENGM	21.10.2008	11:55:07			
Q179	BCG	Test scenarios BCG	QV04	QNS	SENGM	21.10.2008	11:55:07			
Q180	BCG	Test scenarios BCG	QV05	QNS	SENGM	21.10.2008	11:55:07			
Q181	BCG	Test scenarios BCG	QV06	QNS	SENGM	21.10.2008	11:55:07			

You inspect the scenario details by clicking on a single scenario ID or application ID:

List Edit Goto Settings System Help

SAP Measurement Cockpit: Display My Scenarios

Information Cancel

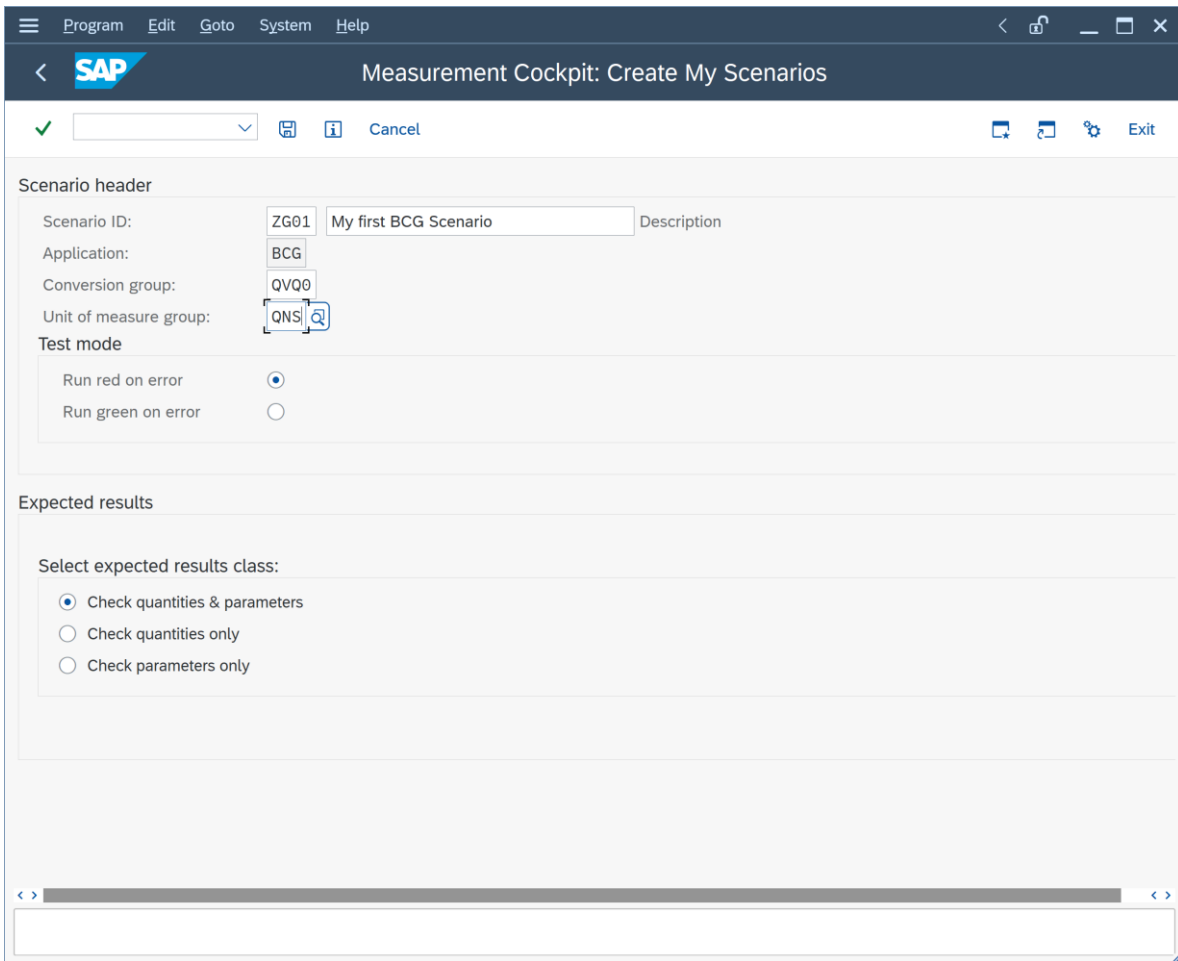
Test Scenario Detail

Scenario ID: QVQ0 MQCI GERG 2008 QVQ0
 QuantityWare: Bulk Calculations - Gas
 Con.Grp.: QVQ0 MQCI GERG 2008 DA,15/15°C,SD,HIGH PRS.
 Read.Grp: QVQ0 MQCI ISO 12213 GAS 1, GERG 2008 D
 UoM Group:QNA QUANTITYWARE NAT. GAS UOM, SUP/INF TEST
 Last changed by/date: JAGERG 09.12.2022 15:51:00

Description	Value	Unit	Measurement unit text
Input parameters:			
Flowing pressure	12,101.325000	KPA	kilopascal
Flowing temperature	0.000000	CEL	degree Celsius
Energy heating value class	SD		
Unit of chemical analysis data	MOM		
Methane(CH4)	0.965000		
Ethane(C2H6)	0.018000		
Propane(C3H8)	0.004500		
n-Butane(n-C4H10)	0.001000		
2-Methylpropane (i-Butane)	0.001000		
n-Pentane(C5H12)	0.000300		
2-Methylbutane (i-Pentane)	0.000250		
2,2-Dimeth.prop. (neo-Pentane)	0.000250		
n-Hexane(C6H14)	0.000700		
n-Heptane(C7H16)	0.000000		
n-Octane(C8H18)	0.000000		

4.5.1.2. Create Scenarios

Enter the Scenario ID (four-character field), a description and the conversion group for the test scenario, as well as a unit of measure group that contains the UoM for which the quantity conversion is executed:



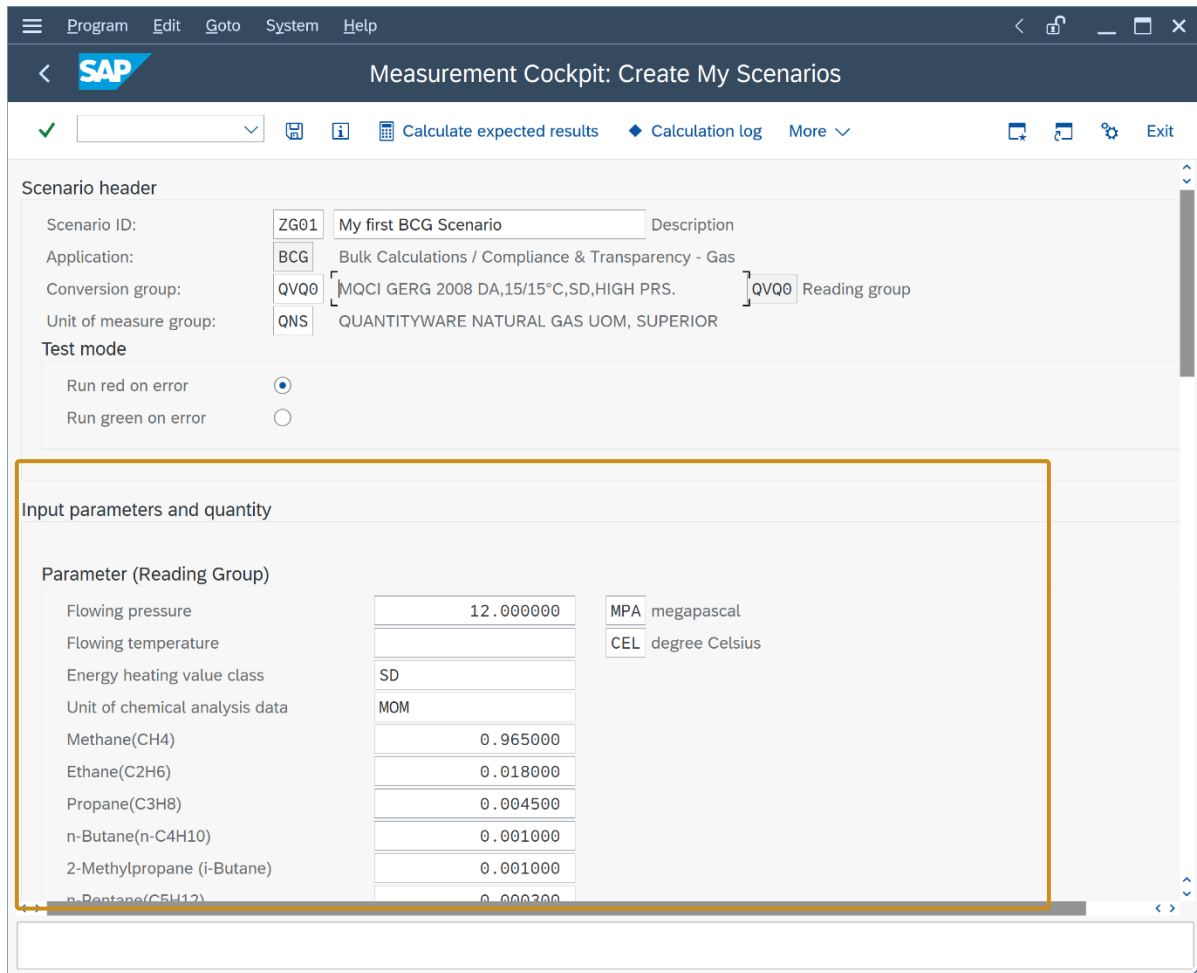
The screenshot shows the 'Measurement Cockpit: Create My Scenarios' dialog box in SAP. The window title is 'SAP Measurement Cockpit: Create My Scenarios'. The dialog has a menu bar with 'Program', 'Edit', 'Goto', 'System', and 'Help'. Below the menu bar, there is a status bar with a green checkmark, a dropdown arrow, a save icon, an information icon, and the text 'Cancel'. On the right side of the status bar, there are icons for a window, a document, a gear, and the text 'Exit'.

The main content area is divided into several sections:

- Scenario header:** This section contains four input fields:
 - Scenario ID: ZG01
 - Application: BCG
 - Conversion group: QVQ0
 - Unit of measure group: QNSI
- Test mode:** This section contains two radio button options:
 - Run red on error:
 - Run green on error:
- Expected results:** This section contains a label 'Select expected results class:' followed by three radio button options:
 - Check quantities & parameters:
 - Check quantities only:
 - Check parameters only:

At the bottom of the dialog, there is a horizontal scrollbar and a large empty text area.

After you press return, the system displays the relevant parameters from the reading group that is linked to the conversion group:

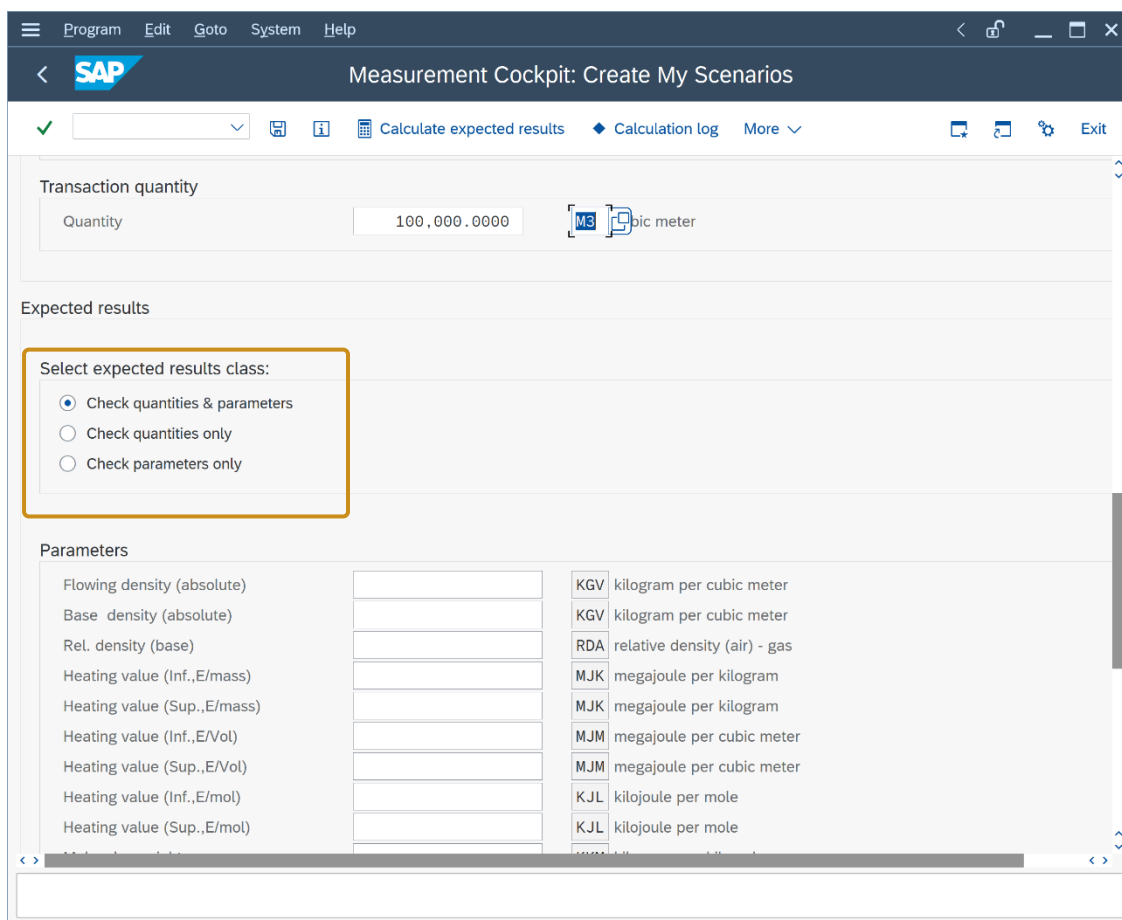


The screenshot shows the SAP Measurement Cockpit interface for creating scenarios. The 'Scenario header' section includes fields for Scenario ID (ZG01), Application (BCG), Conversion group (QVQ0), and Unit of measure group (QNS). The 'Test mode' section has radio buttons for 'Run red on error' (selected) and 'Run green on error'. The 'Input parameters and quantity' section is highlighted with a yellow box and contains the following table:

Parameter (Reading Group)	Value	Unit
Flowing pressure	12.000000	MPA megapascal
Flowing temperature		CEL degree Celsius
Energy heating value class	SD	
Unit of chemical analysis data	MOM	
Methane(CH4)	0.965000	
Ethane(C2H6)	0.018000	
Propane(C3H8)	0.004500	
n-Butane(n-C4H10)	0.001000	
2-Methylpropane (i-Butane)	0.001000	
n-Pentane(C5H12)	0.000300	

For your scenario, you select whether you want to compare the results for:

- Parameters and quantities
- Quantities only
- Parameters only



Then you enter the transaction quantity and UoM and either manually enter the parameter results and/or quantity results, or you select "Calculate expected results" (if you have already validated the correctness of the calculation) and save (CTRL + F4) the test scenario by selecting the "Save scenario" push button (More -> Save scenario).

4.5.1.3. Change Scenarios

Here you change an existing scenario.

4.5.1.4. Copy Scenarios

Allows you to copy an existing scenario to a new scenario ID, with identical conversion group and UoM group.

4.5.1.5. Delete Scenarios

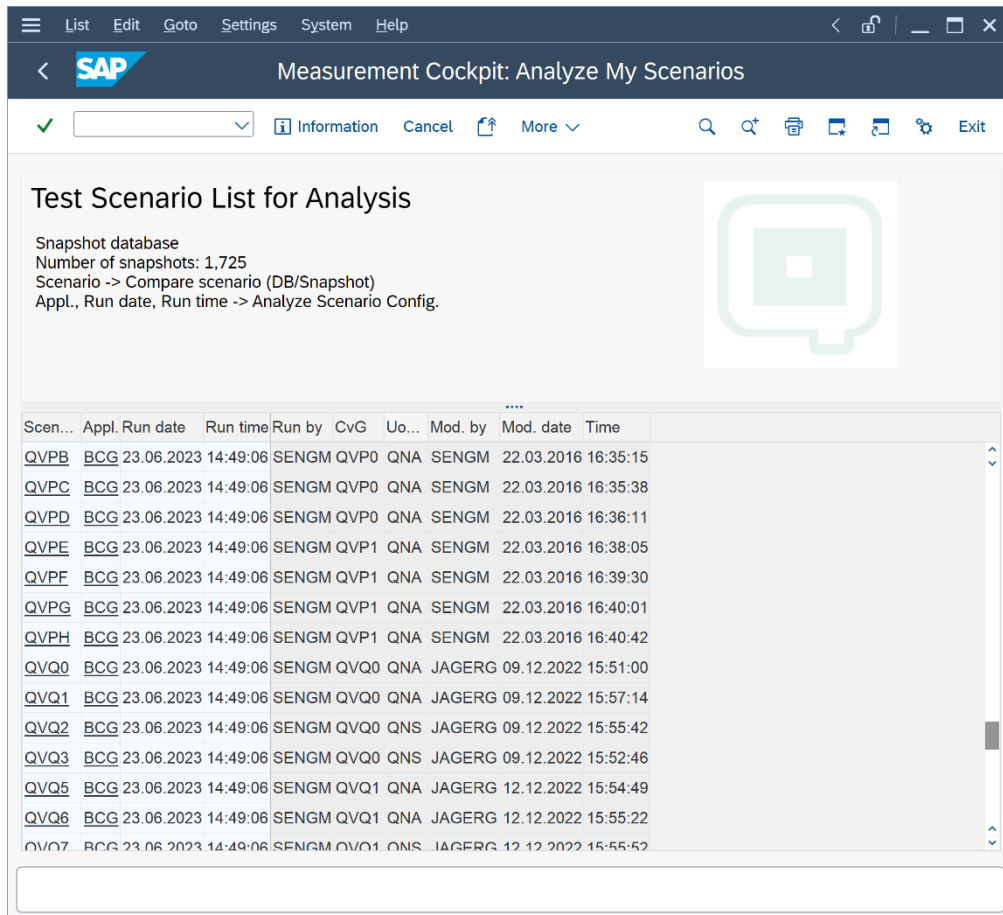
Allows you to list a range of scenarios from which you can then select individual, or multiple scenarios for deletion.

4.5.1.6. Transport Scenarios

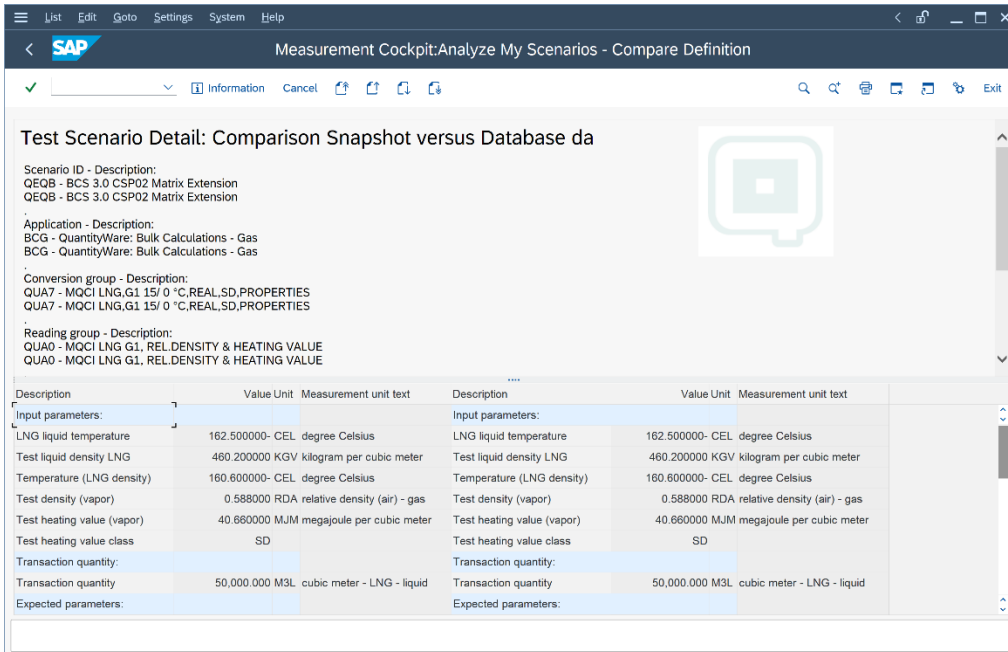
Allows you to list a range of scenarios from which you can then select individual, or multiple scenarios for inclusion into a customizing transport. This transport can be moved into another client or system within your system landscape.

4.5.1.7. Analyze Scenarios

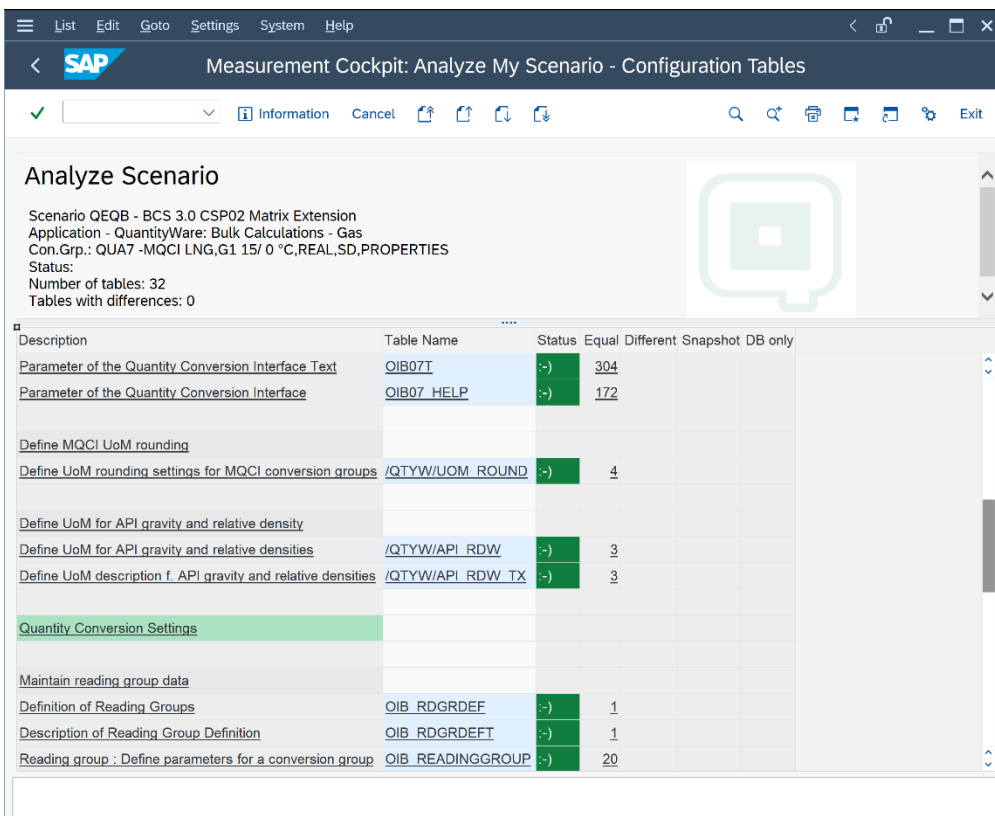
Allows you to list a range of scenarios from which you can then select individual, or multiple scenarios for error analysis. Requires that a snapshot for the scenario is available on the snapshot database:



If you click the Scenario ID for the scenario which reported an error, you compare the current scenario definition with the definition stored in the snapshot database:



If you click on Application, you compare the actual configuration settings with the settings stored in the snapshot database. If differences are found, the different entries will be shown in the detailed analysis screen:



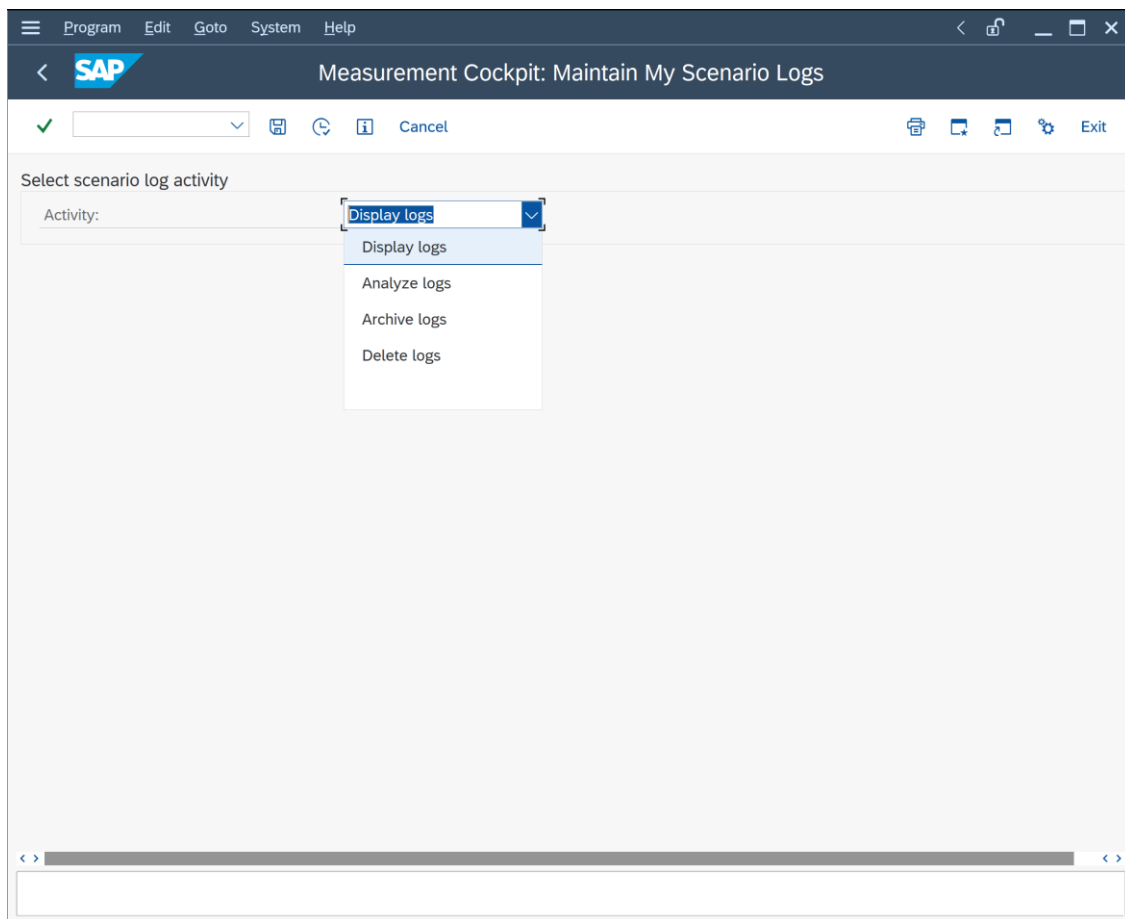
If differences are found (marked in red), you click on the error line to display the setting which is different.

If a scenario runs into an unexpected error and neither the scenario nor the configuration are showing any differences, the ABAP code base is the only remaining source of error. Then you should run the installation test in client 045 and the technical installation test in your current client to ensure a validated code base in that system and check that the code base is consistent through all systems in your system landscape.

4.5.2. Maintain Scenario Logs

If a test scenario runs into an error, you need to analyze the reason for the error. Here you can:

- Display a range of scenario logs – from archive, database, or snapshot
- Analyze a range of scenario logs
- Delete a range of scenario logs
- Archive a range of scenario logs



In the analysis activity, you may set the log error status (none – in process – complete – confirmed) and write a comment line into the log:

Measurement Cockpit: Analyze Scenario Log Errors

Test Scenario Logs with Error Status

Number of error logs 57

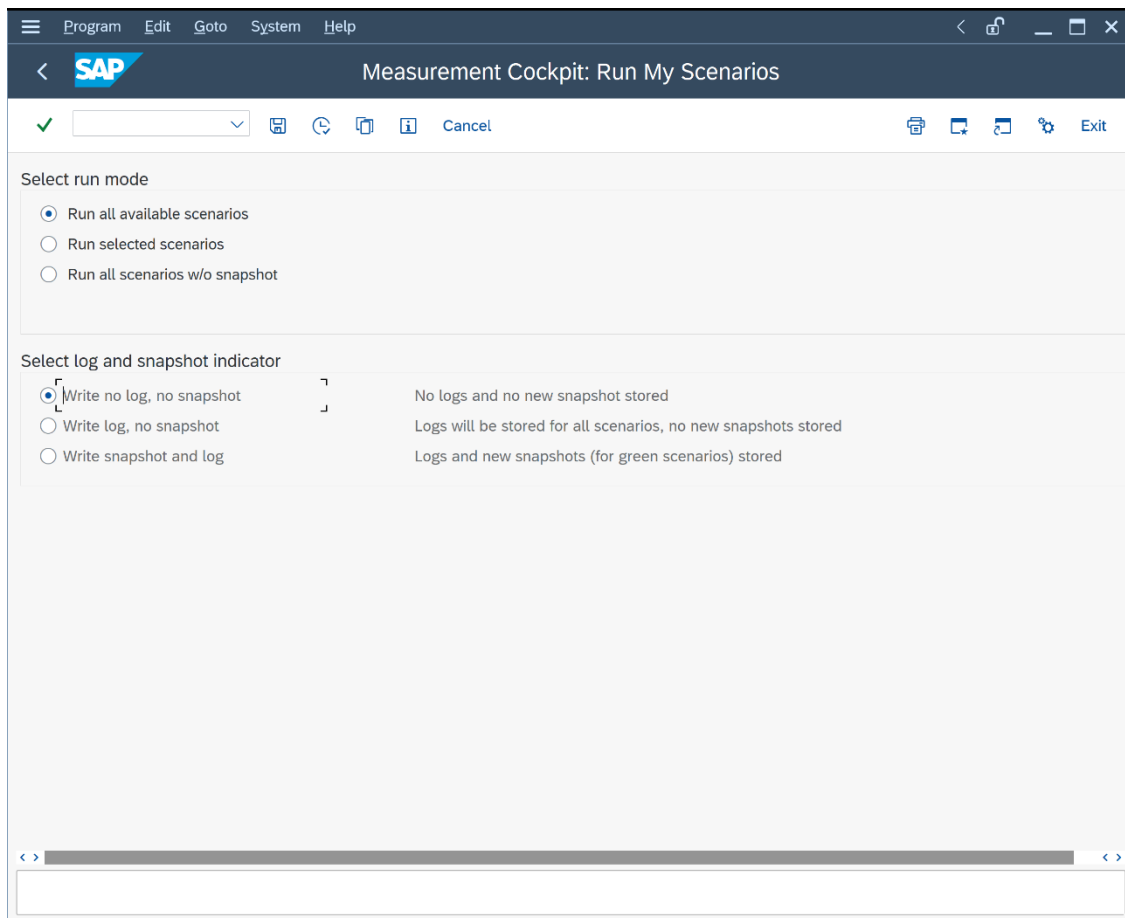
Modify "Log status" and enter a "Log comment" and save your changes

Scenario	Appl.	Run date	Run time	Run by	Status	Check err	CvG	UoMG	Mod. by	Mod. date	Time	Log status	Log comment
<input type="checkbox"/>	Q019	BCG	13.05.2022	18:00:03	JAGERG	-(		QVFJ QNS	SENGM	09.10.2012	12:32:01	In process	Template adjustmen...
<input type="checkbox"/>	Q043	BCG	13.05.2022	18:00:03	JAGERG	-(		QVGJ QNA	SENGM	09.10.2012	12:34:17	Confirmed	Template adjustmen...
<input type="checkbox"/>	Q053	BCG	13.05.2022	18:00:03	JAGERG	-(		QVH9 QNS	SENGM	09.10.2012	12:35:29	Confirmed	Template adjustmen...
<input type="checkbox"/>	Q063	BCG	13.05.2022	18:00:03	JAGERG	-(		QVI9 QNS	SENGM	06.11.2020	12:16:07	Confirmed	Template adjustmen...
<input type="checkbox"/>	Q073	BCG	13.05.2022	18:00:03	JAGERG	-(		QVJ9 QNS	SENGM	06.11.2020	12:16:32	Confirmed	Template adjustmen...
<input type="checkbox"/>	Q083	BCG	13.05.2022	18:00:03	JAGERG	-(		QVK9 QNA	SENGM	06.11.2020	12:09:28	Confirmed	Template adjustmen...
<input type="checkbox"/>	Q093	BCG	13.05.2022	18:00:03	JAGERG	-(		QVL9 QNA	SENGM	06.11.2020	12:11:32	Confirmed	Template adjustmen...
<input type="checkbox"/>	QEHO	BCG	13.05.2022	18:00:03	JAGERG	-(		QVGJ QNS	SENGM	16.09.2020	12:06:57	Confirmed	Template adjustmen...
<input type="checkbox"/>	QEHP	BCG	13.05.2022	18:00:03	JAGERG	-(		QVGJ QNS	SENGM	16.09.2020	12:07:10	Confirmed	Template adjustmen...
<input type="checkbox"/>	QEHQ	BCG	13.05.2022	18:00:03	JAGERG	-(		QVGJ QNS	SENGM	16.09.2020	12:07:35	Confirmed	Template adjustmen...
<input type="checkbox"/>	QEIL	BCG	13.05.2022	18:00:03	JAGERG	-(		QVH9 QNS	SENGM	16.09.2020	12:27:11	Confirmed	Template adjustmen...
<input type="checkbox"/>	QEIM	BCG	13.05.2022	18:00:03	JAGERG	-(		QVH9 QNS	SENGM	16.09.2020	12:27:28	Confirmed	Template adjustmen...
<input type="checkbox"/>	QEIN	BCG	13.05.2022	18:00:03	JAGERG	-(		QVH9 QNS	SENGM	16.09.2020	12:27:55	Confirmed	Template adjustmen...
<input type="checkbox"/>	QEJF	BCG	13.05.2022	18:00:03	JAGERG	-(		QVI9 QNS	SENGM	16.09.2020	12:37:32	Confirmed	Template adjustmen...
<input type="checkbox"/>	QEJG	BCG	13.05.2022	18:00:03	JAGERG	-(		QVI9 QNS	SENGM	16.09.2020	12:37:48	Confirmed	Template adjustmen...
<input type="checkbox"/>	QEJH	BCG	13.05.2022	18:00:03	JAGERG	-(		QVI9 QNS	SENGM	16.09.2020	12:38:09	Confirmed	Template adjustmen...

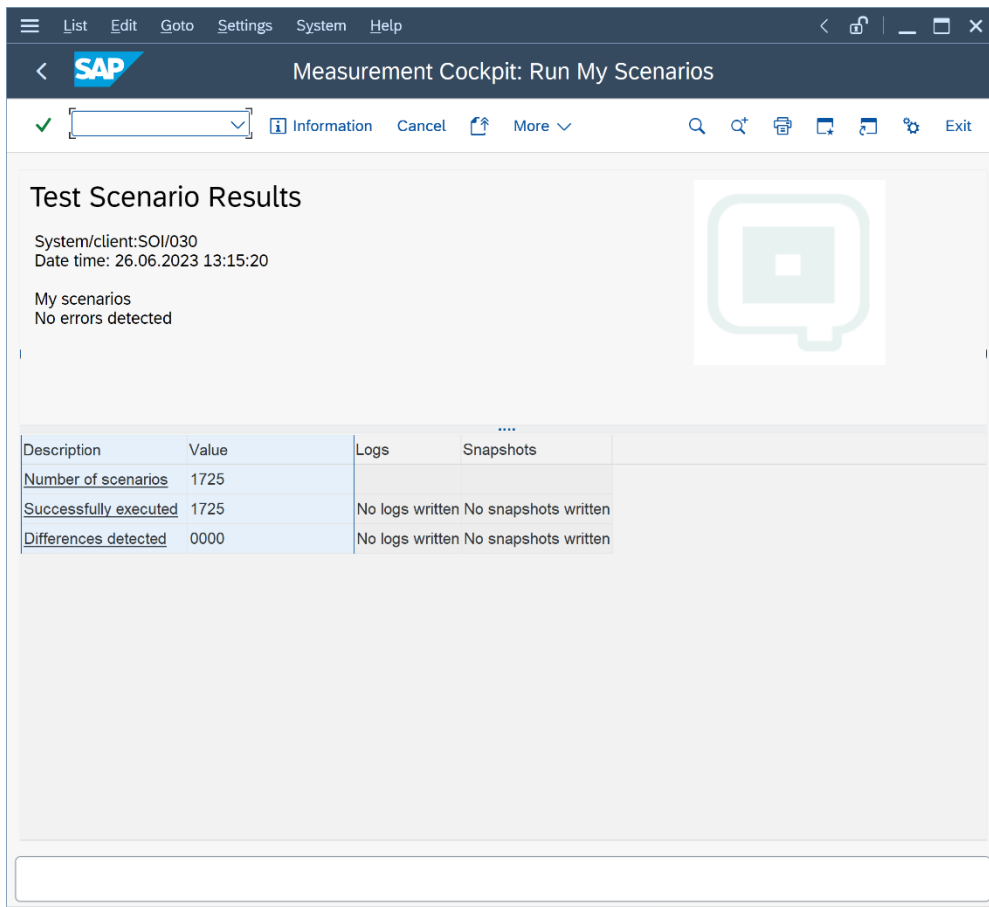
Note that error logs may only be archived if the log status is set to **“confirmed”**.

4.5.3. Running Test Scenarios

If you select the “**Run Scenarios**” push button, you have the option to run all test scenarios, or one set of user specified scenarios. Here you set an indicator that writes a log protocol and/or snapshot for the scenario execution results.



The results of each scenario run are listed as shown in the next screen print, which is identical with the list for the BCG installation test scenario results.



Test Scenario Results

System/client: SOI/030
Date time: 26.06.2023 13:15:20

My scenarios
No errors detected

Description	Value	Logs	Snapshots
Number of scenarios	1725		
Successfully executed	1725	No logs written	No snapshots written
Differences detected	0000	No logs written	No snapshots written



Note: all these activities require a careful semi-manual procedure where you calculate your expected results independently from the system results and use at least a four eyes principle to validate your results.

4.6. Summary

The QuantityWare Test Scenario Tool provides easy-to-use management functions for all your important quantity conversion test scenarios. With these scenarios, you continuously monitor and check the correctness of your productive BCG implementations, thus providing maximum security and stability for all logistics processes, which rely on accurate and well-defined quantity conversion data for bulk products. Governance, Risk Management and Control procedures should always include such a state-of-the-art test procedure for bulk quantity values.

5. BCG – Configuration Template

5.1. Introduction

This chapter describes the BCG configuration template that is delivered with BCG within one BC set.

QuantityWare delivers only **client dependent** customizing configuration data (template data) as part of the BC set, which BCG customers need to activate in one new test client (045) to run the QuantityWare BCG installation test and validate the BCG installation.

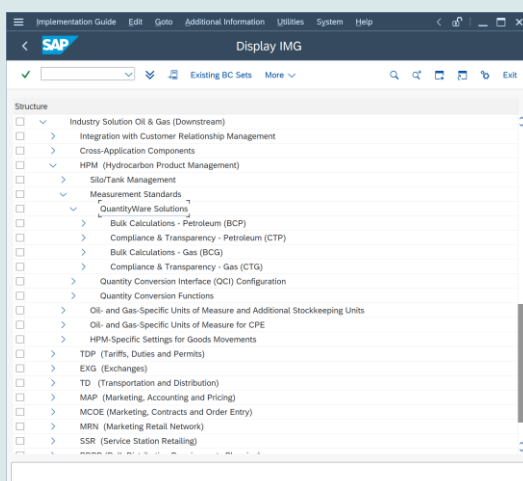
The second important purpose of the template is the provision of a complete blueprint for each customer, such that certified BCG consultants can implement BCG based on customer requirements with reasonable effort.

QuantityWare delivers language-dependent entries in English (EN), French (FR), Spanish (ES) and Portuguese (PT) for all customizing template data which is visible to the business user.



All customizing data can be accessed via the QuantityWare Gas Measurement Cockpit (PMC) via transaction `/n/qtyw/cockpit_gas`, menu path:

Goto -> QuantityWare IMG - or via the SAP Reference IMG:



If you require detailed information as to how to access all BCG customizing data, see Chapter 7 BCG - Customizing Transactions.

QuantityWare requires that customers utilize the template configuration (e.g., conversion groups) in one development system (client 045); all required data must be copied into the customer name space (Z*) and that only the customer name space entries be distributed into all other clients and systems.

The template configuration data can be divided into three parts:

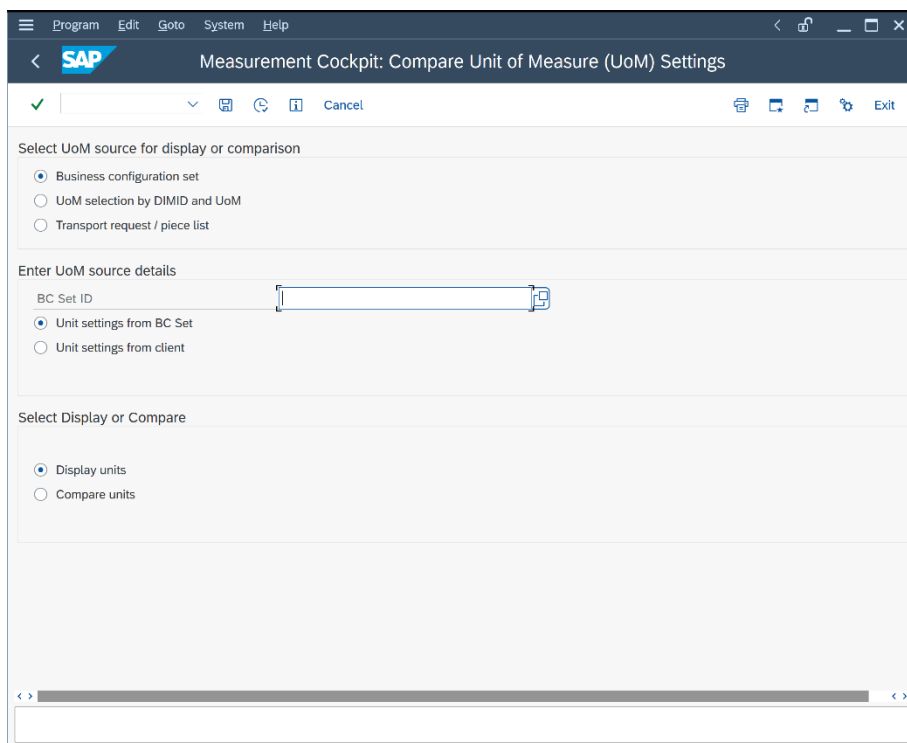
- Unit of measure (UoM) definitions – SAP customizing tables
- Quantity conversion configuration – SAP customizing tables
- Quantity conversion configuration – QuantityWare customizing tables

5.2. Unit of Measure Definitions

QuantityWare delivers Unit of Measure (UoM) definitions and dimension ID as part of the template. These definitions have been carefully checked via the **BCG UoM compliance analysis**. ISO/UNECE code definitions are also delivered. The UoM definitions fall into three categories:

- UoM definitions which are part of the SAP client 000 template, and which are not adjusted/corrected by QuantityWare with respect to quantity conversions – SAP UoM
- UoM definitions which are part of the SAP client 000 template, and which are corrected by QuantityWare with respect to quantity conversion – SAP UoM corrected
- New QuantityWare UoM definitions which are not part of the SAP client 000 template – QuantityWare UoM

You access and check all UoM configuration data directly from the GMC, via tab strip “Units of Measurement”; here you navigate to the UoM maintenance transaction CUNI “SAP Units -> Maintain” or display lists of UoM in your logon client “SAP Units -> Display” for various selection criteria. If you select “Unit Tools -> Comparison”, you may analyze the QuantityWare BCG BC set and compare UoM delivered within that BC set with UoM definitions in any client in your system:



5.3. Conversion Group Configuration

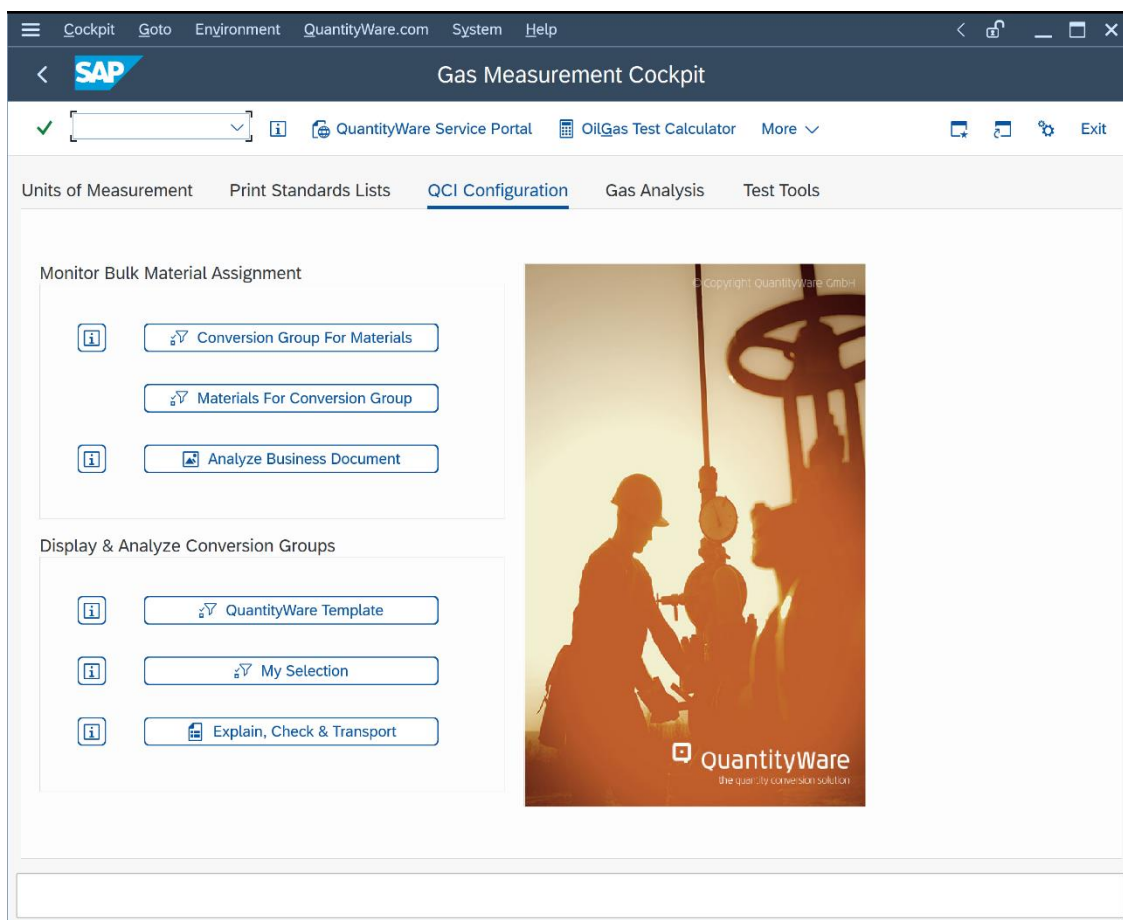
QuantityWare delivers a complete quantity conversion configuration for high and low pressure dry natural gas, LNG and NGL as part of the BCG template. These definitions are maintained in SAP and QuantityWare customizing tables. More than 320 conversion groups and associated reading groups, range check groups etc. are delivered with the BC set template. QuantityWare BCS conversion groups (and the associated reading groups and range groups) follow the QuantityWare naming convention as described in the table below:

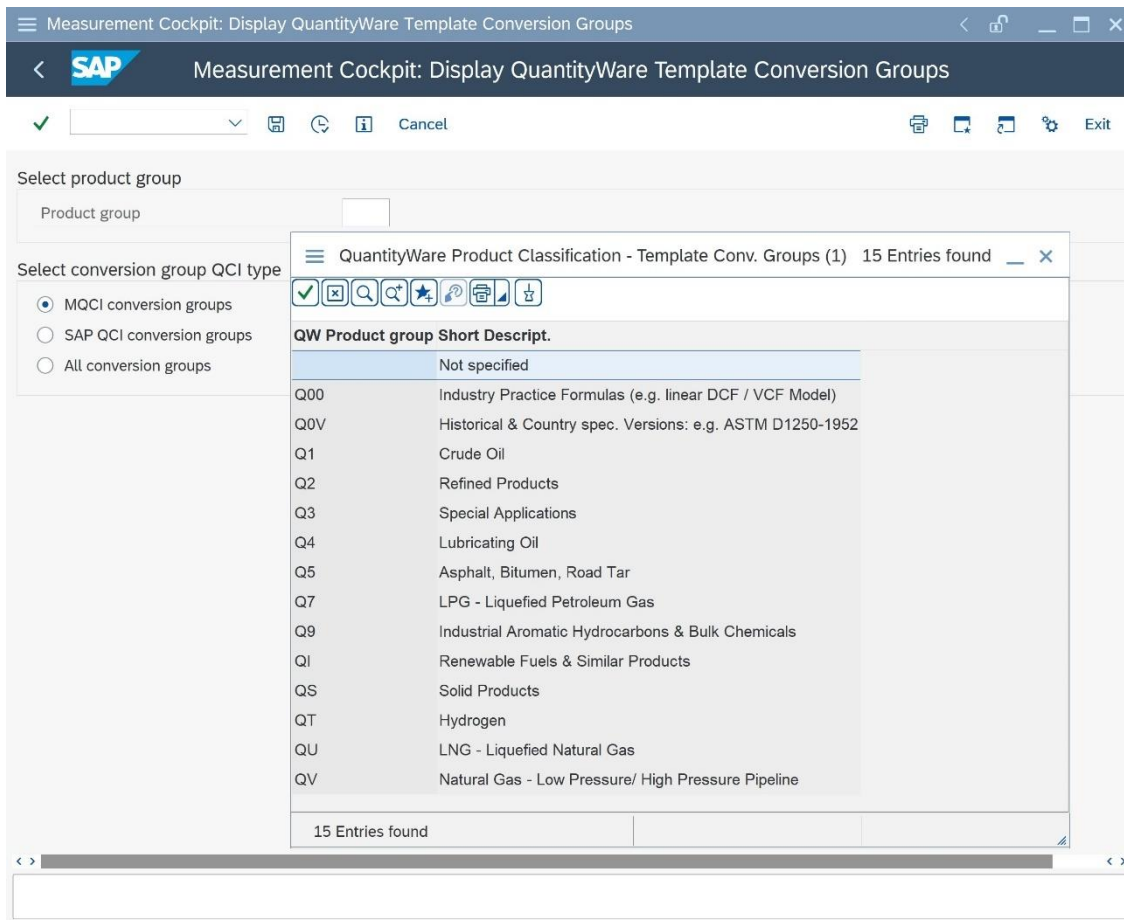
Conversion Group	Product Group
Q00* - Q0U*	Products handled by industry practice formula (e.g., linear density correction)
Crude Oil & Products – not part of BCG	
	ASTM D 1250
Q0V* - Q0Z*	ASTM D 1250-52 products
Q1*	Crude Oil
Q2*	Refined Products
Q3*	Special Applications “Chemicals”
Q4*	Lubricating Oils
Other Standards – NGL/LPG part of BCG	
Q5*	Asphalt, Bitumen, Road Tar
Q7*	LPG – Liquefied Petroleum Gas
Q9*	Industrial Aromatic Hydrocarbons & Bulk Chemicals
QI*	Renewable Fuels & similar products
QS*	Solids (e.g., sulfur)
Natural Gas & LNG	
QT*	100 % Hydrogen - BCG
QU*	LNG – Liquefied Natural Gas – BCG
QV*	Natural gas – high- and low-pressure pipeline – BCG
QWWW	MQCI zero model conversion group - technical

5.3.1. Accessing Conversion Group Configuration – Gas Measurement Cockpit

Via the GMC you display a list of all template conversion groups if you are logged on to client 045 where the BC set /QTYW/BCG_30A (SAP ECC) or /QTYW/BCG_30B (SAP S/4HANA) has been activated:

1. Start the cockpit using transaction /QTYW/COCKPIT_GAS
2. Choose tab strip “QCI Configuration”
3. Select “QuantityWare Template” (note the documentation button for further information)





You select e.g., QU as product group and "MQCI conversion groups" to display all MQCI template conversion groups for LNG:

☰ List Edit Goto Settings System Help < 🔍 🏠 🗑️ ✖

< **SAP** Measurement Cockpit: Display QuantityWare Template Conversion Groups

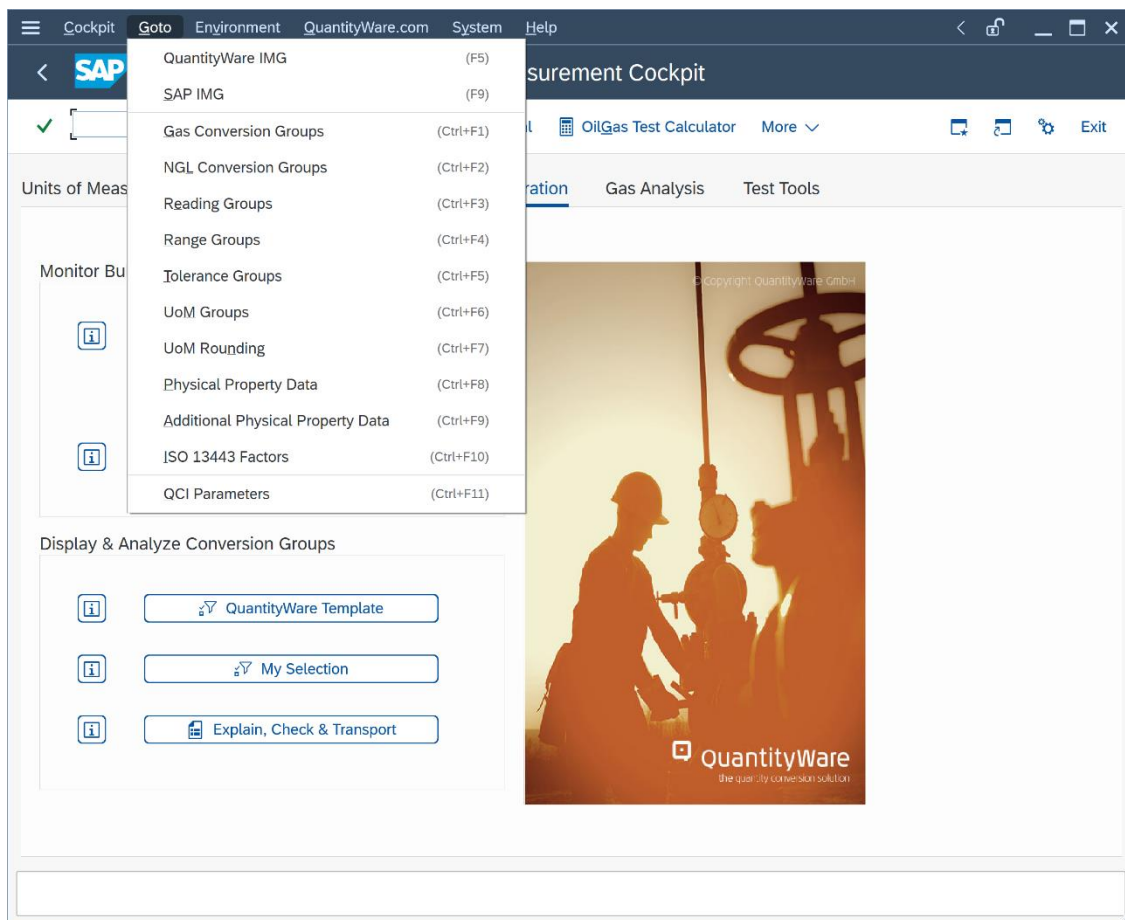
✓ 📄 📊 🔍 🔍 📄 📄 📄 ⚙️ 🚪

Display Template Conversion Groups for Product Group:
 QU
 LNG - Liquefied Natural Gas

No	C.Grp	Rdg.	group	Ranges	QCI	Set ID	Description	P.t.	Qty.EL %	Qty.WL %	Qty.WH %	Qty.EH %
20	QUB5	QUB0	QUB0	QTYW Q6			MQCI LNG,G2 25/20 °C,IDEAL,SD,PROPERTIES	7	0.50	0.10	0.10	0.50
21	QUB6	QUB6	QUB6	QTYW QB			MQCI LNG,G2 60 °F/14.696 PSI,IDEAL,SD,PR	7	0.50	0.10	0.10	0.50
22	QUC0	QUC0	QUC0	QTYW Q8			MQCI LNG 15/15 °C,REAL,SD,COMP. Q8	7	0.50	0.10	0.10	0.50
23	QUC1	QUC0	QUC0	QTYW Q2			MQCI LNG 15/15 °C,REAL,SD,COMP. Q2	7	0.50	0.10	0.10	0.50
24	QUC2	QUC0	QUC0	QTYW Q3			MQCI LNG 0/ 0 °C,REAL,SD,COMP. Q3	7	0.50	0.10	0.10	0.50
25	QUC3	QUC0	QUC0	QTYW Q1			MQCI LNG 25/0°C,REAL,SD,COMP. Q1	7	0.50	0.10	0.10	0.50
26	QUC4	QUC0	QUC0	QTYW Q4			MQCI LNG 15/ 0 °C,REAL,SD,COMP. Q4	7	0.50	0.10	0.10	0.50
27	QUC5	QUC0	QUC0	QTYW Q5			MQCI LNG 20/20 °C,REAL,SD,COMP. Q5	7	0.50	0.10	0.10	0.50
28	QUC6	QUC0	QUC0	QTYW Q6			MQCI LNG 25/20 °C,REAL,SD,COMP. Q6	7	0.50	0.10	0.10	0.50
29	QUC7	QUC7	QUC7	QTYW QB			MQCI LNG 60 °F/14.696 PSI,REAL,SD,CP QA	7	0.50	0.10	0.10	0.50
30	QUCA	QUCA	QUCA	QTYW Q8			MQCI LNG 15/15 °C,REAL,SD,CP,Q8 K1/2 VI	7	0.50	0.10	0.10	0.50
31	QUCB	QUCB	QUCB	QTYW Q8			MQCI LNG 15/15 °C,REAL,SD,COMP.Q8 VC VI	7	0.50	0.10	0.10	0.50
32	QUCC	QUCC	QUCC	QTYW Q8			MQCI LNG 15 °C HHV/WOBBE 60°F Q8 K1/2 VI	7	0.50	0.10	0.10	0.50
33	QUCD	QUCD	QUCD	QTYW QS			MQCI LNG 15 °C, ISO 6578:17 QS K1/2 VI	7	0.50	0.10	0.10	0.50
34	QUCE	QUCD	QUCD	QTYW QS			MQCI LNG 15 °C, ISO 6578:17 QS C K1/2 VI	7	0.50	0.10	0.10	0.50

5.4. QuantityWare IMG Access

You access all configuration data from the GMC via the QuantityWare IMG or the SAP Reference IMG (IS-Oil -> HPM -> Measurement Standards -> QuantityWare Solutions), where the QuantityWare IMG is integrated:



A detailed description is provided in Chapter 7 BCG - Customizing Transactions.

5.5. Summary

A clearly defined template of values describing calculations parameters, as well as the background knowledge as to where the values can be found within SAP DDIC, forms the basis of a reliable quantity calculations environment. Without such an extensive framework, true transparency and accurate representation of the calculations required by business processes and their regulatory bodies cannot be practically validated. QuantityWare presents a clearly defined reference configuration template to meet customers' needs.

6. BCG – QuantityWare MQCI

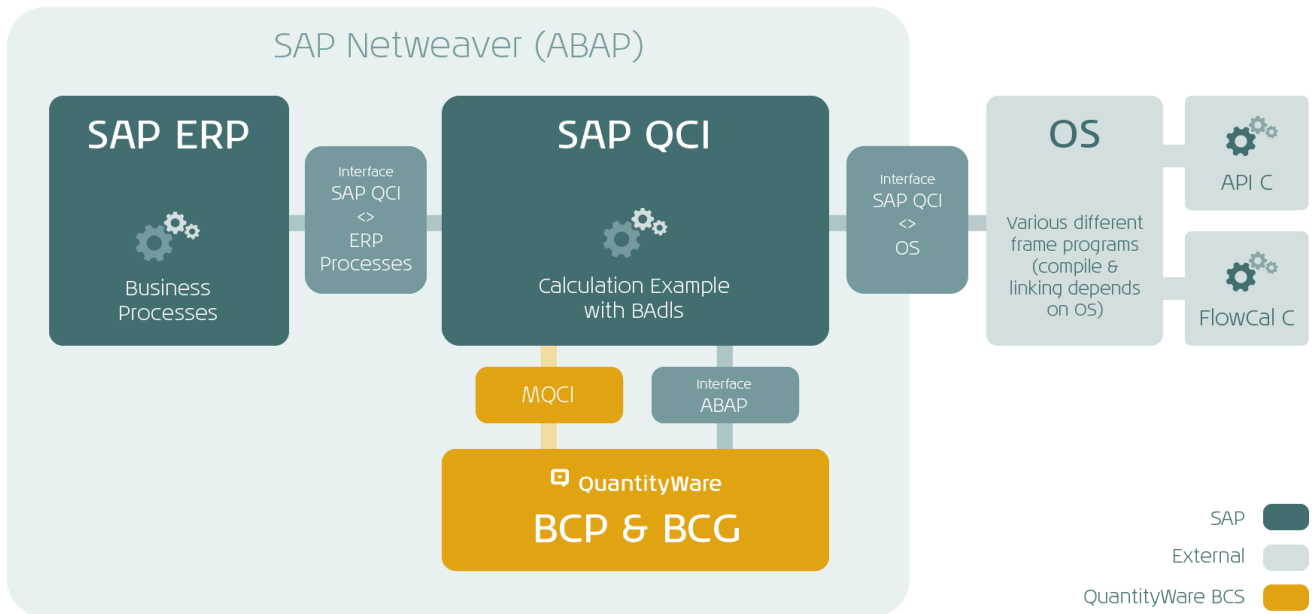
6.1. Introduction

There are several ways in which quantity conversion calculations can be approached, all of which are comprised of distinct “calculation steps”. A sequence of calculation steps, typically including calculation procedures of measurement parameters, the conversion of UoM quantity values for different kinds of quantities (“dimensions” in SAP terminology), as well as rounding procedures, comprise the basic definition of the conversion model.

Different conversion models are defined in national and international measurement standards and are in use within the oil & gas and chemicals industries.

Technically, the implementation of a specific model should be independent of the interface by which the model-based conversion algorithms are accessed.

The standard SAP QCI (Quantity Conversion Interface) provides one calculation model which is integrated within the technical interface. This model can be enhanced via BAdI (Business Add In) implementations to a certain extent but does not allow for deviation from the hard-coded SAP QCI calculation model. In addition to this, extension of the standard SAP model to e.g., include weight and mass calculations in parallel is cumbersome and requires code modifications.

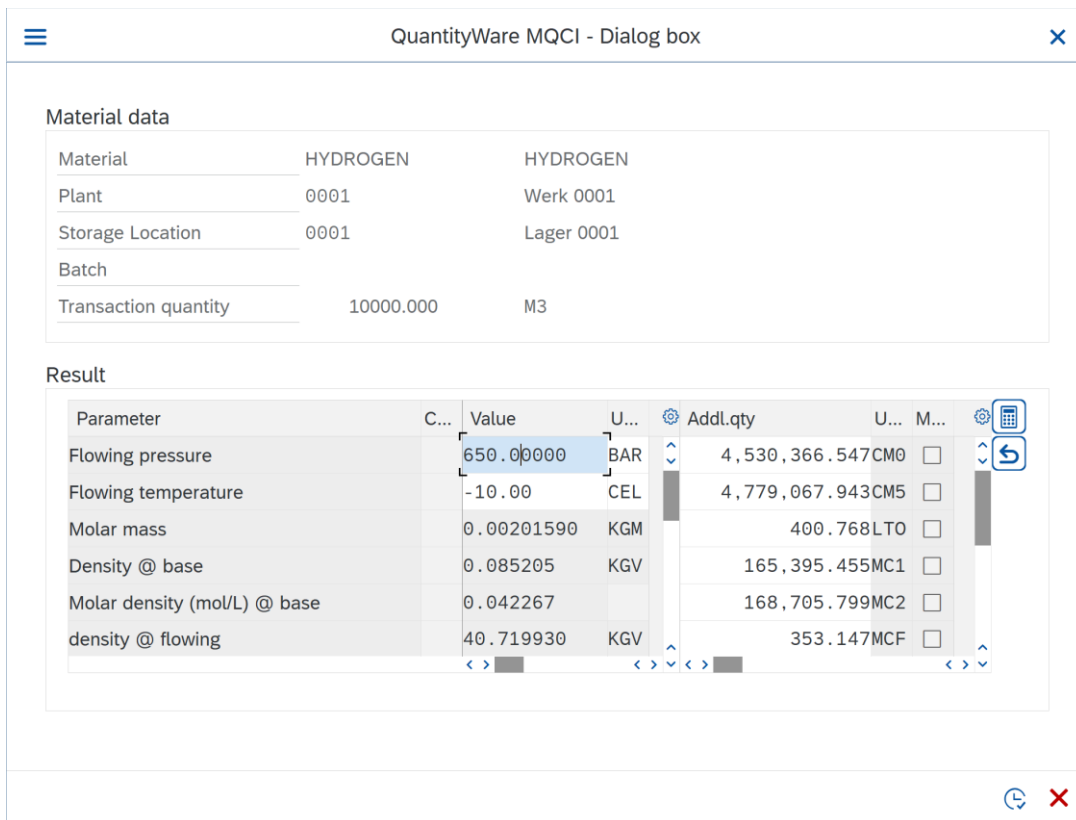


QuantityWare has developed a new model based QCI (MQCI), which enables implementations of any possible model, for any given quantity (weight, mass, gaseous volume, energy, liquid volume (LNG), gross, net volumes etc.). The MQCI is seamlessly integrated into the SAP QCI and can be either utilized in parallel with the proven SAP QCI conversion logic in any SAP Oil, Gas, & Energy system, or as the single quantity conversion model solution within your SAP Oil, Gas, & Energy system, still allowing all SAP Oil, Gas, & Energy logistics business transactions to access the calculations through the proven SAP QCI interface.

6.2. MQCI – SAP Integration

The QuantityWare MQCI is integrated via the proven SAP QCI Interface into all logistics processes of the SAP Oil, Gas, & Energy system. A conversion group is either configured to utilize the classic SAP QCI or the advanced MQCI quantity conversion logic. Business users will not notice any difference in the behavior of their known SAP transactions, with two exceptions:

In classic SAP transactions (e.g., TD shipment, physical Inventory, classic goods movement transactions) where the SAP QCI dialog box appears for data entry when using the SAP QCI, a new MQCI dialog box appears for MQCI conversion groups, which is designed based on the proven SAP reading group concept.:



Material data

Material	HYDROGEN	HYDROGEN
Plant	0001	Werk 0001
Storage Location	0001	Lager 0001
Batch		
Transaction quantity	10000.000	M3

Result

Parameter	C...	Value	U...	Addl.qty	U...	M...
Flowing pressure		650.00000	BAR	4,530,366.547	CM0	<input type="checkbox"/>
Flowing temperature		-10.00	CEL	4,779,067.943	CM5	<input type="checkbox"/>
Molar mass		0.00201590	KGM	400.768	LTO	<input type="checkbox"/>
Density @ base		0.085205	KGV	165,395.455	MC1	<input type="checkbox"/>
Molar density (mol/L) @ base		0.042267		168,705.799	MC2	<input type="checkbox"/>
density @ flowing		40.719930	KGV	353.147	MCF	<input type="checkbox"/>

This way, all reading group parameters are available to the business user for data entry achieving QCI / MQCI process harmonization. If you do not maintain quantity conversion defaults, this MQCI dialog box shows initial values for all parameters within a classic SAP transaction. You can assign an MQCI default function to the MQCI conversion group function sequence to default the reading group parameters. The function /QTYW/MQCI_GET_READINGGRP_DEF needs to be assigned with function module type 9.

In classic SAP transactions running as batch input processes (BTI), a new MQCI batch input screen will be processed for NGL/LPG. Thus, existing BTI maps may have to be adjusted if a switch from SAP QCI to

MQCI conversions for existing materials is required. SAP OGSD processes that still utilize BTI (e.g., for data collation) must be adjusted if MQCI conversion groups are utilized.

With the QuantityWare BCG configuration template, QuantityWare delivers more than 320 conversion groups for NGL/LPG, low and high pressure dry natural gas, hydrogen, and LNG. For all these major product lines, SAP QCI conversion groups (NGL and low-pressure natural gas only) and QuantityWare MQCI conversion groups are delivered.



SAP QCI conversion groups are considered as being “legacy” for natural gas and LNG; usage of MQCI conversion groups in new implementation projects is strongly recommended for these two major product lines, otherwise active BAdI implementations are required.

For NGL/LPG, either SAP QCI conversion groups or MQCI conversion groups may be utilized.

For natural gas and LNG MQCI conversion groups delivered with BCG, Batch Input is not supported.

6.3. MQCI Technical Integration Details

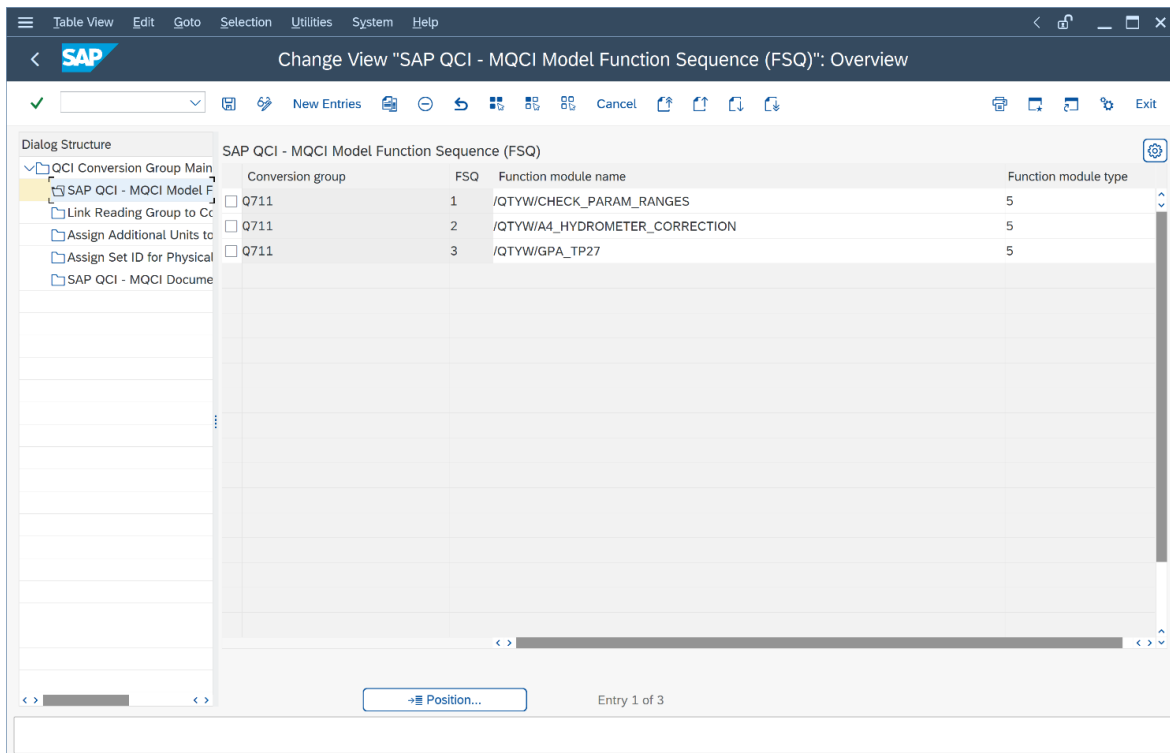
The technical MQCI installation is delivered with software package /QTYW/QCI. The package contains:

- function groups which implement the model-based quantity conversion interface
- the dialog screen and the BTI screen for classic SAP transactions
- conversion models
- MQCI functions that solve specific quantity conversion requirements (“plug and play”)



The MQCI integration is realized via enhancement implementation /QTYW/MQCI which delivers a dynamic enhancement point in function OIB_QCI_QUANTITY_CONTROL. This SAP technology method does not modify your system.

Example: SAP QCI Conversion Group Q711:



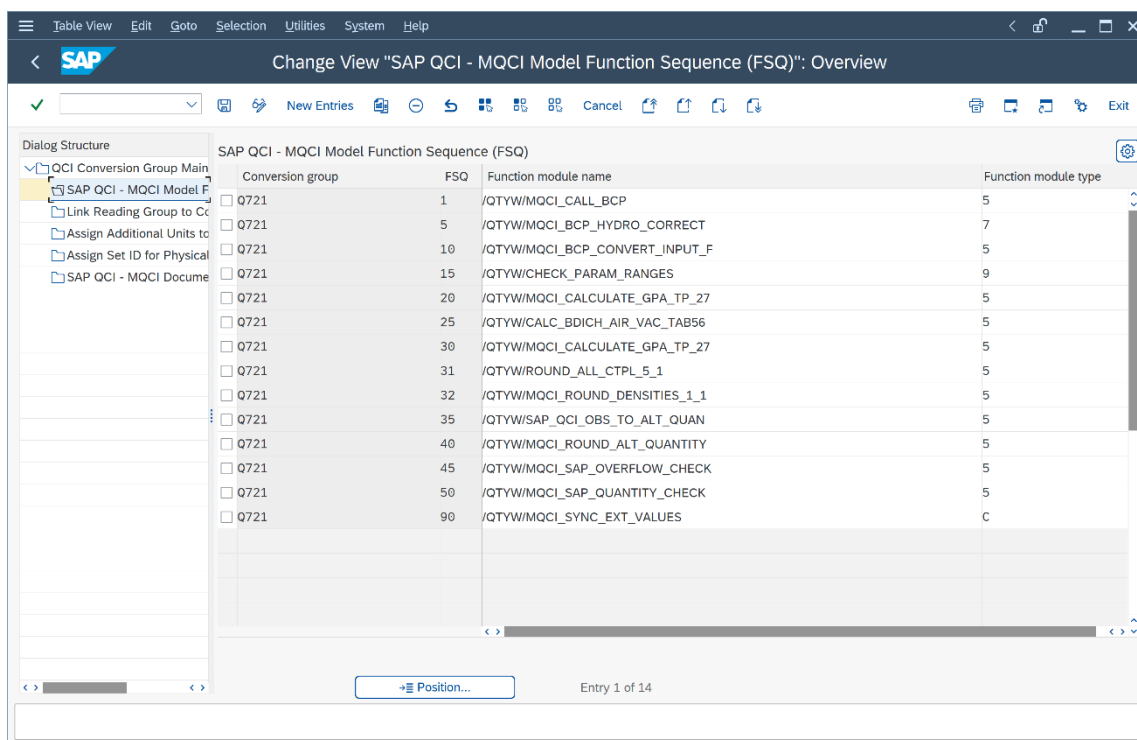
Conversion group	FSQ	Function module name	Function module type
<input type="checkbox"/> Q711	1	/QTYW/CHECK_PARAM_RANGES	5
<input type="checkbox"/> Q711	2	/QTYW/A4_HYDROMETER_CORRECTION	5
<input type="checkbox"/> Q711	3	/QTYW/GPA_TP27	5

This conversion group calculates LPG quantities, utilizing the SAP QCI calculation model and GPA 8217 (TP-27) CTL calculations. It has three functions assigned, one parameter range check function, a

hydrometer correction function, and the CTL calculation function. All other ABAP code executed during a calculation is embedded within the standard SAP QCI logic (SAP function group OIB_QCI).

Example: MQCI conversion group Q721:

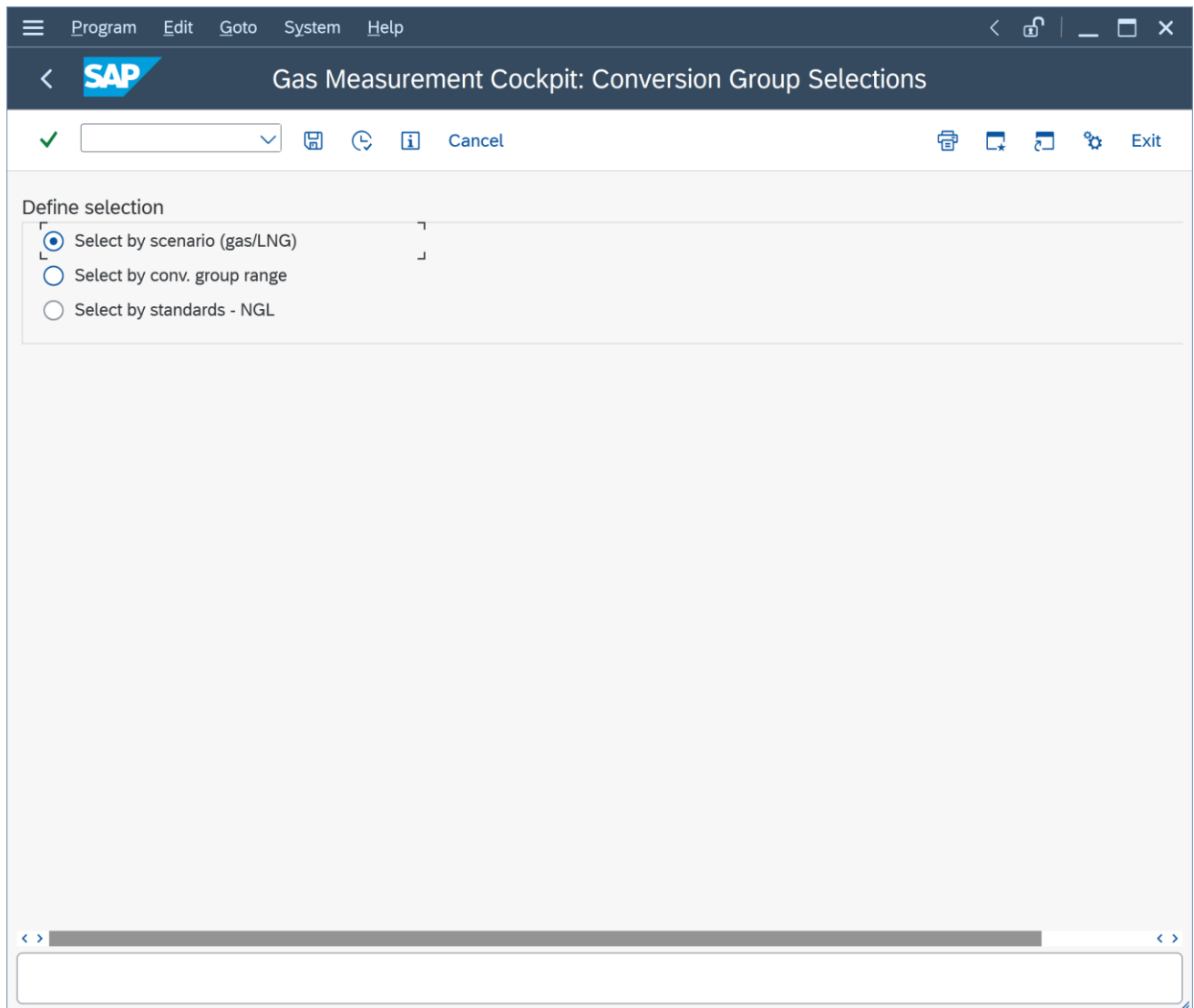
This conversion group also calculates LPG quantities, utilizing an MQCI calculation model (e.g., allowing masses and weight to be calculated in parallel via ASTM D1250-80 Table 56).

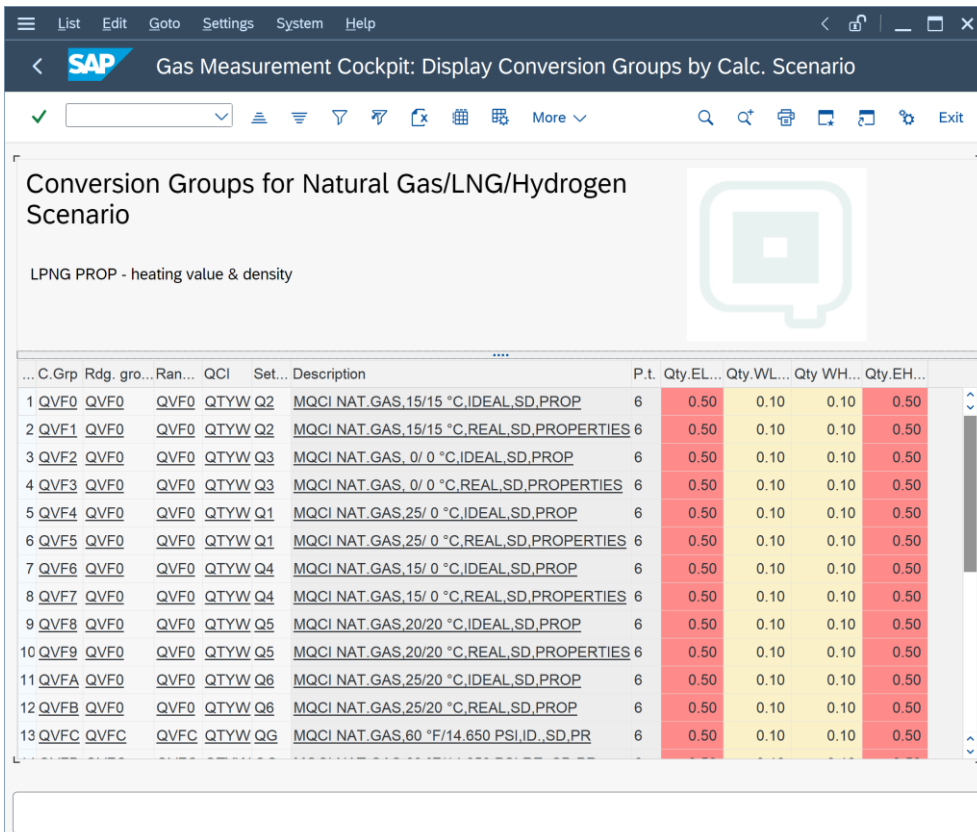
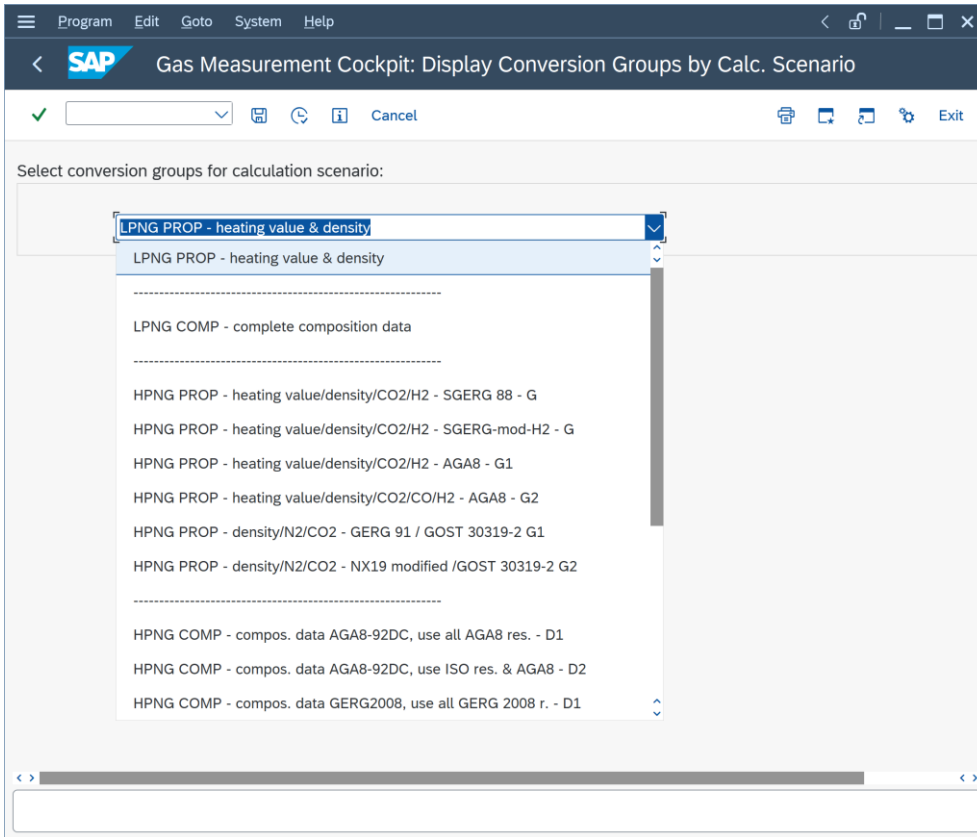


The model function sequence contains all required ABAP functions for the calculation of all quantity values, enabling exchange (e.g.) of the calculation model or hydrometer calculation without code modifications.

6.4. MQCI Calculation Scenarios

For LNG, hydrogen and natural gas quantity conversions, the MQCI conversion groups are organized via 17 calculation scenarios:





While each **NGL** conversion group is comprised of 4 different measurement standards:

- UoM conversion standards
- Mass-to-weight conversion standards
- CT(P)L standards (“Corrections for the effect of Temperature and Pressure on Liquid”)
- Calculation model standards

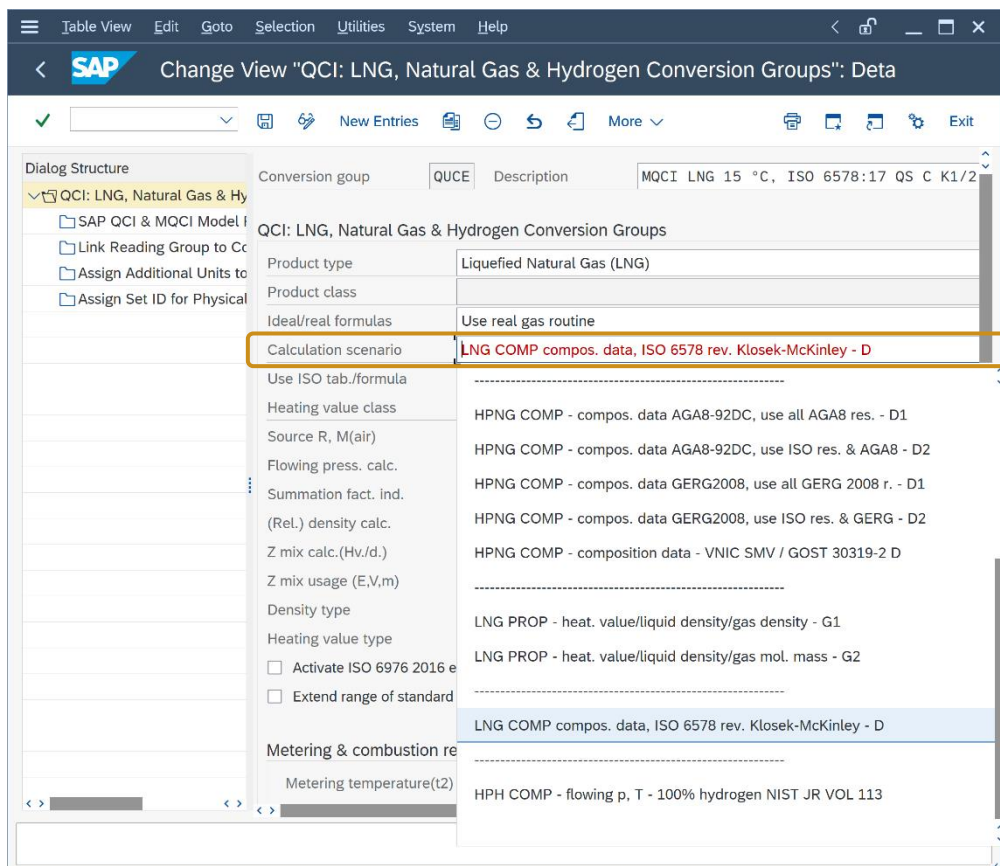
Natural gas and hydrogen conversion groups fall into four main categories:

- Low pressure dry natural gas – LPNG (including natural gas / hydrogen mixtures)
- High pressure dry natural gas – HPNG (including natural gas / hydrogen mixtures)
- Liquefied natural gas – LNG
- High pressure hydrogen – HPH (100 % hydrogen)

For each category, two types of conversion groups are available:

- Conversion groups configured to perform quantity conversions based on **complete chemical composition** and flowing conditions of the dry natural gas (LP/HP)H / NG / LNG - COMP
- Conversion groups configured to perform quantity conversions based on **physical properties** (heating value, density) and **possibly partial** chemical composition and flowing conditions of the dry natural gas (LP/HP)NG / LNG - PROP

The BCG template **MQCI** conversion groups for natural gas (LP/HP) NG and LNG are identified via 17 different calculation scenarios (considering the relevant combinations of natural gas calculation standards):



These 17 calculation scenarios are mapped in the following table to the 7 possible classification combinations (as defined above):

Category	Type	Conversion group calculation scenario
LPNG	COMP	complete composition data
LPNG	PROP	heating value & density
HPNG	COMP	compos. data AGA8-92DC, use all AGA8 res. - D1
HPNG	COMP	compos. data AGA8-92DC, use ISO res. & AGA8 - D2
HPNG	COMP	compos. data GERG2008, use all GERG 2008 r. - D1
HPNG	COMP	compos. data GERG2008, use ISO res. & GERG - D2
HPNG	COMP	composition data - VNIC SMV / GOST 30319-2 D
HPNG	PROP	heating value/density/CO2/H2 - SGERG 88 - G
HPNG	PROP	heating value/density/CO2/H2 - SGERG-mod-H2 - G
HPNG	PROP	heating value/density/CO2/H2 - AGA8 - G1
HPNG	PROP	heating value/density/CO2/CO/H2 - AGA8 - G2
HPNG	PROP	density/N2/CO2 - GERG 91 / GOST 30319-2 G1
HPNG	PROP	density/N2/CO2 - NX19 modified /GOST 30319-2 G2
LNG	COMP	compos. data, ISO 6578 rev. Klosek-McKinley - D
LNG	PROP	heat. value/liquid density/gas density - G1
LNG	PROP	LNG PROP - heat. value/liquid density/gas mol. mass - G2
HPH	COMP	flowing p, T - 100% hydrogen NIST JR VOL 113

6.5. MQCI Calculation Models

All current and future models are implemented via standard SAP QCI customizing table settings. As described above, a model consists of a sequence of function module calls, which are defined in a conversion group customizing table. This sequence is executed for each conversion calculation to calculate a target quantity based on a set of conversion parameters and a source quantity.

A model sequence typically consists of implementations of complex parameter calculation functions (based on measurement standards, e.g., AGA Report No. 8) as well as the conversion calculation model functions (also based on measurement standards, e.g., DIN 51650 for NGL/LPG) which are defined in the correct processing order.

This document describes the MQCI and implementations for all available conversion models.

A single conversion model can be utilized for several products, where each product may require a different standard implementation allowing the calculation of (e.g.) volume correction factors or density values.

Once new models beyond the currently available models described in this document are available, these will be documented in an updated version of this document. However, with the currently available basic models many different conversion models can already be configured. As an example, integration of ASTM table 1 conversion factors is possible via customizing and configuration of a conversion group for NGL/LPG products.

Also, legacy system results that operate on fixed point arithmetic can be reproduced with a flexible rounding model, which is part of all but the DIN 51650 model functions.

6.5.1. DIN 51650 SI Model – Net Quantities

This model is described in German standard DIN 51650 “Testing of mineral oils and related products – determination of quantity”. It describes the relevant conversion formulas used to calculate a target quantity at ambient conditions from a given source quantity for the quantities (“dimensions”):

- Mass
- Weight
- Volume

It also specifies rounding of intermediate results (mass in kg to 0 decimals, volume in L to 0 decimals).

6.5.2. SI Base Model – Net Quantities

This model is also known as the SAP QCI mode. It is an open model based on DIN 51650 without built-in intermediate rounding.

6.5.3. Alternate Base Model – Net Quantities

This model supports all possible alternate base conversion UoM for density, mass, weight and volume conversions. The flexibility of this model enables MQCI conversion group configurations for all possible models that utilize a volume correction factor approach, using density **in vacuum** and density **in air** data that is calculated as defined in a specific standard.

6.5.4. API MPMS 12.2 / 11.5.1/2/3 Model – Inverse Densities – Net Quantities

This model supports all possible alternate base conversion UoM for density, mass, weight and volume conversions in conjunction with the inverse density approach defined in API MPMS Chapter 11.5. The flexibility of this model enables MQCI conversion group configurations for all possible models using a volume correction factor approach.

6.5.5. LPG Vapor Model (Mass, Weight, Volume) – Net Quantities

This model supports calculation of LPG tank vapor space volumes as defined in DIN 51650 and ISO 6578.

6.5.6. LPG Vapor Model (Mass, Weight, Volume, Energy) – Net Quantities

This model supports calculation of LPG tank vapor space volumes as defined in DIN 51650 and ISO 6578, as well as calculation of LPG energy values. This model is implemented in two versions; one version utilizes the LPG base density to convert between masses, weights and volumes, the other version utilizes the LPG observed and alternate density for the conversion. Important: These models calculate the total masses, weights, and energies if vapor space calculations are triggered. Volumes are **not updated** with the equivalent vapor volumes. See [FAQ LPG Total Volumes](#) for additional information.



NOTE: the models described above are relevant for LNG/LPG only.

NOTE: All 17 LNG, hydrogen and natural gas calculation scenarios described in section 6.4. utilize one of the three following calculation models:

6.5.7. LNG Alternate Base Model

This model supports all possible alternate base conversion UoM for density, mass, energy, heating value, liquid volume and gaseous volume conversions. The flexibility of this model enables MQCI conversion group configurations for all possible LNG scenarios. Conversion from and to quantity values is always achieved via a mass conversion.

6.5.8. Natural Gas Alternate Base Model

This model supports all possible alternate base conversion UoM for density, mass, energy, heating value, liquid volume and gaseous volume conversions. The flexibility of this model enables MQCI conversion group configurations for all possible natural gas (pipeline, storage, gas plant) scenarios.

6.5.9. 100% Hydrogen Alternate Base Model

This model supports all possible alternate base conversion UoM for density, mass and gaseous volume conversions. The flexibility of this model enables MQCI conversion group configurations for 100% hydrogen scenarios.

6.6. MQCI Quantity Value Calculation & Rounding

6.6.1. Calculation Steps - MQCI Models

All MQCI models described above perform a sequence of conversion steps to convert a given transaction quantity (volume, mass, weight) at observed conditions to a target quantity (volume, mass, weight, energy) at alternate conditions.

In step one, the transaction quantity value is converted to the quantity value in the base conversion UoM BCUNIT_dim1 (the BCUNIT_dim1 is of the same dimension as the transaction quantity). The transaction quantity is at **observed** conditions.

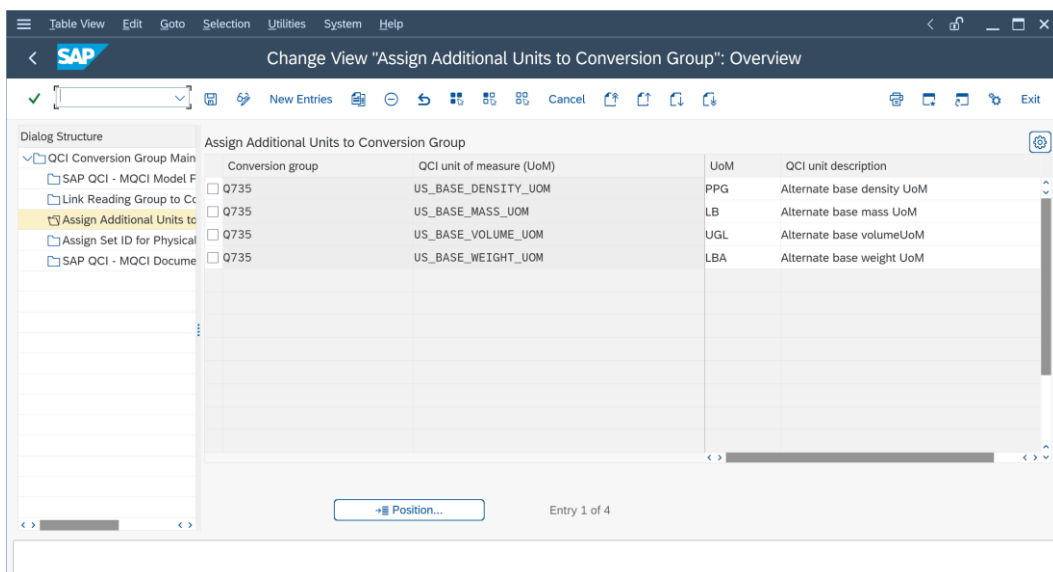
The BCUNIT_dim1 quantity value is then converted to the base condition, BCUNIT_dim1 in step two.

This quantity value is then converted to the BCUNIT_dim2 (e.g., from volume to weight dimension) in step three, utilizing parameters like density, heating value at base – whatever is appropriate.

Conversion to the quantity value in BCUNIT_dim2 at **alternate** conditions is performed in step four.

Finally, the BCUNIT_dim2 quantity value is converted in step five to the target UoM at alternate conditions

BCG Example: Conversion group Q735 is defined at standard temperature 60 °F. Base conversion volume UoM is UGL (U.S. gallon), Base conversion weight UoM is LBA (pound in air), Base conversion mass UoM is LB (pound in vacuum) - See the screen print below:



6.6.2. The Base Conversion Unit Concept

As described above, the base conversion UoM for density, mass, weight, and volume (and energy, gross volume, heating value if required by model) is defined for each model. The SI based models always use the SI UoM as base conversion UoM. Important for the alternate definitions is, that the base conversion UoM are consistent. If you choose LB (pound) as mass or weight base conversion UoM, and UGL (U.S. gallon) as volume base conversion UoM, the density base conversion UoM must be LB/UGL =: PPG (pound per gallon) in SAP configuration terminology.

For BCG NGL/LPG conversion groups, you maintain the base UoM for all relevant dimensions as shown in section 6.5.1 (Additional UoM Assignment). The SI base conversion units for NGL/LPG conversion groups are not explicitly maintained in a conversion group for SI models. For BCG natural gas and BCG LNG conversion groups, you define the coherent base units within the conversion group detail maintenance:

The screenshot shows the SAP S/4HANA configuration interface for 'Change View "/>

Metering & combustion reference conditions			
Metering temperature(t2)	15.00	Combustion temperature(t1)	15.00
Metering temperature UoM	CEL	Combustion temperature UoM	CEL
Metering pressure(p2)	101.325	Combustion pressure (p1)	101.325
Metering pressure UoM	KPA	Combustion pressure UoM	KPA

Base conversion units of measure			
Heating value (volume) UoM	MJM	Base conversion UoM - volume	M3G
Heating value (molar) UoM	MJL	Base conversion UoM - energy	MEJ
Heating value (mass) UoM	MJK	Base conversion UoM - mass	KG
Density (absolute) UoM	KGV	Base conversion UoM - LNG vol.	M3
Wobbe index UoM	MJM	Base molar mass (weight) UoM	KGM

Compression factor calculation standard: units of measure			
Standard Heating value UoM		Standard temperature UoM	
Standard Density UoM		Standard pressure UoM	

LNG settings			
LNG base temperature	-161.00	LNG base density UoM	KCM
LNG base temp. UoM	CEL	LNG base heat.val.(liq.) UoM	MJM

6.6.3. Rounding Steps

As described above, up to five (5) calculation steps are possibly to convert a transaction quantity to a target quantity value. Within each step, you may want to apply UoM specific rounding to the intermediate results.



QuantityWare recommends applying rounding only to the initial transaction quantity value and the final target quantity value and to utilize maximum floating-point accuracy for the intermediate steps. However, it may also be necessary to apply rounding to intermediate results, if legacy system results need to be mapped, or national standards require such rounding.

6.6.3.1. Transaction Quantity Rounding

The transaction quantity is passed via SAP transactions to the MQCI. SAP transactions typically do not support rounding of the transaction quantity. You can enforce rounding within the MQCI of the transaction quantity by assigning the rounding function /QTYW/MQCI_ROUND_TRAN_QUANTITY to the MQCI configuration. You need to set the UoM rounding settings to the required decimals (see description below in point 6.6.3.6 how to perform these settings).

6.6.3.2. Base Transaction Quantity Rounding

Base transaction quantity rounding can be achieved by setting the “Round base transaction quantity” flag in the conversion group. The base quantity value is then rounded as defined by the UoM rounding settings of the Base conversion UoM.

6.6.3.3. Intermediate Value Rounding

Intermediate rounding is achieved by setting the “round intermediate results” flag in the conversion group. The intermediate quantity value is then also rounded as defined by the UoM rounding settings of the Base conversion UoM.

6.6.3.4. Base Target Quantity Rounding

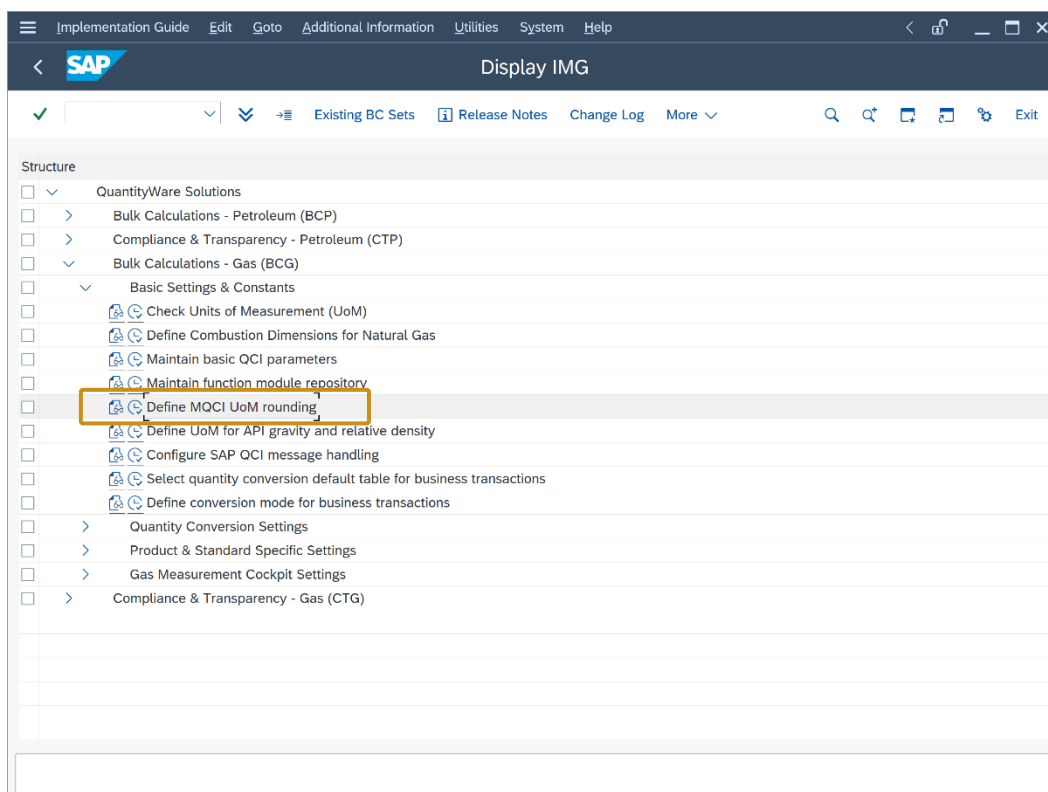
Base target (alternate) quantity rounding can be achieved by setting the “Round base target quantity” flag in the conversion group. The base target quantity value is then rounded as defined by the UoM rounding settings of the Base conversion UoM.

6.6.3.5. Target Quantity Rounding

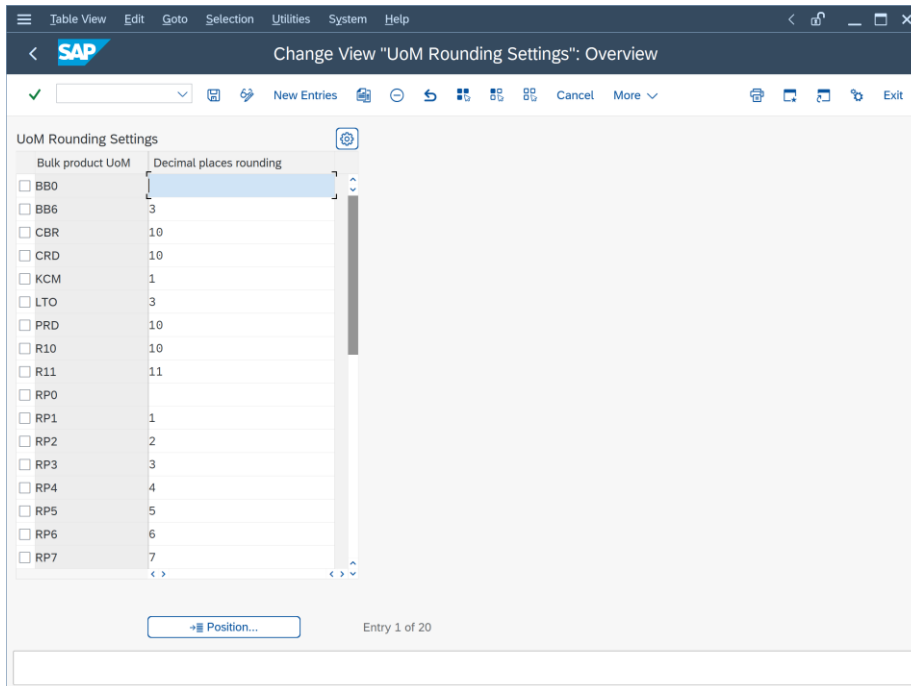
MQCI implementations contain a generic function /QTYW/MQCI_ROUND_ALT_QUANTITY which is part of every conversion group configuration contained in our MQCI template. Within this function, final target/alternate quantity value rounding (masses, volumes, weights, energies etc.) can be performed, if the corresponding unit of measure is to be rounded (defined in customizing, see 6.6.3.6.). The rounding is activated in the conversion group details.

6.6.3.6. Rounding Definition

The rounding definition must be made separately via transaction /QTYW/UOM_ROUND for each unit of measure. You can also access this transaction via the QuantityWare Gas Measurement Cockpit (BCG): Goto -> QuantityWare IMG:



If you maintain a valid entry in the field: “Decimal places rounding”, the values for that UoM are rounded. Rounding settings are delivered with the BCG template for test purposes of the Installation Test Scenarios only:



Valid entries for “Decimal places rounding” are:

Any number between 14 and 0 (rounding to the 14th up to 0 decimal places after the period)

Any number between -1 and -10 (rounding to the second up to the 10th digit before the period).



- Example 1: You set “Decimal places rounding for the unit BBL to 2 (two). The system calculates a volume of **42.227 896 789 BBL**. Rounding leads to a reported result of **42.23 BBL**.
- Example 2: You set “Decimal places rounding for the unit BBL to 1- (one minus). The system calculates a heating value of **42.227 896 789 BBL**. Rounding leads to a reported result of **40 BBL**.
- Important: The rounding definitions defined in the BCG template are merely delivered as examples and for testing purposes and **do not represent a realistic definition for productive usage**.

6.6.3.7. Statistician's Rounding

In a conversion group, you can define that all rounding within the MQCI model functions is done using statistician's rounding.



In the conversion group settings, you define the base conversion units for **natural gas** and **LNG**, which are utilized for intermediate rounding. You also define rounding UoM for temperature, pressure, combustion correction and compression factors.

6.7. MQCI Property Rounding

Physical properties such as densities (in vacuum and in air), heating values etc. may require rounding as defined in business contracts or national standards. MQCI conversion groups can be configured to apply such rounding via dedicated MQCI rounding functions. Examples are provided via Q* template conversion groups.

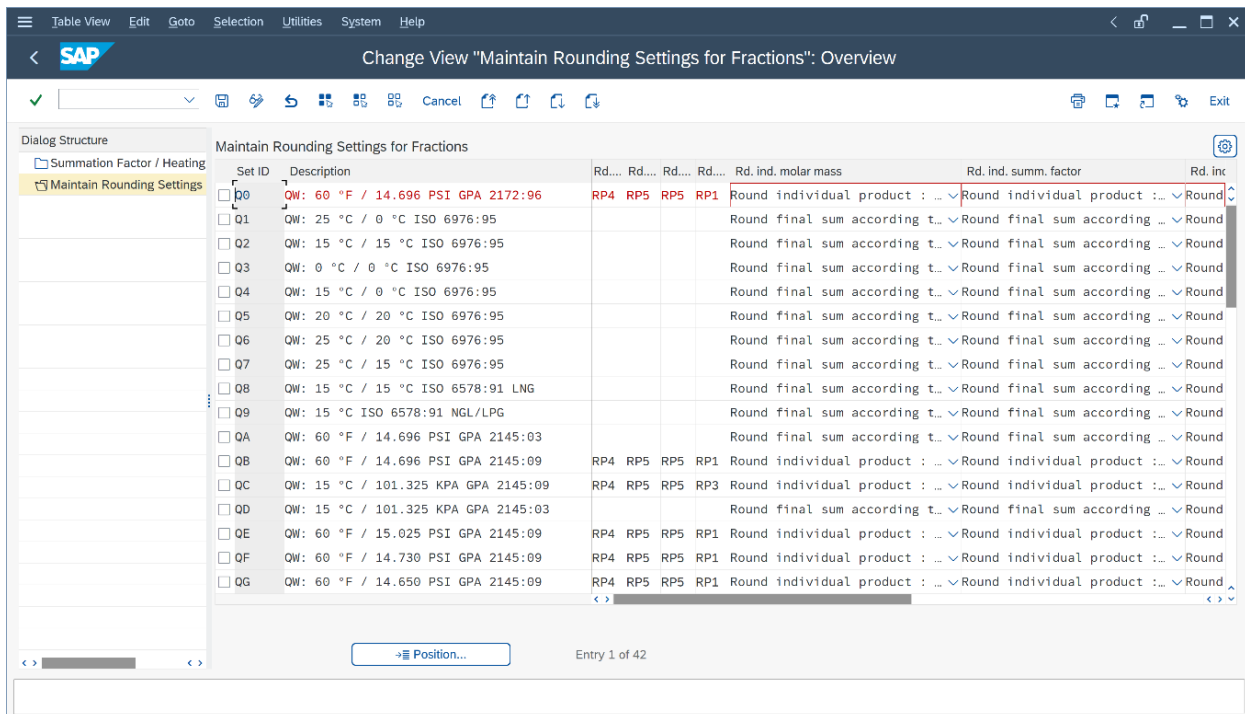


Not all template conversion groups are equipped with such rounding functions.

This task needs to be completed within your implementation project and requires careful analysis of the property values.

6.7.1. Physical Property Data Rounding Settings

For each physical property data set, you define rounding settings and rounding UoM in customizing – relevant if properties are calculated from composition:



Set ID	Description	Rd...	Rd...	Rd...	Rd...	Rd. ind. molar mass	Rd. ind. summ. factor	Rd. inc
Q0	QW: 60 °F / 14.696 PSI GPA 2172:96	RP4	RP5	RP5	RP1	Round individual product : ...	Round individual product : ...	Round
Q1	QW: 25 °C / 0 °C ISO 6976:95					Round final sum according t...	Round final sum according ...	Round
Q2	QW: 15 °C / 15 °C ISO 6976:95					Round final sum according t...	Round final sum according ...	Round
Q3	QW: 0 °C / 0 °C ISO 6976:95					Round final sum according t...	Round final sum according ...	Round
Q4	QW: 15 °C / 0 °C ISO 6976:95					Round final sum according t...	Round final sum according ...	Round
Q5	QW: 20 °C / 20 °C ISO 6976:95					Round final sum according t...	Round final sum according ...	Round
Q6	QW: 25 °C / 20 °C ISO 6976:95					Round final sum according t...	Round final sum according ...	Round
Q7	QW: 25 °C / 15 °C ISO 6976:95					Round final sum according t...	Round final sum according ...	Round
Q8	QW: 15 °C / 15 °C ISO 6578:91 LNG					Round final sum according t...	Round final sum according ...	Round
Q9	QW: 15 °C ISO 6578:91 NGL/LPG					Round final sum according t...	Round final sum according ...	Round
QA	QW: 60 °F / 14.696 PSI GPA 2145:03					Round final sum according t...	Round final sum according ...	Round
QB	QW: 60 °F / 14.696 PSI GPA 2145:09	RP4	RP5	RP5	RP1	Round individual product : ...	Round individual product : ...	Round
QC	QW: 15 °C / 101.325 KPA GPA 2145:09	RP4	RP5	RP5	RP3	Round individual product : ...	Round individual product : ...	Round
QD	QW: 15 °C / 101.325 KPA GPA 2145:03					Round final sum according t...	Round final sum according ...	Round
QE	QW: 60 °F / 15.025 PSI GPA 2145:09	RP4	RP5	RP5	RP1	Round individual product : ...	Round individual product : ...	Round
QF	QW: 60 °F / 14.730 PSI GPA 2145:09	RP4	RP5	RP5	RP1	Round individual product : ...	Round individual product : ...	Round
QG	QW: 60 °F / 14.650 PSI GPA 2145:09	RP4	RP5	RP5	RP1	Round individual product : ...	Round individual product : ...	Round

6.8. MQCI and SAP QCI: Parameter Range Checks

Within the standard SAP QCI (without BCG installed), you cannot define that certain measurement parameters need to lie within a specified range of values.

An example would be the natural gas heating value. In the standard SAP Oil, Gas, & Energy system, you can enter any value between 0.000 01 and 1 000 000 000.000 MJM (Mega joule per cubic meter), and the system calculates volume and energy quantity values for any heating value.

Typically, several parameters are required for the quantity conversion, thus data entry can be cumbersome and, if not checked, lead to erroneous results which may have considerable financial impact on your business. This is true for automated data input via SAP BAPI as well as manual user data entry.

To provide the parameter ranges requirement, QuantityWare delivers customizing tables which for all template reading groups, contain the relevant parameter data sets within the configuration template (client 045) with initial values, for which data range checks can be maintained. It is not possible to deliver the datasets with preset range values, since these values depend greatly on customer specific business process details and specific product characteristics. If you select one specific reading group, you may select all available parameters for which the following data can be maintained:

High level error limit: Any number with up to 6 decimal places

Low level error limit: Any number with up to 6 decimal places

High level warning limit: Any number with up to 6 decimal places

Low level warning limit: Any number with up to 6 decimal places

The unit of measure (UoM) for each parameter

For character format parameters, you can define an exact match or if a value needs to be excluded.

The range check function can be activated for both SAP QCI as well as QuantityWare MQCI conversion groups.



It is not required to maintain all data for all parameters. You may - for example - just maintain lower limits (E and W), or just warning limits.

Technically, the range checks are executed if function `/QTYW/CHECK_PARAM_RANGES` is included within the conversion group. This is the case for all BCG template conversion groups (Q7**, QT**, QU**, QV**). As soon as range data is maintained, the checks are performed for each quantity conversion calculation.

6.9. MQCI ASTM Table 1 – NGL/LPG

ASTM Table 1 defines conversion factors for volume, weight, and length units. Since this table is a “de facto” industry standard for liquid petroleum products, QuantityWare supports - within the MQCI quantity conversions between masses, weights and volumes - the ASTM Table 1 factors – [for NGL and LPG MQCI conversion groups](#).

In the “Extended conversion group maintenance” transaction (accessible via the GMC) you define if the ASTM Table 1 conversion factors or the standard SAP conversion factors are to be utilized for each conversion group. QuantityWare delivers the ASTM Table 1 values as part of the QuantityWare BCG BC set for SAP Dimension ID (DIMID) VOLUME and QuantityWare Dimension ID (DIMID) WGHTA (Weight in air). For other DIMID (e.g., MASS or VMASS or gross volume GRSVOL) you simply assign the correct UoM to the corresponding WGHTA or VOLUME UoM.

QuantityWare delivers ASTM Table 1 conversion factors based on ASTM D1250-80 and ASTM D1250-08. You select which version of the factors the conversion group shall utilize.

You also select whether the MQCI solely uses ASTM Table 1 factors, raising an error if an entry is missing, or continues with the SAP standard conversion factor if no ASTM Table 1 conversion factor is maintained or available.

You also choose whether the MQCI skips the conversion to the base UoM if source and target UoM are identical (except for possible temperature assignments). This setting avoids rounding issues that will occur quite naturally due to the limited accuracy and non-symmetric definition of the ASTM Table 1 conversion factors, especially when converting back and forth between base UoM and source and target UoM.



With Note 000055, the ASTM Table 1 concept has been extended considerably. Read QuantityWare [Note 000055](#) for additional configuration options.



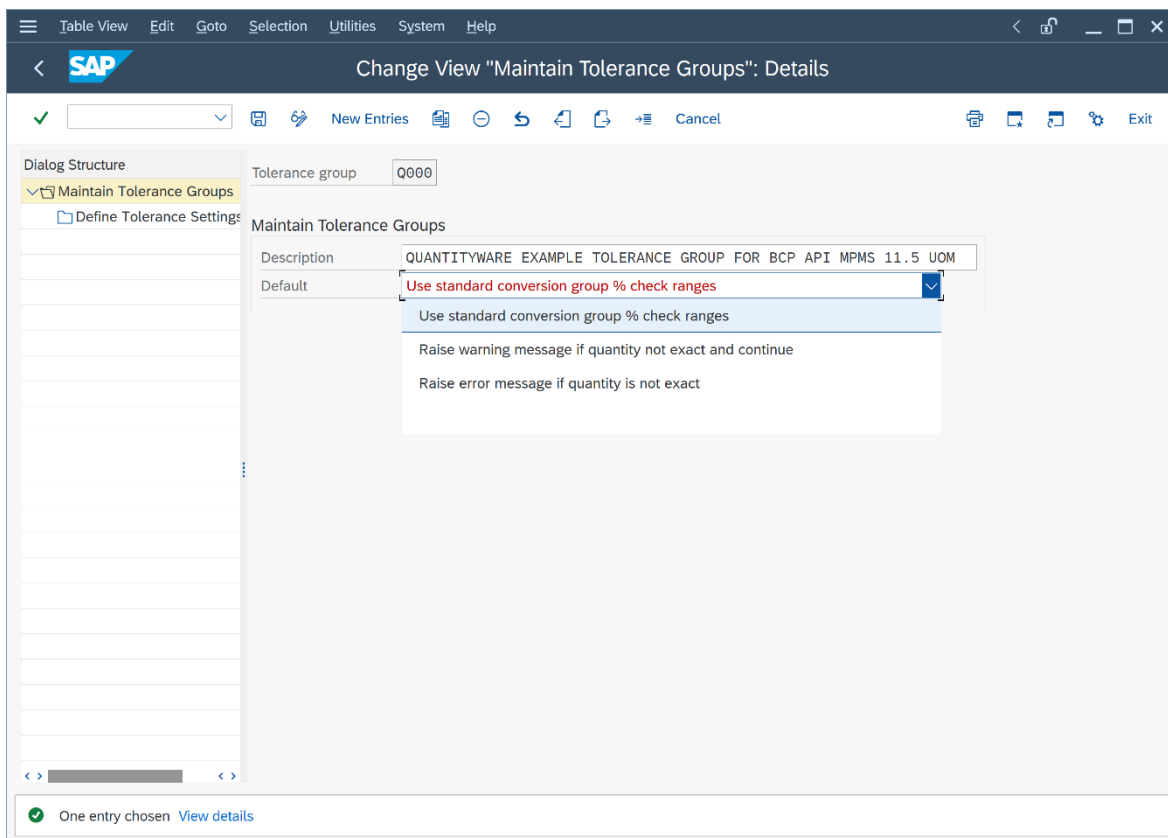
For natural gas and LNG conversions, ASTM Table 1 is not relevant. If customers require a similar approach that is well defined in an international standard, integration into the relevant model functions can be made available in a future BCG support package or release.

6.10. MQCI Tolerance Group

As described in our working paper “Quantity Data Flow in the Natural Gas and LNG Supply Chain”, quantity data - that is passed from external measurement systems to the SAP ERP system - needs to be checked and possibly enriched, before ERP documents with financial impact are posted.

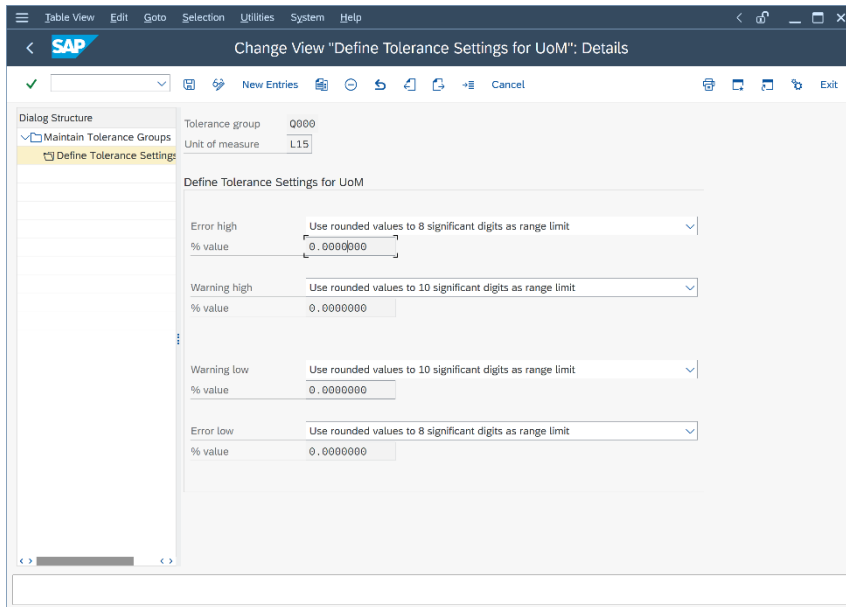
Standard SAP QCI supports the definition of tolerance settings for a conversion group. You define percentage limits for quantity value deviations, which trigger a warning or error message if quantity values passed from external systems (or manual changes made by users) deviate from the calculated results.

For the QuantityWare MQCI, you may define tolerance groups in addition to this simple standard SAP check.



You assign all relevant UoM to the tolerance group, for which an individual check is made. In the header of a tolerance group, you define the behavior if no detailed limits for a UoM are defined.

For each UoM, you define either a percentage deviation or a deviation after rounding to 3, 4, 5...10 significant digits. If a quantity value for that UoM deviates from these defined limits, a warning or error message is raised:



You assign a tolerance group to a conversion group.

With this concept, you ensure that quantity value deviations for UoM which are (e.g.) relevant for pricing and excise duty calculations, are tightly controlled. For UoM that are (e.g.) relevant for logistics control only, higher deviations are possible.

Additionally, the implementing MQCI function /QTYW/MQCI_QW_QUANTITY_CHECK - which you need to assign to your conversion group to activate a tolerance group check - contains the following logic based on the manual entry indicator (SAP domain OIB_MANEN):

- Initial Quantity calculated by QCI
- X Quantity checked by QCI, deviation within tolerance
- U Quantity passed through interface; Not checked
- C Quantity passed through interface, deviation within tolerance

If the manual indicator is set to "U" or "C", no check will be performed, since the value is passed from external systems and has been checked there - "U" or has already been checked once before within the SAP ERP system - "C". See SAP note 568867 for additional details.

Example:

UoM L15 (liter @ 15 °C) is the basis for your NGL product price calculations. Here you define a tolerance limit where equality up to 8 significant digits is required.

UoM L (liter at ambient) is utilized for tank capacity control. Since the L quantity values show a high fluctuation depending on the current observed temperature, you define a 0.1 percentage deviation which is still acceptable and does not lead to unnecessary process flow interruptions.

6.11. MQCI Advanced Configuration Options

6.11.1. MQCI LNG & NGL/LPG configuration options

For LNG and NGL/LPG products (e.g., commercial propane, commercial butane, and mixtures) LNG/NGL/LPG vapor space calculations as defined in DIN 51650 and ISO 6578 are supported by the MQCI.



Mass and energy quantity values are updated with the vapor mass and vapor energy, such that these values contain the total LNG or NGL/LPG product quantity for valuation purposes. Volume quantity values always contain the liquid volume quantity w/o vapor volume.

For the calculation of LNG or NGL/LPG quantities (masses, weights, and volumes) the following data is required:

LNG or NGL/LPG base density at conversion group base temperature (You may also extend the reading group to enable entry of a density at a temperature different than base temperature)

LNG or NGL/LPG observed temperature

LNG or NGL/LPG molar weight (required for vapor calculation)

LNG or NGL/LPG vapor pressure

LNG or NGL/LPG vapor temperature (can be defaulted from observed temperature)

The tank capacity

Apply vapor corr. (tank dip): An indicator that triggers static tank measurement vapor calculation

Vapor recovery (movement) ind.; An indicator that triggers vapor correction for goods movements



All required data parameters such as density, temperature and pressure values may be defaulted using SAP transaction /no3defaults. In addition, the QuantityWare MQCI design supports customer specific defaulting into the MQCI model sequence.

6.11.1.1. Vapor Correction Indicators

Set the “Apply vapor corr. (tank dip)” indicator if you enter a tank dip in SAP tank management and enter the tanks’ capacity. Once this has been entered, the vapor mass is calculated too and added to the liquid product mass and the observed vapor density. The vapor mass is added to the liquid product mass that is derived from the liquid product level.

You combine an opening and closing tank dip and calculate the quantity differences (masses and volumes) which are then posted as movement quantities. You may do this directly via SAP tank management.

Alternatively, you may take this data and enter the differences as movement data within your logistics processes (e.g., TD transactions). Here, enter the transferred liquid volume and the density of the liquid being transferred, as well as the final transfer LNG or NGL/LPG parameters (vapor pressure and temperature) and set the “Vapor recovery (movement)” indicator. As defined in ISO 6578, the mass of the liquid transferred will be calculated (which is basically the mass of the liquid transferred minus the vapor mass displaced by the liquid). This calculation does not require a tank capacity.

You may also directly enter all additional quantities derived from two tank dips (differences between opening and closing quantity values). Using this scenario, you must ensure that the tolerance settings allow such postings.

6.11.1.2. Vapor pressure correction

Typically, the vapor pressure is measured as gauge pressure and needs to be corrected to absolute pressure. This can be achieved the following way:

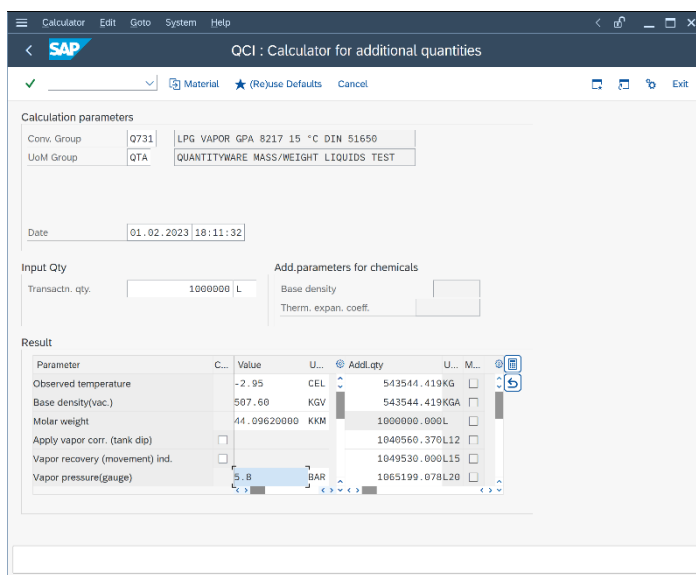
You enter a pressure value using a pressure UoM that is not defined as base pressure UoM in the conversion group (in our template, we utilize kilopascal (kPa, SAP UoM KPA) as a base pressure UoM).

Example:

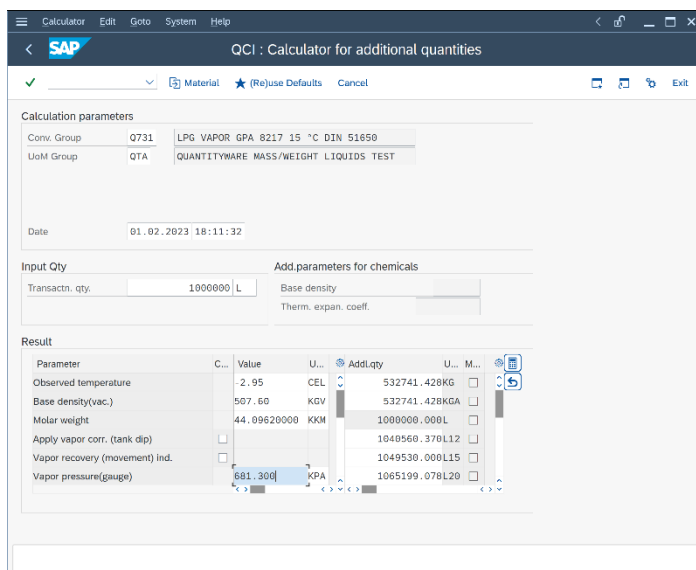
Conversion group Q731 is defined at the base atmospheric pressure of 101.300 kPa (DIN definition), Q732 and Q733 are defined at 101.325 kPa (ISO definition), Q735 at 14.696 lbf/in² (SAP UoM PSI - U.S. standard base). This value is also used for the vapor calculation formula.

Technically, the vapor correction is calculated by function /QTYW/MQCI_BCG_ABS_PRESS_CALC in the MQCI model sequence, which you may remove if you enter absolute pressure values.

Example: You enter the gauge pressure value of 5.8 bar (SAP UoM BAR):



The system converts your pressure value by adding the base pressure defined in the conversion group and utilizes this value for the detailed calculations and displays the corrected absolute pressure in kPa:



6.11.1.3. Tank Capacity Defaulting

Within SAP tank management, you must enter the tank capacity into the quantity conversion sub screen. Conversion group Q732 is configured to default the tank capacity via function /QTYW/LPG_GET_TANK_CAPACITY. This defaulting will only work if you have configured SAP tank management so that a **single** storage location is assigned to a **single** tank and vice-versa.

If this is not required, you should remove function /QTYW/LPG_GET_TANK_CAPACITY from your MQCI configuration. Read the [FAQ on SAP Tank Management integration](#) for additional details.

6.11.1.4. Weight Calculations

NGL/LPG products are stored in closed containers. As defined in DIN 51650, the air buoyancy for the gross and tare measurement are basically identical. This means that the air buoyancy correction can be set to 0, i.e., the density **in vacuum** and in air are equal - in first order.

Hence the conversion groups Q73* are configured with function /QTYW/CALC_BDICH_AIR_VAC_LPG_C in the MQCI function model sequence. If you wish to apply the standard air buoyancy calculation, this function needs to be replaced with the appropriate MQCI model function.

6.11.2. MQCI Energy Calculations

With BCG, energy calculations (based on ISO 6578 / ISO 6976) for NGL/LPG products and natural gas and LNG products are supported. Preconfigured conversion groups are delivered with the BCG template where you calculate energy values; simply assign the required energy units of measure to the UoM group.

6.11.3. MQCI Parameter Defaulting

In BCG you can configure all conversion groups so that certain required measurement parameters (e.g., test density temperature is always set to base temperature) are defaulted as defined by your business requirements. This way you minimize the number of parameters required for input.

6.11.4. MQCI Business Integration Logic

BCG contains business specific functions (delivered within function group /QTYW/MQCI_COMMON), which you can add to your MQCI conversion group function sequence. QuantityWare welcomes your new requirements for analysis; if a solution is technically feasible, it will be delivered as new integration logic with a CSP.

6.11.5. MQCI External System Data Synchronization

BCG contains function /QTYW/MQCI_SYNC_EXT_VALUES, which you can add to your own MQCI conversion group logic. This function detects data from external systems passed to the SAP ERP system (via the “manual entry indicator”) and synchronizes dependent quantity values based on that data.

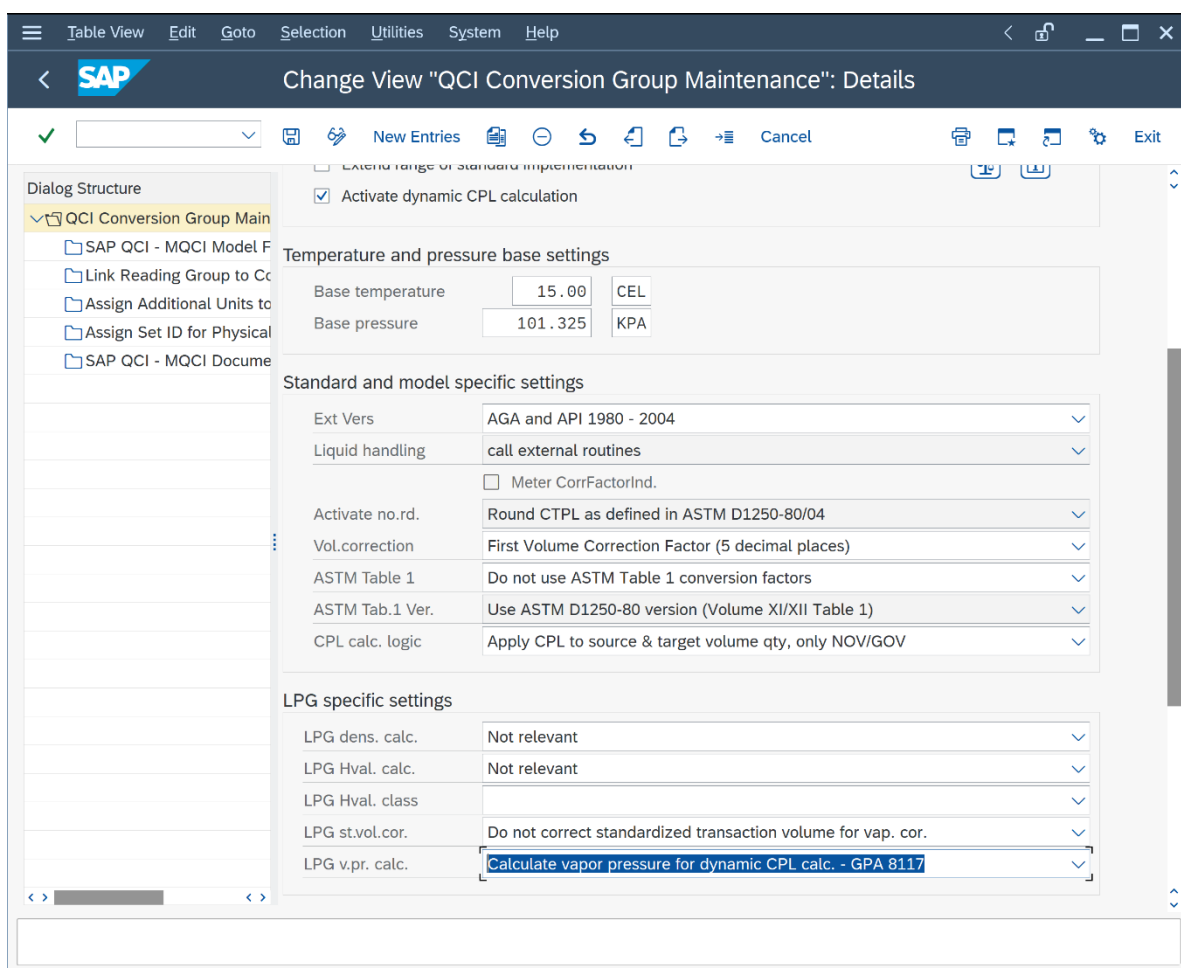
All QuantityWare MQCI template conversion groups are configured such that the MQCI function module sequence contains function /QTYW/MQCI_SYNC_EXT_VALUES. If not required, you may remove this function from your copy of the template conversion group. Read the [Synchronization FAQ](#) for details.

6.11.6. MQCI Country Specific Base Temperature Definition

For GPA 8217 / TP-27 (NGL/LPG) you can configure your SAP QCI and MQCI conversion groups to calculate standard based CTPL for any required base temperature, e.g., 23 °C (Egypt) or 85 °F (Pakistan). The QuantityWare GPA 8217 / TP-27 implementation has been extended via a soft conversion to support all possible base temperatures.

6.12. MQCI Support of CPL Calculations

Implementations of API MPMS Chapter 11.2.2(M) and GPA 8117 / TP-15 are delivered with BCG, together with template conversion groups for LPG/NGL, which are configured to calculate combined CTL and CPL correction factors based on these standards. List printing of API MPMS Chapter 11.2.1(M) and API MPMS Chapter 11.2.2(M) compressibility factors is provided via the PMC "Print Standards Lists" tab strip. CPL calculations are supported for MQCI conversion groups in conjunction with the GPA TP-27 CTL standard. The CPL calculation needs to be activated for a conversion group via customizing – e.g., Q72A:



A CPL calculator is available, allowing CPL factors to be calculated online for control and audit purposes.

6.13. Summary

Leveraging the flexibility of the SAP Oil, Gas, & Energy solutions' technical design, the Model-based QCI from QuantityWare can operate as a "single solution", or in parallel with existing SAP QCI functionality, allowing customers to represent business- and regulatory-driven calculation requirements accurately and transparently in a single, controlled environment, on demand.

7. BCG - Customizing Transactions

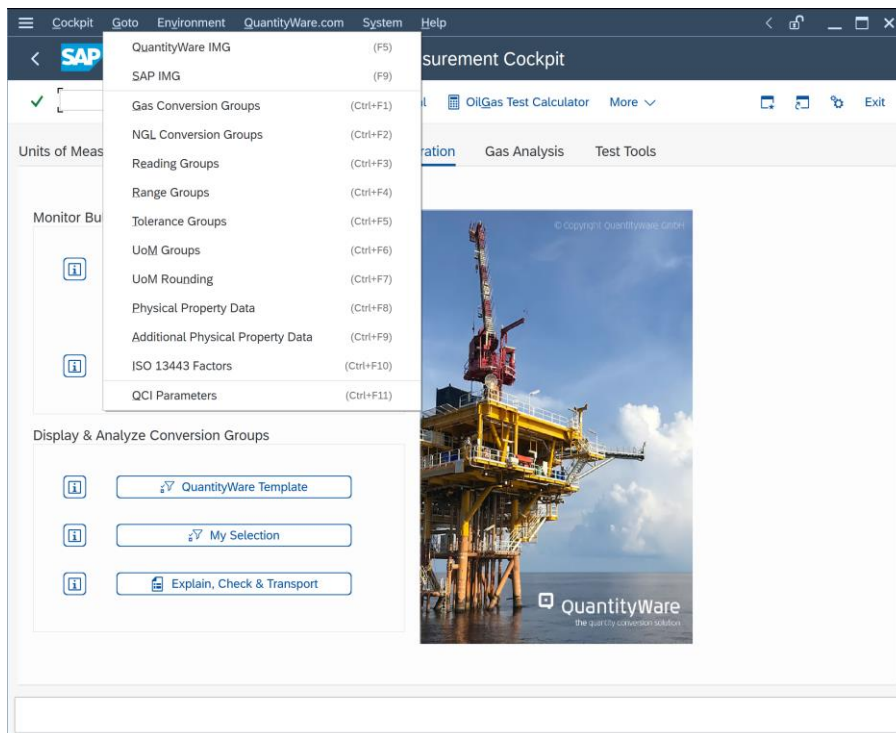
7.1. Introduction

With BCG, QuantityWare delivers a complete configuration template to the oil & gas and allied industries. This template is delivered as a BC set. QuantityWare requires installation of this template into exactly one client (recommended 045, if not already in use) in one development system in your system landscape, from where the implementation project team selects the relevant configuration (via SAP customizing transports) based on customer specific requirements.

Within this chapter, we provide an overview of BCG customizing transaction access, as well as some basic documentation on the configuration options provided via customizing options.

7.2. QuantityWare Customizing Transactions

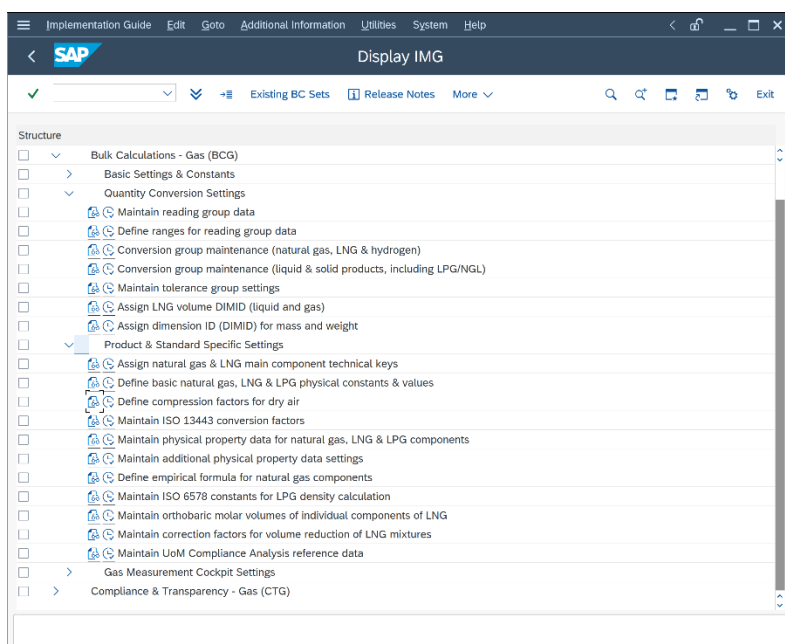
QuantityWare delivers client specific customizing data for BCG that are maintainable via transactions. All relevant customizing transactions for bulk quantity conversion configuration can be accessed via the QuantityWare Gas Measurement Cockpit (transaction /QTYW/COCKPIT_GAS):



Under menu path GOTO you can navigate to the QuantityWare IMG, as well as to the complete SAP IMG, where the QuantityWare IMG is included as well. For fast access, the following transactions can be called directly from the menu:

- Gas Conversion Groups - /n/QTYW/MQCI_GAS
- NGL Conversion Groups - /n/QTYW/MQCI
- Reading Groups - /n/QTYW/READINGGROUP
- Range Groups - /n/QTYW/RANGES
- Tolerance Groups - /n/QTYW/TOLERANCE
- UoM Groups - /n/QTYW/UOMGR
- UoM Rounding - /n/QTYW/UOM_ROUND
- Physical Property Data - /n/QTYW/PPP_DATA
- Additional Physical Property Data - /n/QTYW/PPP_SUMMATION
- ISO 13443 Factors - /n//QTYW/ISO13443
- QCI parameters - /n/QTYW/QCI

To provide a structured implementation guide (IMG) for all relevant customizing transactions for bulk quantity conversions, these transactions are collected within the QuantityWare customizing IMG structure (Transaction SIMGH – IMG Structure “QuantityWare Solutions”) or you can access the BCG IMG directly via the Gas Measurement Cockpit, Menu: Goto – QuantityWare IMG and expand the “Bulk calculations gas – BCG” node:



With QuantityWare BCG, all business user-relevant customizing template entries are delivered in languages English (EN), French (FR), Spanish (ES) and Portuguese (PT) as part of the BCG BC set. QuantityWare recommends that you perform your configuration work using the GMC in logon language English (EN). As a last step, you check and possibly enhance the configuration data in your required language. With BCG, you may also launch the GMC in all other logon languages. The Cockpit UI is only available in English (EN).

In detail, the following configuration data is translated within the BCG template:

- All UoM definitions (dimensions, ISO/UNECE codes, UoM short and long texts)
- All conversion group definitions (header texts)
- All reading group definitions (header texts and individual parameter descriptions)
- All range group definitions (header texts and individual parameter descriptions)
- All UoM group definitions (header texts)

7.3. Summary

Via a comprehensive IMG structure, the complex and detailed customizing required for modern quantity conversions can be accessed and governed in an efficient and transparent manner.

8. BCG - Natural Gas Component Physical Properties Data

8.1. Introduction

All comprehensive natural gas conversions require data sets containing physical property data for all natural gas components. Based on these data, natural gas properties such as compression factors, heating values, molecular weight and densities can be calculated.

QuantityWare delivers 42 data sets for natural gas, LNG and NGL/LPG conversions. These data sets are based on seven standards:

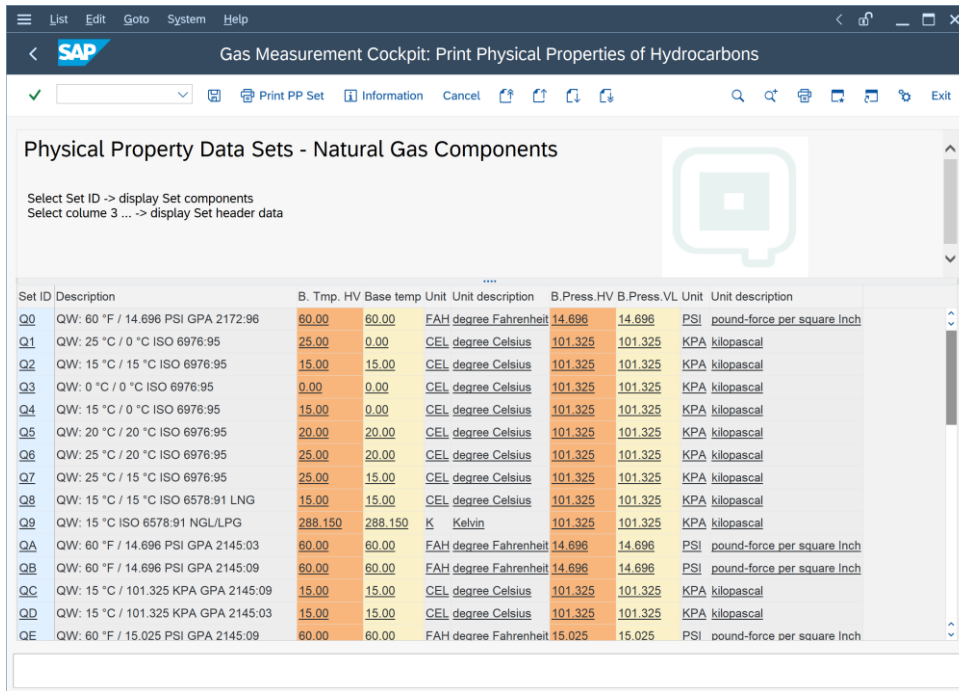
- ISO 6976:2016
- DIN EN ISO 6976:2005 (English version of ISO 6976:1995 incl. Corrigendum 1:1997, Corrigendum 2:1997 and Corrigendum 3:1999)
- ISO 6578:1991, First edition
- ISO 6578:2017, Second edition
- GPA 2145-03, Rev.02 (07/07)
- GPA 2172-96
- GPA 2145-09
- GPA 2145-16
- GOST 30319.1-96
- GOST 22667-82

As an example, LNG contracts typically specify which data sets need to be applied for custody transfer measurements and calculations. QuantityWare has selected these data sets based on an analysis of publicly available contract data. If customers require data sets based on other standards or other versions of the standards noted above, QuantityWare can deliver such sets together with the relevant validation test reports as part of the maintenance agreement.

In this chapter, we describe the delivered data sets and how data correctness can be validated using QuantityWare validation tools.

8.2. Physical Properties - Data Set Description

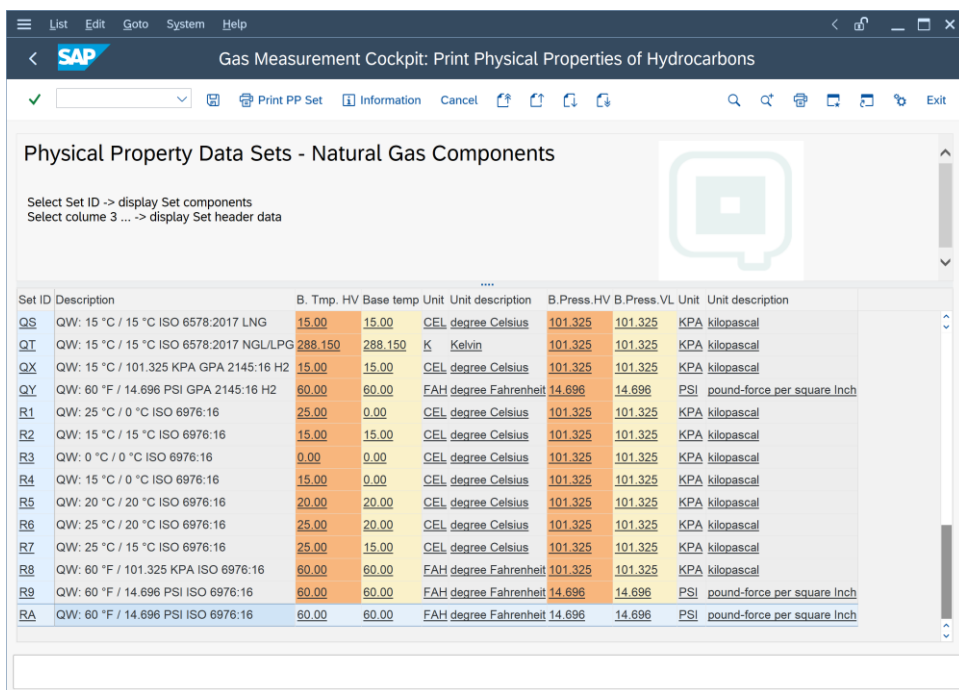
The following 42 data sets are contained in BCG and can be easily accessed directly from the GMC via tab strip "Print Standards Lists ->Physical Property Data - Gas Components -> Display Data Set:



Physical Property Data Sets - Natural Gas Components

Select Set ID -> display Set components
Select column 3 ... -> display Set header data

Set ID	Description	B. Tmp.	HV Base temp	Unit	Unit description	B.Press.HV	B.Press.VL	Unit	Unit description
Q0	QW: 60 °F / 14.696 PSI GPA 2172:96	60.00	60.00	FAH	degree Fahrenheit	14.696	14.696	PSI	pound-force per square Inch
Q1	QW: 25 °C / 0 °C ISO 6976:95	25.00	0.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
Q2	QW: 15 °C / 15 °C ISO 6976:95	15.00	15.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
Q3	QW: 0 °C / 0 °C ISO 6976:95	0.00	0.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
Q4	QW: 15 °C / 0 °C ISO 6976:95	15.00	0.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
Q5	QW: 20 °C / 20 °C ISO 6976:95	20.00	20.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
Q6	QW: 25 °C / 20 °C ISO 6976:95	25.00	20.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
Q7	QW: 25 °C / 15 °C ISO 6976:95	25.00	15.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
Q8	QW: 15 °C / 15 °C ISO 6578:91 LNG	15.00	15.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
Q9	QW: 15 °C ISO 6578:91 NGL/LPG	288.150	288.150	K	Kelvin	101.325	101.325	KPA	kilopascal
QA	QW: 60 °F / 14.696 PSI GPA 2145:03	60.00	60.00	FAH	degree Fahrenheit	14.696	14.696	PSI	pound-force per square Inch
QB	QW: 60 °F / 14.696 PSI GPA 2145:09	60.00	60.00	FAH	degree Fahrenheit	14.696	14.696	PSI	pound-force per square Inch
QC	QW: 15 °C / 101.325 KPA GPA 2145:09	15.00	15.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
QD	QW: 15 °C / 101.325 KPA GPA 2145:03	15.00	15.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
QE	QW: 60 °F / 15.025 PSI GPA 2145:09	60.00	60.00	FAH	degree Fahrenheit	15.025	15.025	PSI	pound-force per square Inch



Physical Property Data Sets - Natural Gas Components

Select Set ID -> display Set components
Select column 3 ... -> display Set header data

Set ID	Description	B. Tmp.	HV Base temp	Unit	Unit description	B.Press.HV	B.Press.VL	Unit	Unit description
QS	QW: 15 °C / 15 °C ISO 6578:2017 LNG	15.00	15.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
QT	QW: 15 °C / 15 °C ISO 6578:2017 NGL/LPG	288.150	288.150	K	Kelvin	101.325	101.325	KPA	kilopascal
QX	QW: 15 °C / 101.325 KPA GPA 2145:16 H2	15.00	15.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
QY	QW: 60 °F / 14.696 PSI GPA 2145:16 H2	60.00	60.00	FAH	degree Fahrenheit	14.696	14.696	PSI	pound-force per square Inch
R1	QW: 25 °C / 0 °C ISO 6976:16	25.00	0.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
R2	QW: 15 °C / 15 °C ISO 6976:16	15.00	15.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
R3	QW: 0 °C / 0 °C ISO 6976:16	0.00	0.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
R4	QW: 15 °C / 0 °C ISO 6976:16	15.00	0.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
R5	QW: 20 °C / 20 °C ISO 6976:16	20.00	20.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
R6	QW: 25 °C / 20 °C ISO 6976:16	25.00	20.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
R7	QW: 25 °C / 15 °C ISO 6976:16	25.00	15.00	CEL	degree Celsius	101.325	101.325	KPA	kilopascal
R8	QW: 60 °F / 101.325 KPA ISO 6976:16	60.00	60.00	FAH	degree Fahrenheit	101.325	101.325	KPA	kilopascal
R9	QW: 60 °F / 14.696 PSI ISO 6976:16	60.00	60.00	FAH	degree Fahrenheit	14.696	14.696	PSI	pound-force per square Inch
RA	QW: 60 °F / 14.696 PSI ISO 6976:16	60.00	60.00	FAH	degree Fahrenheit	14.696	14.696	PSI	pound-force per square Inch

The data set Q0 is defined in GPA 2172-96. Data sets Q1 to Q7 are based on ISO 6976:1995. Each set contains the relevant physical properties for the 55 possible natural gas components defined in ISO 6976:1995. The molar heating values are maintained as given in ISO 6976:1995.

Data set Q8 contains data for 13 LNG components defined in ISO 6578:1991. The mass-based heating values are maintained as given in ISO 6578:1991.

Data set Q9 contains data for 16 NGL/LPG components defined in ISO 6578:1991. The mass-based heating values are maintained as given in ISO 6578:1991.

Sets QA to QH and QM to QR contain the data as defined in GPA 2145:03 and GPA 2145:09. The volume-based heating values are maintained as given in GPA 2145:03 and GPA 2145:09. For data set QH and QR (NGL/LPG) the mass-based heating values are maintained.

Data set QI contains data for LPG heating value calculations at 20 °C combustion temperature defined in ISO 6976:1995. Data sets QJ, QK and QL contain data defined in GOST 30319.1 and GOST 22667.

Data sets QM to QR are based on GPA 2145:16.

In detail, the following data is maintained by QuantityWare:

- Molecular weight (molar mass)
- Summation factor
- Inferior heating value (not for ISO 6976:2016)
- Superior heating value
- Relative density (only QB, QC, QE, QF; QG)
- Absolute density (only QJ)
- Critical temperature (Only Q9 & QH)
- Data sets QS and QT contain data defined in ISO 6578:2017

The definition of the summation factor is different in ISO standards and GPA standards. With GPA 2145-16, GPA supports both formats. QuantityWare supports both summation factor definitions. If you define your own data set, you need to declare which definition you intend to use for the data you maintain. Transnational standard GOST 22667 already defines heating values and relative densities corrected with the compression factor at the reference conditions. This fact is declared in the additional physical property data set settings as well.

8.3. Fundamental Constants and Properties of Dry Air

8.3.1. Fundamental Constants

Natural gas quantity conversions need to utilize the proper value of the molar gas constant R. The value of this constant changed due to progress made in scientific research. The Committee on Data for Science and Technology of the International Council of Science (CODATA) publishes data in a consistent way on a regular basis (see <https://codata.org/>). The accepted value of the molar gas constant R used to be 8.314 472 J mol⁻¹ K⁻¹(2017). This value can also be found at <https://physics.nist.gov/cuu/Constants/Table/allascii.txt> and is published in GPA 2145-03. ISO 6976:1995 on the other hand, still references the older value of 8.314 510 J mol⁻¹ K⁻¹. The SAP QCI also utilizes that value based on ISO 6976:1995.

The gas constant R is defined as the Avogadro constant N_A multiplied by the Boltzmann constant k (or k_B): **Since the 2019 redefinition of SI base units, both N_A and k are defined with exact numerical values when expressed in SI units. Therefore, the SI value of the molar gas constant is exactly 8.31446261815324 J·K⁻¹·mol⁻¹**



Within BCG, QuantityWare utilizes the value 8.314 510 J mol⁻¹ K⁻¹, to be consistent with SAP QCI for the SAP QCI conversion groups for the gas constant R. If you utilize the MQCI conversion groups, you can configure a conversion group to use any required value for R

8.3.2. Properties of Dry Air

8.3.2.1. Molar Mass

Natural gas quantity conversions utilize compression factors of dry air at various conditions and the molar mass of dry air for conversion calculations.

Dry air:

ISO 6976 defines the proper value of these constants. For the molar mass of dry air, it defines the value to be 0.0289626 kg/mol. GPA 2145-03, Rev.02 and GPA 2145-09 define a value of 0.0289625 kg/mol.

Within BCG, QuantityWare utilizes the value 0.0289626 kg/mol to be consistent with the SAP QCI for the SAP QCI conversion groups. If you use the MQCI conversion groups, you can configure a conversion group to use any desired value.

GPA 2145-16 defines a value of 0.028 965 46 kg/mol.

8.3.2.2. Compression Factors

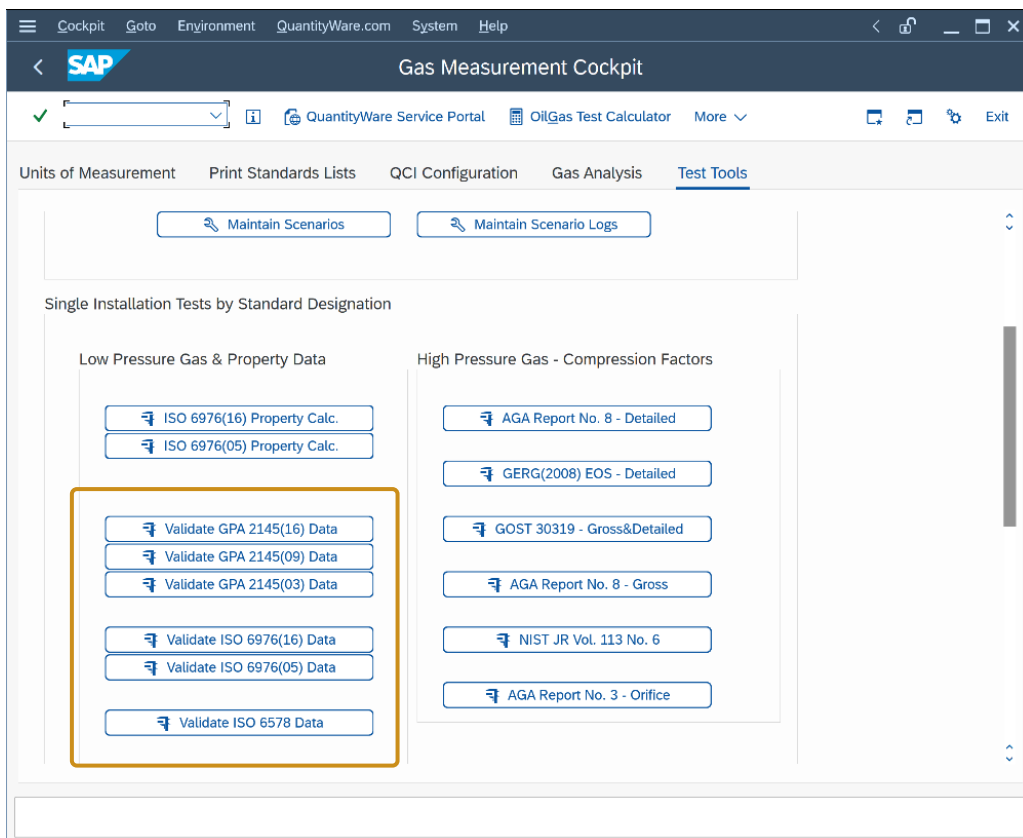
ISO 6976:1995 defines a compression factor of 0.999 58 at 15 °C and 101.325 kPa. GPA 2145-03 Rev.02 defines a summation factor of 0.002 01 which transforms to a compression factor of 0.999 59 (rounded value to five decimal places).



Within BCG, QuantityWare utilizes the value 0.999 58 to be consistent with SAP QCI for SAP QCI conversion groups. This value can also be reproduced in the same way as the other relevant values utilizing the virial equation defined in AGA Report No.8, equation C3-12 (page 131). QuantityWare delivers ABAP function /QTYW/CALC_ZAIR based on that equation to calculate compression factors of dry air with an accuracy of 5 decimal places. If you utilize MQCI conversion groups, you can define any desired value in customizing.

8.4. Physical Property Data Validation

As part of BCG, QuantityWare provides test and validation programs that can be used to test the installation and to validate the SAP QCI for natural gas conversions. The test reports are accessible from the Gas Measurement Cockpit:



The validation reports check that each component value is identical with the hard-coded values within the report datasets.

8.5. Summary

The ability to define physical property data is revolutionary advance within the SAP Oil, Gas, & Energy solution. With the accurate definition of such data, it is possible to apply SAP Oil, Gas, & Energy business process logic to allow the processing of new materials within an ERP-system with great accuracy and transparency. The usage of physical property data and the many calculations standards provided by QuantityWare also allows differing products such as propylene to be calculated.

9. BCG - Natural Gas & LNG Measurement

9.1. Introduction

This chapter describes basic natural gas and LNG definitions and provides also high-level process summaries, independent of BCG specific software settings in your system. It is intended as a detailed guide to help understanding of natural gas measurement and quantity conversion principles from an engineering/business point of view and provides rough guidance as to which conversion groups should be chosen for which measurement and conversion requirements. Read the BCG PAIG (Project Assessment & Implementation Guidelines) document to utilize the proven methodology for BCG deployment into your system landscape.

BCG conversion groups are either configured for the SAP QCI or the QuantityWare MQCI. The SAP QCI conversion groups are considered legacy and serve as a reference for CTG customers only.



QuantityWare requires BCG customers to utilize **QuantityWare MQCI** conversion groups. These allow greater flexibility in defining your business relevant quantity conversion scenarios and make your implementation independent of the legacy BAdI **/QTYW/LNG**.

9.2. Basic Definitions - Natural Gas Quantities and Measurements

Besides serving as a 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.

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 QuantityWare delivers conversion groups that are designed for all globally known standard reference conditions for:

- Natural gas in the gas phase (low and high-pressure regime (CNG))
- NGL (Natural Gas Liquids)
- LNG (Liquefied Natural Gas)
- 100% Hydrogen

To aid comprehension of the BCG documentation, we cite the most important definitions from standards ISO 13443, ISO 12213, ISO 6976 & ISO 6578 and GOST 30319 as a reference, as well as GPA 2145 and GPA 2172.

9.2.1. Common Definitions

9.2.1.1. 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 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 .

9.2.1.2. 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 products being in the gaseous state.

9.2.1.3. Density

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

9.2.1.4. 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.

9.2.1.5. 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 – superior Wobbe index. The inferior Wobbe index is defined accordingly.



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.

Legacy SAP QCI conversion groups **do not calculate** the Wobbe index for natural gas. All MQCI BCG conversion groups calculate all possible gas property values including the Wobbe index.

9.2.1.6. 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.

9.2.1.7. Ideal and Real Gas Law

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.

9.2.1.8. 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.

9.2.1.9. 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.

9.2.1.10. 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 globally. 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.

9.2.1.11. 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

Cited from: ISO 13443 and ISO 12213.

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 use in some countries. QuantityWare defines a global template for the SI system based on six sets of combustion and metering reference conditions, plus an additional three (SAP QCI) and four sets (MQCI) of U.S. customary conditions.

9.2.1.12. Liquefied Natural Gas (LNG)

Liquid natural gas composed predominantly of methane.

9.2.1.13. Orthobaric Density

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

9.2.1.14. Orifice Meter

Pipeline transmission of natural gas requires metering devices that calculate the total volume (or mass) flow rate of natural gas for a given time-period, based on e.g., pressure and temperature conditions at specific metering points.



For natural gas flow rate measurements, the following definition (as defined in AGA report No. 3) needs to be considered.

An orifice meter is a fluid flow measuring device that produces a differential pressure to infer flow rate. The meter consists of the following elements:

- A thin, concentric, square-edged orifice plate
- An orifice plate holder consisting of a set of orifice flanges (or orifice fitting) equipped with the appropriate differential pressure sensing taps
- A meter tube consisting of the adjacent piping sections (with or without flow conditioners)



A detailed list of all orifice engineering and technical terms and their definitions can be found in AGA report No. 3, part 1: “General equations and uncertainty guidelines”.

9.3. Basic Measurement Principles

9.3.1. Natural Gas – Gaseous State

In the gaseous state, natural gas is transmitted through pipeline systems that easily span thousands of kilometers. Storage for demand buffering and fluctuating seasonal demand is organized using large underground caverns or special high-pressure storage pipe systems.

After extraction, natural gas typically flows at low pressures to gas processing (gas plant) facilities, where it is “cleaned” (removal of unwanted components (e.g.) corrosives, such as hydrogen sulfide, water etc. and extraction of high value components (e.g.) butane, propane etc.). To transmit commercially relevant quantities over large distances, high pressure pipelines are then fed with pipeline quality gas, where compressor stations along the line ensure that the gas flows at high pressures to the destination locations (e.g., large utility companies or industrial consumers). Finally, end consumer delivery is achieved by a wide-spread pipeline network operating at moderate to low pressure conditions, again.

From a measurement and quantity conversion point of view, we distinguish here between low and high-pressure regimes for natural gas. The definitions of these two regimes vary per literary source. We have decided to utilize the ISO standard 13443:1996(E) temperature and pressure range given therein in Annex B (informative) to define the low-pressure range, where the pressure range for reference condition conversions is given as

$95 \text{ kPa} < p < 105 \text{ kPa}$, which is approximately: $13.78 \text{ PSI} < p < 15.23 \text{ PSI}$.

The temperature range is given as $270 \text{ K} < T < 300 \text{ K}$ which is approximately: $26 \text{ °F} < T < 80 \text{ °F}$.

Within that range, the ideal gas law and the correction formulas for real gases can be applied as given in ISO 13443.

High pressure transmission introduces additional calculation complexity.



Business partners (e.g., sellers, buyers, transmission companies, utility companies) trading natural gas, need to distinguish whether they operate in the low pressure or high-pressure regime.

9.3.1.1. Low Pressure Regime

If business partners operate in the low-pressure regime or if high pressure data is already converted into low pressure volumes at defined conditions, conversion groups defined for low pressure calculations are sufficient to define supply chain processes within the SAP Oil, Gas, & Energy system.

Typically, as a minimum requirement, a heating value (and density value) at specified standard reference conditions is supplied by a transmission company for a certain amount of natural gas at metering conditions. With this information, volumes, masses and energy quantity values can be calculated, also at standard reference conditions required by other business partners (e.g., buyers) that differ from the transmission conditions but are within the ISO 13443 ranges.

9.3.1.2. High Pressure Regime

If business partners operate in the high-pressure regime, the calculation of volume, mass, and energy quantity values, as well as the Wobbe index requires a “compression factor”. This factor can be calculated using methods defined in ISO 12213.

- The BCG template contains conversion groups that can be utilized if business partners agree to calculate quantities based on the GERG88 method, which is described in ISO 12213-3
- With BCS 30A CSP03 30B CSP02, a new SGERG-mod-H2 implementation is delivered, to support higher hydrogen mixtures with natural gases
- Alternatively, partners may agree to base their trading agreements (contracts) on AGA8 gross methods 1 or 2, which are defined in AGA Report 8 (“Compressibility Factors of Natural Gas and other related Hydrocarbon Gases” AGA Transmission Measurement Committee Report No. 8, Second Edition, November 1992, 2nd Printing July 1994, API MPMS Chapter 14.2, Second Edition, Revised August 1994, Reaffirmed, February 2006)
- If the complete molar composition of the natural gas is known, the AGA8 report Part 1 - detailed characterization method - described also in ISO 12213-2 is applicable. Based on this molar composition, all parameters such as heating values, densities and compression factors can be calculated. The BCG template contains predefined conversion groups based on this standard as well
- Alternatively, AGA Report No. 8 - Part 2 - Thermodynamic Properties of Natural Gas and Related Gases GERG-2008 Equation of State - April 2017 may be applicable. This is supported with BCS 30A CSP03 30B CSP02.

- Russian transnational standard GOST 30319.2 provides four different methods to calculate compression factors, two gross methods (NX19mod and GERG91) as well as AGA8 and VNIC SMV for detailed calculations. The BCG template contains predefined conversion groups based on this standard as well.



BCG also includes implementations of AGA report 3 “Orifice Metering of Natural Gas”, third edition, August 1992. If customers require such an implementation (e.g.) within the SAP Trader’s & Scheduler Workbench Ticketing transactions for pipeline metering, QuantityWare can support such an implementation based on specific project requirements.

Special attention is required if quantity conversions for wet gases are to be implemented. Contact QuantityWare if you require definition of quantity conversions for wet gases – such conversions can be supported by BCG but require careful analysis of the detailed requirements.

9.3.2. LNG

While natural gas in the gaseous state is transmitted through pipelines, LNG (Liquefied Natural Gas) offers the possibility to supply global locations that cannot be reached via pipelines, e.g., Japan, South Korea and Taiwan, via special LNG tankers. In addition, LNG composition, due to the liquefaction process where components are removed, results in the delivery of a higher heating value product to market at the end of the transport process.

Simply put, LNG is natural gas with a specified composition (high methane content, low levels of corrosive components and components that would solidify during liquefaction) that is cooled down to cryogenic temperatures (typically at, or slightly below the melting point of methane - approximately minus 161 °C). At such low temperatures, the gas condenses into a liquid and experiences a volume reduction to approx. 1/600 when compared to the same amount in gaseous form. Using special tankers with insulated tanks, LNG can be shipped across oceans to reach locations where pipelines are not feasible, due to geographical, political, or environmental obstacles. The LNG market is expected to show high growth rates within the next decades. The rising demand for clean and reliable energy from LNG at an increasing number of locations justifies large investments – in liquefaction, storage, and regasification sites, as well as LNG tankers. As an example of increasing interest and investment, tanker capacities are growing; the latest plans include tankers with 250.000 cubic meter capacity, at initial investments of approx. 200 million US Dollars for one tanker.

From a measurement point of view, during custody transfer of the liquid (LNG), the LNG's density, molar composition and heating value are required; typically, molar composition is determined from several samples taken during transfer. Using the transfer samples, gas chromatography is applied to determine the composition (e.g., mole % of all components) of LNG, which can then be utilized to calculate the LNG density and heating values, as well as the density of the gaseous state at any desired reference condition. At a high level, the LNG process can be divided into the following steps:

1. Production of the natural gas
2. "Sweetening", Removal of undesired components and Liquefaction ("Liquefaction trains") at LNG loading sites and the storage of LNG in large tanks for shipment with LNG tankers
3. Liquefied product transfer to LNG tankers (shore – to ship) – Custody transfer point
4. Shipping to receiving countries - LNG custody transfer into receiving storage tanks
5. Regasification of LNG into pipeline network (high pressure) and distribution to end consumers (low & high-pressure connectivity)

With BCG, LNG processes (transfer shore to ship, ship to shore), using the SAP Traders & Schedulers Workbench (TSW), are fully supported from a measurement and quantity conversion point of view, including corrections for gas/vapor phase quantities, as well as transmission processes for pipeline via TSW, based on the solutions described above.

Both LNG and natural gas (gaseous) measurement and conversion are typically based on the molar composition analysis of the natural gas' individual components. The physical properties of these components must be known before accurate calculations can be attempted.

9.4. Summary

The accurate parameter definition required for a realistic ERP-based business implementation of the materials being handled in daily physical processes is only possible with a detailed technical and process knowledge. Configurators must work closely in conjunction with engineering/business representatives to achieve this, as it is the basis for the calculation framework.

10. BCG – Gas Measurement Cockpit - Security

BCS contains single roles and example composite roles for PMC and GMC access and usage (including SAP QCI legacy RFC and “call system” test reports).

13 technical authorization objects are the basis for all single roles, 20 single roles are available:

Role Name (2) 20 Entries found	
Single Roles	Composite Roles Roles
Single Role	Short Role Description
Y_QTYW_BUSINESS_OBJ_DISPLAY	QTYW single role - display business objects
Y_QTYW_CALCULATIONS	QTYW single Role - execute calculations
Y_QTYW_CALL_SYSTEM	QTYW single role - CALL SYSTEM by QTYW
Y_QTYW_COCKPIT	QTYW single role - Cockpit authorization
Y_QTYW_CROSS_CLIENT	QTYW single role - Cross client reading of customizing data
Y_QTYW_CUSTOMIZING	QTYW single role - create, maintain and delete customizing
Y_QTYW_LICENSE_MAINTAIN	QTYW single role - install and update QW licenses
Y_QTYW_LIST	QTYW single role - generate and print lists of standards
Y_QTYW_RFC	QTYW single role - authorization to use the QTYW RFC modules
Y_QTYW_TABU_DISPLAY	QTYW single role - Display QTYW customizing tables
Y_QTYW_TABU_MAINTAIN	QTYW single role - Maintain QTYW customizing tables
Y_QTYW_TABU_SAP_DISPLAY	QTYW single role - Display SAP customizing tables
Y_QTYW_TABU_SAP_MAINTAIN	QTYW single role - Maintain SAP customizing tables
Y_QTYW_TCD_CUS_MAINTAIN	QTYW single role - create, maintain and delete customizing
Y_QTYW_TCD_SAP_BUS_OBJ_DIS...	QTYW single role - display business objects of SAP
Y_QTYW_TCD_SAP_CUS_MAINTAIN	QTYW single role - create, maintain and delete customizing of SAP
Y_QTYW_TEST_EXECUTE	QTYW single role - execute test programs
Y_QTYW_TEST_MAINT_LOGS	QTYW single role - maintain the scenario log database
Y_QTYW_TEST_MAINT_SCENARIOS	QTYW single role - Crate, change and delete test scenarios
Y_QTYW_TEST_MAINT_SNAPSHOTS	QTYW single role - maintain the scenario snapshot database

These single roles encompass all Petroleum and Gas Measurement capabilities for which a user may be granted authority.



No additional QuantityWare authority check is performed during actual quantity conversion calculations in business transactions - all QuantityWare implementations are ABAP based calculations which are already secured via the standard SAP-suggested security concepts implemented in these transactions

3 composite roles are delivered as examples:

Role Name (2) 3 Entries found	
Single Roles	Composite Roles
Y_QTYW_CERTIFIED_CONSULTANT	QTYW composite role - Certified BCS Consultant
Y_QTYW_EXPERT_BUSINESS_USER	QTYW composite role - Expert Business User
Y_QTYW_MEASUREMENT_SPECIALIST	QTYW composite role - Measurement Specialist

All roles are documented and accessible via standard SAP role maintenance. Role Y_QTYW_CERTIFIED_CONSULTANT must be assigned to the user ID which is used to run the QuantityWare implementation and installation test in client 045.

11. BCG - Protection of Intellectual Property

With QuantityWare BCS, QuantityWare delivers a powerful and unique quantity conversion solution to the oil & gas industries. Technically, the solution is delivered as a certified SAP Add-On to the Oil & Gas solution. To enhance customer security and protect QuantityWare GmbH's intellectual property (IP), three protection measures have been defined as an integral part of the technical ABAP solution:

Every BCS customer requires a valid software license key to execute quantity conversions. The license key is checked each time a quantity conversion is triggered

The ABAP source code that implements the license check logic, the QuantityWare MQCI and all central ABAP implementations of CTPL / CTPG standards are technically defined – using standard SAP methods – to be SAP system programs and thus cannot be debugged

All code comments marked internally with */ and empty lines are removed from all BCS ABAP sources before BCS shipment.

Measurement standards can be divided into four major classes:

- Standards defining the conversion factors between units of measure “of the same kind”
- Standards defining the corrections of the effect of temperature and pressure onto the liquid or gas (CTPL / CTPG)
- Standards defining the mass to weight conversions
- Standards defining the quantity conversion calculation model

Since CTPL / CTPG standards are the most complex to implement and on the other hand, once correctly implemented, do not require any code changes, all such implementations cannot be debugged in customer systems. The functional accuracy and correctness of such implementations is validated via dedicated installation test programs (based on implementation tests defined in the related measurement standards) and list printing reports (accessible via the PMC or GMC) and can be reproduced and tested by each customer without having to debug the ABAP source code. Software license installation is documented in the BCS Technical Installation Guide.



If required, it is still possible to debug SAP QCI or MQCI calculation model steps for any conversion group in customer systems, since the CTPL implementation results (typically calculating a base density or CTPL factor) can be accepted as being correct during debugging and can be validated independently (using the validation procedures described above which are available in the PMC and GMC)

12. Abbreviations

In this section, we provide a list of abbreviations used in the BCG documentation documents. For detailed explanations of the terms, refer to the individual BCG documentation documents:

ABNT Associação Brasileira de Normas Técnicas (Brazilian National Standards Organization)

AGA American Gas Association

API (1) American Petroleum Institute

API (2) SAP commercial key for API gravity unit

ASTM ASTM International (originally, "American Society for Testing and Materials")

BAdI Business Add In (SAP term)

BCG Bulk Calculations - Gas

BCP Bulk Calculations – Petroleum

BCS Bulk Calculations Solution

BCU Base Conversion Unit

BTI BaTch Input (SAP term)

CSP Component Support Package

CTG Compliance & Transparency - Gas

CTP Compliance & Transparency – Petroleum

CTPL Correction factor for the effects of Temperature and Pressure on the Liquid

CTPG Correction factor for the effects of Temperature and Pressure on the Gas

DIN Deutsches Institut für Normung e.V.

GERG	Groupe Européen de Recherches Gazières
GMC	Gas Measurement Cockpit
GOST	Gossudarstwenny Standard – Russian standard organization
GPA	Gas Processors Association
GRC	Governance, Risk management & Control
HPM	Hydrocarbon Product Management (SAP term)
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MQCI	Model based Quantity Conversion Interface
MPMS	Manual of Petroleum Measurement Standards (API term)
NGL	Natural Gas Liquids
NIST	National Institute of Standards and Technology
PAIG	Project Assessment and Implementation Guidelines
PMC	Petroleum Measurement Cockpit
QCI	Quantity Conversion Interface (SAP term)

ROI Return On Investment

SI Système International d'unités

TD Transportation and Distribution (SAP term)

TSW Traders and Schedulers Workbench (SAP term)

UoM Unit of Measure or Unit of Measurement

VCF Volume Correction Factor

13. BCG - Documentation Rules



The decimal point and thousand separators for numbers and quantity values for BCG documentation documents are defined as follows: The decimal point is a dot '.', the thousand separator is a comma or a space: ',' or ' '. Example: 123,456.987 or 123 456.789. Owing to the definition of business-relevant scenarios in our systems, numbers in screen prints may display differing formats.



For unit of measure symbols and spelling of unit names, NIST special publication 811 (latest version) is relevant – see the document “BCG Supported Standards Manual” for details

14. BCG - Basic System Settings

To use the SAP QCI conversion groups delivered with the BCG template in client 045, you must activate the SAP basic natural gas conversion routines in customizing in your relevant clients beyond client 045:
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 activate the SAP natural gas routines. Now, productive usage of the SAP QCI with BCG for natural gas is possible.



QuantityWare MQCI conversion groups do not require this activation.

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