QuantityWare

Bulk Calculations - Gas
BCG 3.0

Supported Standards Manual

Lists the standards supported by BCG 3.0 at the time of document publication

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 Version
01	2017-05-26	IMPORTANT: Nomenclature changed to support additional SAP basis releases for BCS 3.0
01.1	2017-08-03	Updated GPA 2172 support
02	2017-11-10	S/4HANA 1709 validity confirmed; ISO 6578:2017 support added; AGA Report No. 8 - 2017 support added
02.1	2019-02-17	S/4HANA 1809 validity confirmed
02.2	2019-11-20	S/4HANA 1909 validity confirmed
03	2020-07-17	API MPMS 11.2.4 second edition support added – clarification when to use ISO 6578 for LPG / NGL added
04	2021-09-20	S/4HANA 2020 / 2020_EX validity confirmed - modern QW document style applied - 30A CSP02 / 30B CSP01 changes
05	2022-02-01	Support of API MPMS Chapter 11.2.5 – second edition
06	2022-07-06	Support of GPA 2172-19 & NIST hydrogen standard, editorial update
07	2023-11-01	30A CSP03 / 30B CSP02 changes and new ISO 6976 and GERG 2008 standard support
08	2024-01-09	AGA8 maximum available technical component range limits added
09	2024-01-26	AGA8 range extension option noted

Contents

1. Bulk Calculations Gas – List of Supported Standards

Natural gas bulk product quantity value calculations in an SAP Oil, Gas, & Energy system are defined by different types of standards that are all equally relevant and need to be considered for your quantity conversion configuration:

- Standards defining the calculation model
- Standards defining correction factors due to pressure and temperature on product volumes and energies
- Standards defining calculations of densities and heating values from composition including physical property data
- Standards defining the conversion factors between mass and weight (NGL/LPG only)
- Standards defining the conversion factors between UoM of one dimension
- Standards defining metering technologies

BCG provides implementation procedures and preconfigured conversion groups that are based on the standards listed in the following chapters.

1.1. Standards - Calculation Model

1. AGA Report No. 7
2. API MPMS Chapter 12
3. EN ISO 4267-2
4. DIN 51650-06
5. Business practice models for LNG & natural gas

Technically, the number of implemented calculation models is determined by the possible combinations of required standards from all three different types of standards described below. In addition, added complexity must be considered (e.g., for NGL and LNG vapor space calculations).

At time of document publication, QuantityWare BCG supports six main calculation models for NGL/LPG and two calculation models for natural gas and LNG.

1.2. Standards - Temperature & Pressure Corrections – CTPL - NGL/LPG

1. API MPMS Chapter 11.2.2(M)
2. API MPMS Chapter 11.2.4 – second edition - GPA 8217 - 2019
3. API MPMS Chapter 11.2.4 – first edition - GPA TP-27
4. API MPMS Chapter 11.2.5 – GPA 8117 – second edition
5. API MPMS Chapter 11.2.5 - GPA TP-15 – first edition
6. ISO 6578 Second edition 2017-10
7. ISO 6578 First edition 1991-12-01
8. QuantityWare extension of GPA TP-27 for 20 °C (and other base temperatures)
9. GPA TP-25
10. QuantityWare extension of GPA TP-25 for 15 °C and 60 °F

1.3. Standards - Temperature & Pressure Corrections – Gases

1. ISO 12213 (Part 1 to 3) Second edition 2006-11-15
2. ISO 20765-1:2005 (reviewed and confirmed 2021)
3. AGA Report No. 8 Part 1: "Thermodynamic Properties of Natural Gas and Related Gases – DETAIL and GROSS Equations of State" third Edition April 2017
4. AGA Report No. 8 Part 2: "Thermodynamic Properties of Natural Gas and Related Gases – GERG-2008 Equation of State" First Edition April 2017
5. 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
6. ISO 13443 First edition 1996-12-15 (reviewed and confirmed 2020)
7. GOST 30319.0/1/2/3 – 96: Natural Gas. Methods of Calculation of Physical Properties
8. J. Res. Natl. Inst. Stand. Technol. 113, 341-350 (2008) - Revised Standardized Equation for Hydrogen Gas Densities for Fuel Consumption Applications
9. SGERG-mod-H2 equation for natural gas / hydrogen mixtures

As stated in the research paper from the DVGW: "Calculation of Compression Factors and Gas Law Deviation Factors Using the Modified SGERG-Equation SGERG-mod-H2" ..."The AGA8 equation and the GERG-2008 equation generally agree better than ± 0.1% for the measured values for all data sets in the entire pressure range. It can thus be expected that these equations of state can be used for any desired H_2 fractions without significantly affecting the underlying 0.1% uncertainty of the equations."

1.4. Standards - Calculation of Densities and Heating Values from Composition

1. ISO 6976 Third edition 2016[1]
2. ISO 6976 Second edition 1995, including Corrigendum 1 to 3
3. ISO 6578 Second edition 2017
4. ISO 6578 First edition 1991
5. GOST 22667-82 (incl. revision 1,1993)
6. GPA 8173-94
7. ASTM D4784 – revised Klosek and McKinley Model
8. GPA 2172-96 / API MPMS Chapter 14.5 - dry natural gas

[1] ISO 6976 Third edition 2016-08-15 "Natural gas – Calculation of calorific values, density, relative density and Wobbe indices from composition" – New components n-dodecane, n-tridecane, n-tetradecane, n-pentadecane not yet included in BCG 3.0 – Inferior Wobbe index requires customer specific parameter configuration – see Appendix B.4 for details

9. GPA 2172-09 / API MPMS Chapter 14.5 - dry natural gas
10. GPA 2172-14 / API MPMS Chapter 14.5 - dry natural gas
11. GPA 2172-19 / API MMS Chapter 14.5 – dry natural gas
12. GPA Standard 2145-03 Rev.2
13. GPA Standard 2145-09
14. GPA Standard 2145-16

1.5. Standards - Conversion Factors Between Mass and Weight – NGL/LPG

1. ASTM D1250-08 – API MPMS Chapter 11.5
2. ASTM D1250-80 - Tables 8, 26, 56
3. DIN 51757-94(11)

1.6. Standards - UoM Conversion Factors

1. API MPMS Chapter 15 – Guidelines for the Use of the International System of Units (SI) in the Petroleum and Allied Industries
2. API MPMS Chapter 11.5 – Appendix D - ASTM D1250-08(13)e1
3. Petroleum Measurement Tables Volume XI/XII - ASTM D1250-80: Table 1
4. IEEE/ASTM SI 10TM – American National Standard for the Use of the International System of Units (SI): The Modern Metric System (2002)
5. NIST – Guide for the Use of the International System of Units (SI) - Special Publication 811 – 2008
6. BIPM – Le Système international d'unités (SI) – 2006

1.7. Standards - Metering Technologies & Terminology

1. "Orifice Metering of Natural Gas and other related Hydrocarbon Gases", AGA Report No. 3, Third Edition, October 1990, API MPMS Chapter 14.3, GPA 8185-90.
2. AGA Report No. 7 – Measurement of Natural Gas by Turbine Meters
3. ISO 6974 First edition – 1984-10-15: Normalization calculations
1. GPA 1167-83
2. ISO/DIS 14532
3. Terminology defined in standards listed above

For all standard implementations of all types defined above and the complete software integration layer, QuantityWare has defined an automated installation test – see Appendix D for details.

BCG conversion groups that are based on the standards listed above are designed for **dry** natural gas, LNG and NGL. Read QuantityWare note 000059 for additional details concerning wet gas conversions.

Appendix A. Physical Property Range Limits

A.1. Natural Gas – Low and High Pressure

A.1.1. Temperature & pressure limits ISO 13443:

The pressure range for reference condition conversions defined in this standard is:

95 kPa < p < 105 kPa (13.78 psi < p < 15.23 psi)

The temperature range for reference condition conversions defined in this standard is:

270 K < T < 300 K (26°F < T < 80 °F)

A.1.2. Parameter limit - guidelines ISO 6976:

N_2 should not be present in amounts exceeding 0.3 mole fraction.

CO_2 and C_2H_6 should each not exceed 0.15 mole fraction.

No other component (other than methane) should exceed 0.05 mole fraction.

A.1.3. Ranges of application ISO 12213-3:

Pipeline quality gas:

- absolute pressure: 0 MPa to 12 MPa
- temperature: 263 K to 338 K
- mole fraction of carbon dioxide: 0 to 0.20
- mole fraction of hydrogen: 0 to 0.10
- superior calorific value: 30 MJ/m³ to 45 MJ/m³
- relative density: 0.55 to 0.80

The mole fraction of other components is not required as input but shall lie within the ranges defined as well in ISO 12213. A set of wider ranges is also given in ISO 12213-3.

A.1.4. Ranges of application ISO 12213-2:

Pipeline quality gas:

- absolute pressure: 0 MPA to 12 MPa (up to 65 MPa)
- temperature: 263 K to 338 K (225 K to 350 K)
- superior calorific value: 30 MJ/m³ to 45 MJ/m³
- relative density: 0.55 to 0.80
- mole fraction of methane: 0.7 to 1.00 (0.0 to 1.00) [0.0 to 1.0]
- mole fraction of nitrogen: 0 to 0.20 (0.0 to 0.5) [0.0 to 1.0]
- mole fraction of carbon dioxide: 0 to 0.20 (0.0 to 0.3) [0.0 to 1.0]
- mole fraction of hydrogen sulfide: [0.0 to 1.0]
- mole fraction of ethane: 0 to 0.10 (0.0 to 0.3) [0.0 to 1.0]
- mole fraction of propane: 0 to 0.035 (0.0 to 0.05) [0.0 to 0.12]
- mole fraction of butanes: 0 to 0.015 [0.0 to 0.6]
- mole fraction of pentanes: 0 to 0.005 [0.0 to 0.04]
- mole fraction of hexanes: 0 to 0.001 [0.0 to 0.10]
- mole fraction of heptanes: 0 to 0.0005 [0.0 to 0.10]
- mole fraction of octanes plus higher hydrocarbons: 0 to 0.0005 [0.0 to 0.10]
- mole fraction of hydrogen: 0 to 0.10 [0.0 to 1.0]
- mole fraction of oxygen: [0.0 to 0.21]
- mole fraction of carbon monoxide: 0 to 0.03 [0.0 to 0.03]
- mole fraction of helium: 0 to 0.005 [0.0 to 0.03]
- mole fraction of argon: [0.0 to 1.0]
- mole fraction of water: 0 to 0.00015 [0.0 to 0.10]

Wider ranges in round brackets ( ) as given in ISO 12213-2. Values in square brackets [ ] are the technically implemented maximum possible ranges as given in other AGA8 implementations (C-code) and thus also QuantityWare BCG, where the uncertainty of the result may exceed the uncertainty given in ISO 12213-2. Read the natural gas – hydrogen mixtures FAQ for supported hydrogen fractions. Range

extensions for conversion groups may be set for AGA Report No. 8 Part 1 implementations such that no component limit check is executed. AGA Report No. 8 Part 2 (GERG 2008 implementation) allows 100% mol for all supported components.

A.2. LPG and NGL

1. Should be calculated using API MPMS 11.2.4. This standard is implemented in BCG 3.0. The preceding standard, GPA TP-25, has been superseded by API MPMS 11.2.4 – second edition.
2. If an LPG/LNG product **contains 20% or more of unsaturated hydrocarbons**, the density shall be calculated given one of the methods in ISO 6578. ISO 6578 is implemented in BCG 3.0.
3. If the sale of product or the calculation of densities and quantity conversion takes place in Germany, use the X method defined in DIN 51757 and calculation procedures defined in DIN51650. This standard is implemented in BCP 3.0.

A.3. LNG

A.3.1. ISO 6578:1991(E)

Temperature range: -180 °C to -140 °C Molecular mass: 16 to 30 kg/mol
Allowed components:

- Methane
- Ethane
- Propane
- n-Butane
- i-Butane
- n-Pentane
- i-Pentane
- n-Hexane
- Nitrogen
- Oxygen

QuantityWare also supports data entry and checks of trace components (e.g. mercaptan and sulfur).

A.3.2. ISO 6578:2017(E)

Temperature range: 106 K to 118 K (approx. -167 °C to -155 °C)

Molecular mass: 16 to 20 kg/mol

Allowed components

- Methane
- Ethane
- Propane
- n-Butane
- i-Butane
- n-Pentane
- i-Pentane
- Nitrogen

QuantityWare also supports data entry and checks of trace components (e.g., mercaptan and sulfur).

Appendix B. Implementation Details - Selected Standards

B.1. AGA Report No. 3

The full title of this standard is

"Orifice Metering of natural gas and other related hydrocarbon fluids", AGA report no. 3, adjunct to API MPMS 14.3 & GPA 8185-90".

For natural gas flow rate measurements, the following definition (from AGA report no. 3) must be considered.

B.1.1. Orifice Meter:

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".

With QuantityWare BCG a complete set of calculation functions that implement AGA Report No. 3 orifice functions is delivered with function group /QTYW/AGA83 – function /QTYW/AGA3_ORIFICE. **Within your customer project, you may integrate this function into your metering developments (e.g., SAP TSW ticketing process) – no standard integration is delivered by QuantityWare BCG.**

B.2. ISO 6578

The full title of this standard is:

ISO 6578, first edition 1991-12-01: “Refrigerated hydrocarbon liquids – static measurement – Calculation procedure” – LNG part.

ISO 6578, second edition 2017-10: “Refrigerated hydrocarbon liquids – static measurement – Calculation procedure” – LNG part.

The revised Klosek and McKinley model defined in ISO 6578 is also described in:

ASTM D 4784-93 (Reapproved 2003): “Standard Specification for LNG Density Calculation Models”

The revised Klosek and McKinley Model is one of four available models and is widely used within the LNG processing industry. ISO 6578 is also relevant for refrigerated NGL/LPG density calculations as well as vapor corrections for NGL and LNG. All ISO 6578 calculations are supported with BCG for both NGL/LPG and LNG.

B.3. ISO 13443

The full title of this standard is:

ISO 13443 First edition 1996-12-15 “Natural gas ¬- Standard reference conditions” – last reviewed and confirmed 2020

Although ISO 13443 defines a temperature value of 15 °C (288.15 K) and a pressure value of 101.325 kPa as standard reference conditions for measurements and calculations for real dry gas (natural gases, natural-gas substitutes, similar fluids in the gaseous state), it is recognized that in certain circumstances it may be impracticable or even forbidden to use these ISO standard reference conditions (e.g. forced by national legislation or contractual obligations). Thus, conversion formulas are provided in ISO 13443 which enable values of properties (relating to any known other reference conditions) to be converted to values for the ISO standard reference conditions.

In addition to the formulas provided within ISO 13443, table values are provided as well. With BCG 3.0, you can define for a conversion group whether the formulas from ISO 13443 are utilized or the table values. Via the Gas Measurement Cockpit, you have access to list prints, test calculators and all configuration options. You may also define table values to convert between U.S. customary (°F, psi) and metric (°C, kPa) condition sets.

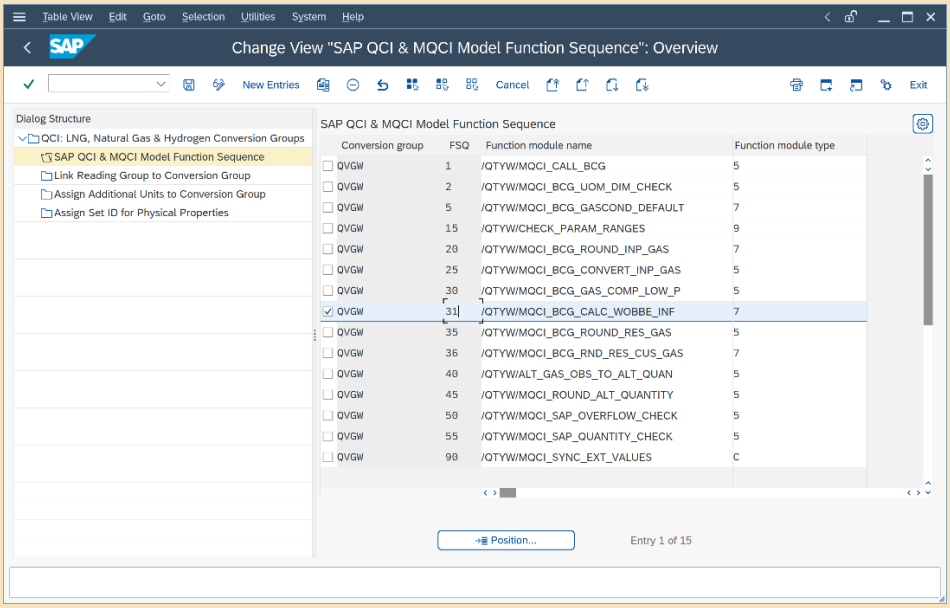
B.4. ISO 6976

The full title of this standard is:

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

ISO 6976 Third edition 2016-08-15 “Natural gas – Calculation of calorific values, density, relative density and Wobbe indices from composition” – New components n-dodecane, n-tridecane, n-tetradecane, n-pentadecane not yet included in BCG 3.0 – Inferior Wobbe index requires customer specific parameter:

The net/inferior Wobbe index may be calculated by plugging function /QTYW/MQCI_BCG_CALC_WOBBE_INF into an MQCI ISO 6976(2016) conversion group in combination with a customer result parameter. This is demonstrated via template conversion group QVGW:



B.5. GPA 2172

The full title of this standard is:

"Calculation of Gross Heating Value, Relative Density, Compressibility and Theoretical Hydrocarbon Liquid Content for Natural Gas Mixtures For Custody Transfer" – GPA Standard 2172, API MPMS Chapter 14.5

Both ISO 6976 and GPA 2172 provide calculation definitions describing how to calculate physical properties based on a known molar composition. QuantityWare supports property calculations of dry natural gas for both standards via the conversion group concept.

B.6. ISO 12213

The full title of this standard is:

ISO 12213, Second edition 2006-11-15, "Calculation of compression factor"

This ISO standard covers AGA Report No. 8 and SGERG88 compression factor calculations, which are all supported by BCG.

B.7. GOST 30319

In GOST 30319.2-96," Natural Gas, Methods of Calculation of Physical Properties – Determination of Compressibility Coefficient" four methods are defined how to calculate the compressibility coefficient. These four methods are the AGA Report No. 8 – 92DC method, the GERG91 method (identical with the AGA Report No. 8 gross method 2), the NX 19modified method, and the VNIC SMV method. QuantityWare provides implementations and configuration data for all four methods.

Appendix C. CPL Standard Integration – NGL/LPG

QuantityWare BCG, supports CPL correction factor calculations for NGL/LPG. The following two standards define NGL/LPG CPL calculations:

1. API MPMS Chapter 11.2.2(M) – NGL/LPG
2. API MPMS Chapter 11.2.5 – GPA 8117 – second edition – NGL/LPG

Due to technical restrictions within the SAP QCI calculation logic, **support of CPL calculations is only possible and thus provided for MQCI conversion groups**, in conjunction with the appropriate CTL standard.

1. If static tank vapor space calculations are applied, no CPL correction is applied.
2. The CPL calculation introduces the material/observed pressure and allows calculation of a CTPL to correct observed volumes (or transaction - observed and standard -volumes only).
3. Test density values are not corrected and are assumed to be either available at base conditions or to require temperature corrections only.

For the following NGL/LPG MQCI CTL standards the CPL calculation is supported:

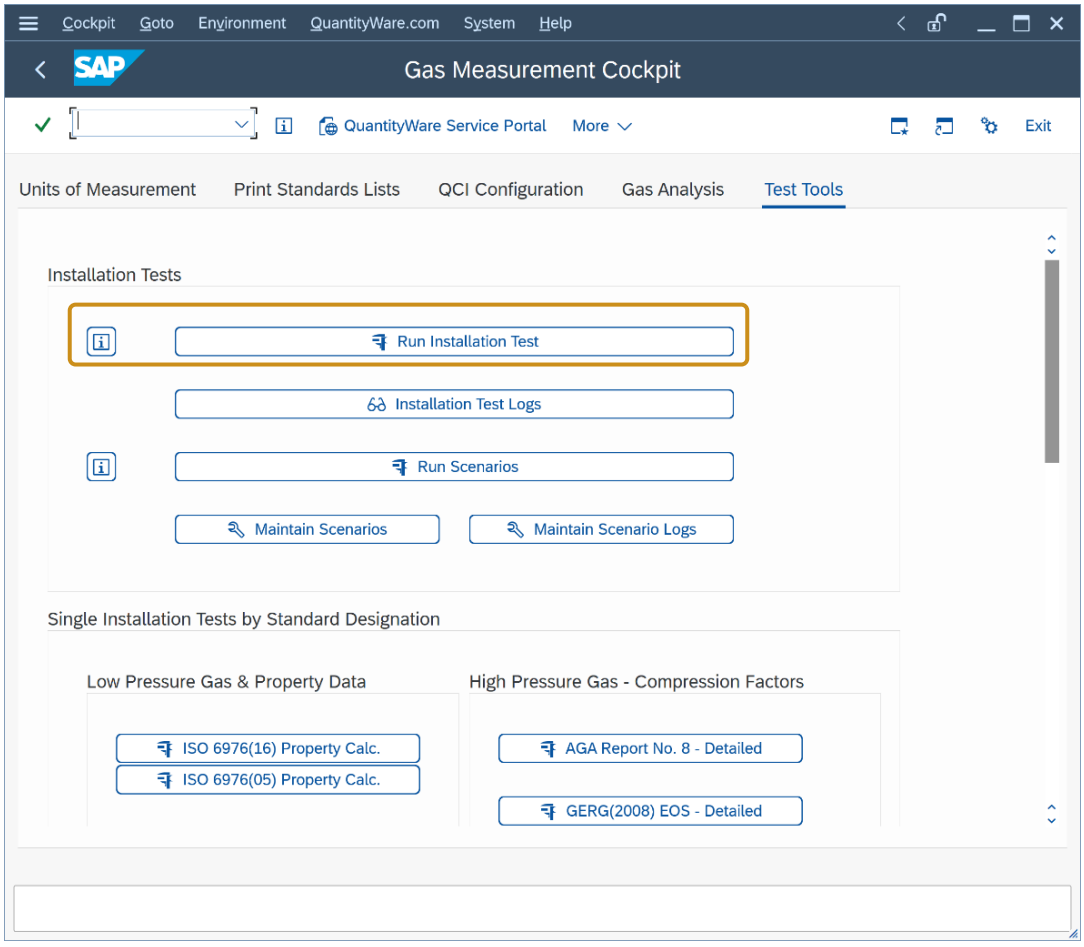
- API MPMS Chapter 11.2.4
- ISO 6578

Appendix D. Supported Standards – Installation Tests

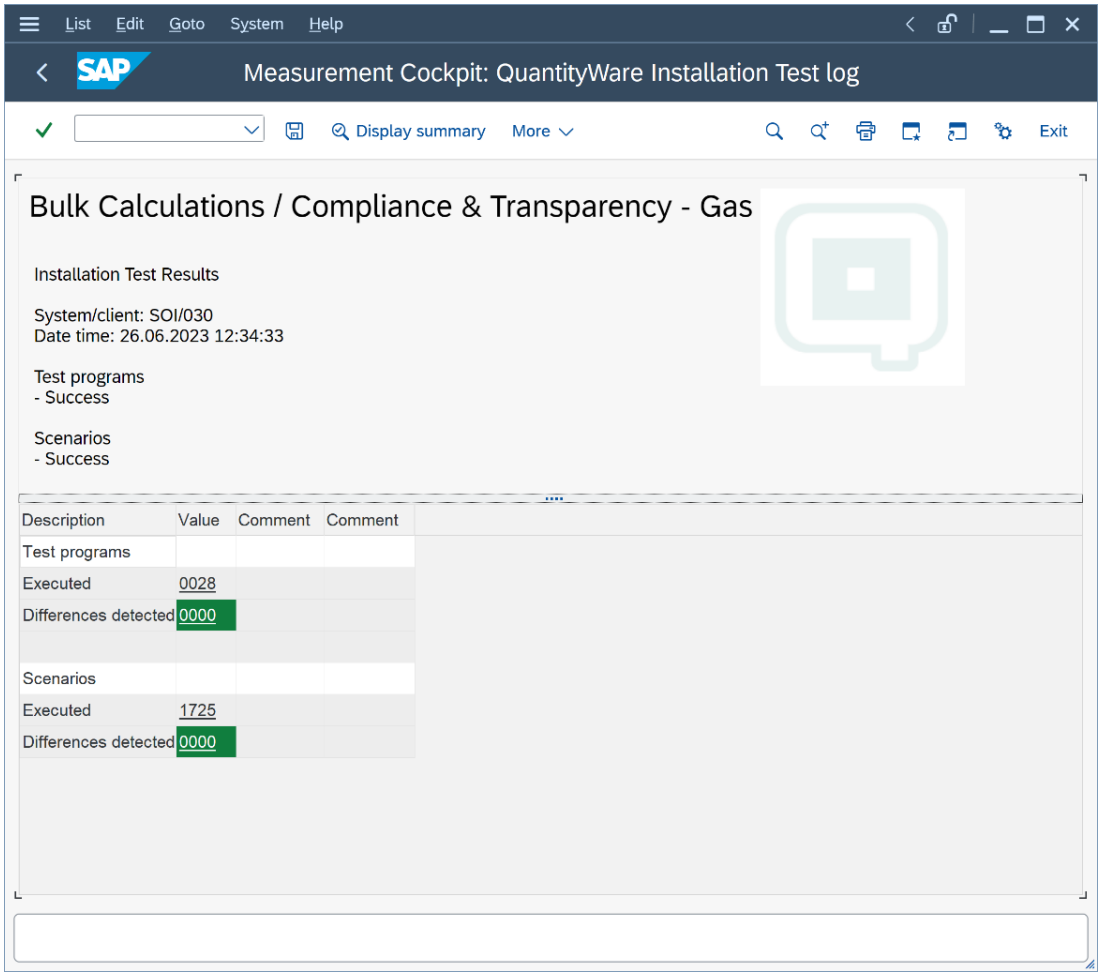
The Gas Measurement Cockpit (GMC) allows easy identification of QuantityWare BCG template conversion groups according to the assigned measurement standards. For all standard implementations, QuantityWare delivers an individual installation test. Each test is implemented as a SAP test report, which typically executes one test case. The BCG installation test is the sum of:

- All individual installation tests
- Additional integration test reports
- 1 725 Test scenarios

The BCG installation test is executed with **one_click** from the GMC and is to be performed **only** in the QuantityWare template client 045, in **one** dedicated system in your system landscape. Execution of the installation test is started while logged on to the BCG template client (045), where you simply click on "Run Installation Test" in tab strip "Test Tools" of the GMC:

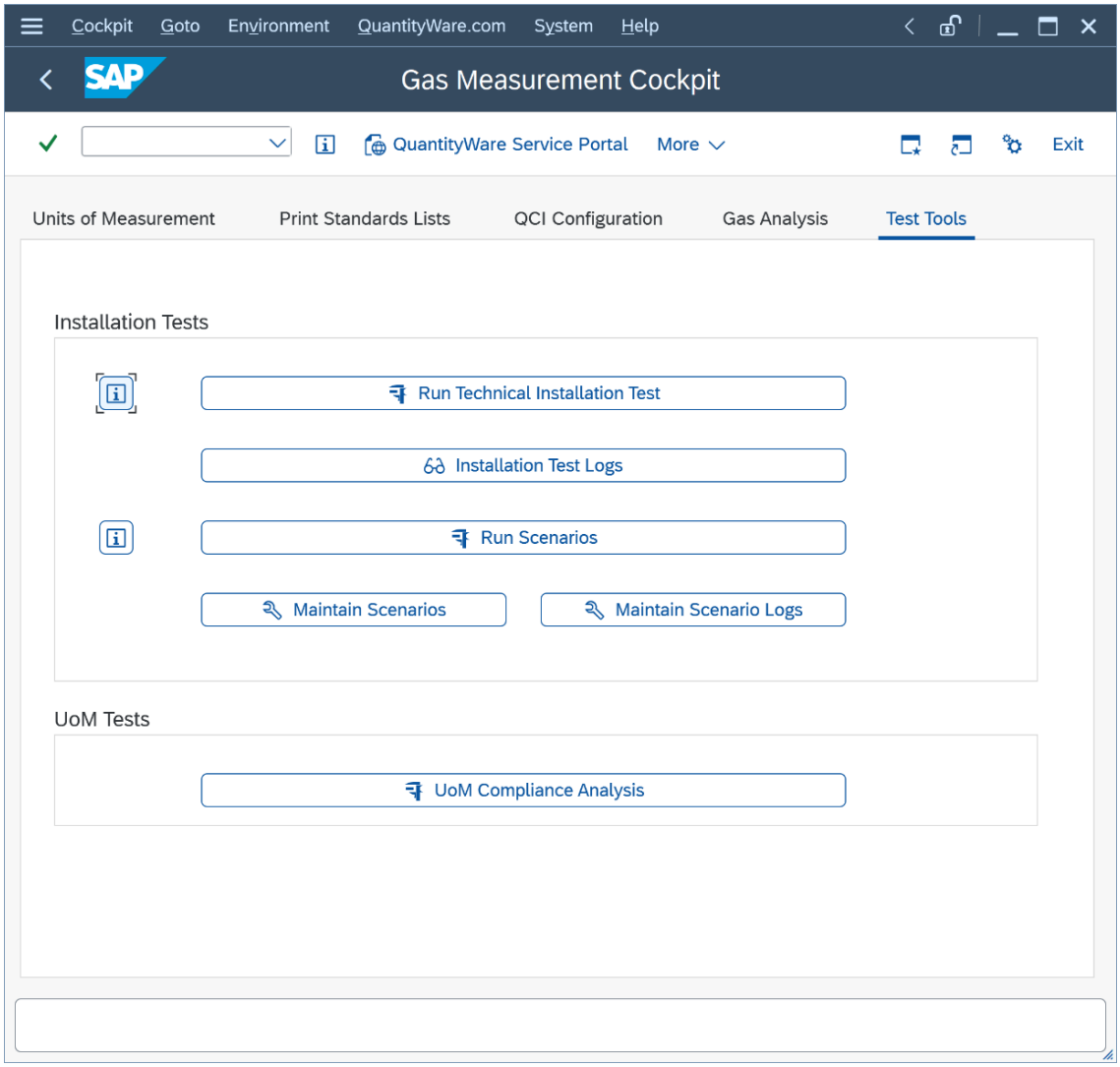


If the test is executed successfully, you see the following result list:



If you want to execute a single test for a specific standard, you can access all tests from this list. All tests are designed in the same way to ensure seamless control of the tests by measurement experts.

If you log on to a client where the QuantityWare BC set has not been activated, you will not have access to the full set of installation tests via the Gas Measurement Cockpit - without the configuration template delivered with the BC set, the technical installation test is available.



More details can be found in the BCG Documentation Reference Manual.

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