Software Applications

FLOCALC^{TM} Calculation Details

Abstract

This document contains the calculation details for working with the KELTON™ Standard Calculation Package (FLOCALC)

Contents

1.0 Revision Control

Rev	Issue date	Description	Prep.	App.
1	12/10/2016	Issued	JON	MH
1.1	20/11/2017	Reformatted	KW	JON
1.2	20/04/2018	Updated	KW	JS
1.3	10/09/2018	Updated in accordance with Brand Guidelines	KW	JON
1.4	30/10/2019	Updated to include new Modules	PK	JON
1.5	23/09/2020	Updated to include new Module	PK	KW
1.6	28/04/2021	Updated to include new calculation	PK	JON

2.0 Calculations by Associated Standards

Standard	Name	Calculation Numbers(s)	Year Published
AGA Report No. 3	Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids	F034, F074, F098	1992, 2012
AGA Report No. 5	Natural Gas Energy Measurement	F087	2009
AGA Report No. 7	Measurement of Natural Gas by Turbine Meters	F088	2006
AGA Report No. 8	Compressibility Factors of Natural Gas and Other Related Hydrocarbon Gases	F013, F014, F063, F318	1985, 1994, 2017
AGA Report No. 9	Measurement of Gas by Multipath Ultrasonic Meters	F089	2007
AGA Report No. 10	Speed of Sound in Natural Gas and Other Related Hydrocarbon Gases	F093	2003
API MPMS - Chapter 11.1	Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils	F060, F092	2004
API MPMS - Chapter 11.1	Volume correction factors - Volume X - Background, Development and Program Documentation	F023	1980
API MPMS - Chapter 11.2.1	Compressibility Factors for Hydrocarbons: 638-1074 Kilograms per Cubic Meter Range	F023, F028, F091	1984
API MPMS - Chapter 11.2.2	Compressibility Factors for Hydrocarbons: 350-637 Kilograms per Cubic Meter Density (15°C) and -46°C to 60°C Metering Temperature	F023, F028, F091, F092	1986
API MPMS - Chapter 11.2.4	Temperature Correction for the Volume of Light Hydrocarbons/LPG and NGL	F090, F091, F092	1998, 2007

Standard	Name	Calculation Numbers(s)	Year Published
API MPMS - Chapter 11.2.5	A Simplified Vapor Pressure Correlation for Commercial NGLs	F058	2007
API MPMS – Chapter 14.3	Concentric, Square-Edged Orifice Meters	F034, F074	1992
ASTM D1250	Petroleum Measurement Tables	F023, F028, F029, F060, F062, F073, F083, F084, F085, F086	1952, 1980, 2004
ASTM D1555	Standard Test Method for Calculation of Volume and Weight of Industrial Aromatic Hydrocarbons and Cyclohexane	F101	2009
ASTM D3588	Standard Practice for Calculating Heat Value, Compressibility Factor, and Relative Density of Gaseous Fuels	F067	1998
BS 1904	Specification for industrial platinum resistance thermometer sensors	F042	1984
BS EN ISO 3171	Petroleum liquids - Automatic pipeline sampling	F095	1999
BS 7577	Calculation procedures for static measurement of refrigerated light hydrocarbon fluids	F054	1992
BS EN 60751	Industrial platinum resistance thermometer sensors	F042	1996
GPA 2145	Table of Physical Constants for Hydrocarbons and Other Compounds of Interest to the Natural Gas Industry	F036, F049, F067	2000, 2003, 2009
GPA 2172	Calculation of Gross Heating Value, Relative Density, Compressibility and Theoretical Hydrocarbon Liquid Content for Natural Gas Mixtures for Custody Transfer	F038	2009
GPA TP-15	A Simplified Vapor Pressure Correlation for Commercial NGLs	F058	2007
GPA TP-25	Temperature Correction for the Volume of Light Hydrocarbons - Tables 24E and 23E	F091	1998
GPA TP-27	Temperature Correction for the Volume of NGL and LPG - Tables 23E, 24E, 53E, 54E, 59E, and 60E	F090, F092	2007
IP 200	Petroleum Measurement Tables	F023, F028, F029, F060, F062, F073,	1952, 1980, 2004

Standard	Name	Calculation Numbers(s)	Year Published
		F083, F084, F085, F086	
IP Paper No.2	Guidelines for Users of the Petroleum Measurement Tables	F022, F029	1984
IP Petroleum Measurement Manual - Part X	Meter Proving	F066	1989
IP Petroleum Measurement Manual - Part XII	Static and Dynamic Measurement of Light Hydrocarbon Liquids	F059, F105, F106	1998
ISO 3171	Petroleum liquids - Automatic pipeline sampling	F095	1988
ISO 5167	Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section closed conduits running full	F026, F032, F033, F037, F068, F069, F070, F075, F076, F079, F080, F099	1991, 1998, 2003, 2016
ISO 6578	Calculation procedures for static measurement of refrigerated light hydrocarbon fluids	F054	1991
ISO 6976	Natural Gas - Calculation of calorific value, density and relative density and Wobbe index	F001, F002, F003, F036, F049, F110	1983, 1995, 2016
ISO 8222	Petroleum measurement systems - Calibration - Temperature corrections for use when calibrating volumetric proving tanks	F097	2002
BS EN 60751	Industrial platinum resistance thermometer sensors	F042	1996
GPA 2145	Table of Physical Constants for Hydrocarbons and Other Compounds of Interest to the Natural Gas Industry	F036, F049, F067	2000, 2003, 2009
ISO 12213	Natural gas – Calculation of compressor factor	F014	2006
ISO TR 9464	Guidelines for use of the ISO 5167	F037, F068, F069, F070, F075, F076, F080	1998, 2008
ISO TR 12748	Natural gas – Wet gas flow measurement in natural gas	F072	2015

3.0 Calculation by FLOCALC Reference Number

Calc. No.	Standard	Title	Calculation Description
F001	ISO 6976:1983	Calorific Value and Relative Density	Volumetric calorific values, standard density, relative density and Wobbe index from a gas composition. Results are calculated for the composition treated as both a real and an ideal gas, inferior (net) and superior (gross) calorific value and Wobbe index are displayed in each case.
ISO 6976:1983 - Natural Gas - Calculation of calorific value, density and relative density			
F002	ISO 6976:1989	Calorific Value and Relative Density	Calorific values, standard density, relative density and Wobbe index from a gas composition. Results are calculated for the composition treated as both a real and an ideal gas, inferior (net) and superior (gross) calorific value and Wobbe index are displayed in each case.
ISO 6976:1989 draft - Natural Gas - Calculation of calorific value, density and relative density			
F003	ISO 6976:1995	Calorific Value and Relative Density	Calorific values, standard density, relative density and Wobbe index from a gas composition. Results are calculated for the composition treated as both a real and an ideal gas, inferior (net) and superior (gross) calorific value and Wobbe index are displayed in each case.
ISO 6976:1995 - Natural Gas - Calculation of calorific value, density and relative density and Wobbe index			
F013	AGA 8:1985	Gas Density and Compressibility	The compressibility and density of a gas are calculated from its composition, temperature and pressure in accordance with the 'Detail Characterisation' method outlined in this standard. Results are displayed for both standard (user configurable) temperature and pressure and operating temperature and pressure.
AGA Report No.8 - Compressibility and Supercompressibility for Natural and Gas and Other Hydrocarbon Gases (1985)			
F014	AGA 8:1994	Gas Density and Compressibility	The compressibility and density of a gas are calculated from its composition, temperature and pressure in accordance with the 'Detail Characterisation' method outlined in this standard. Results are displayed for both standard (user configurable) temperature and pressure and operating temperature and pressure. This 1994 printing of the Second Edition 1992 achieves computational consistency with GPA 2172-94 and AGA 3 1992.
AGA Report No.8 - Compressibility Factors of Natural and Gas and Other Related Hydrocarbon Gases (1994), ISO 12213-2:2006 - Natural gas - Calculation of compression factor - Part 2: Calculation using molar composition analysis			

Calc. No.	Standard	Title	Calculation Description
F015		Orifice Plate Buckling Calculations	An orifice plate, when exposed to differential pressure, will always experience a degree of elastic deformation, in certain cases the elastic deformation can be augmented by plastic (permanent) deformation. The calculation calculates the differential pressure that would cause the plastic distortion of a simply supported orifice plate. In addition to this, flow measurement errors caused by the deformation of the orifice plate are estimated.
Effect of Plate Buckling on Orifice Meter Accuracy - P Jepson and R Chipchase, Journal Mechanical Engineering Science Vol. 17 No. 6 (1975) *Buckling and Eccentricity Effects on Orifice Metering Accuracy - R Norman, M S Rawat and P Jepson (1983)*			
F017		Solartron Appendix A Calculation	The 'Solartron Appendix A calibration considerations' calculated using this form reduce the effect of systematic errors associated with the density sensor, and also the non-ideal behaviour of gasses.
Solartron 3098 Specific Gravity Transducer Technical Manual			
F018		Pressure Calculation - Absolute and Gauge	Determine the pressure generated by deadweight testers, pressure indicators and gauges. Pressure can either be calculated from first principals using mass and piston area or simply applying corrections to the nominal applied pressure. The calculation can also be reversed to calculate the mass required to generate a required pressure. Absolute pressure can be calculated for either using a deadweight tester in absolute mode or combining gauge pressure with barometric pressure.
F022	IP Paper 2	Density Referral	To 'convert' density values between standard conditions and operating conditions by applying a correction for the change in temperature (Ctl) and pressure (Cpl). Cpl is calculated using the methods outlined in IP Paper 2 and Ctl using the API equations from which the appropriate product group can be selected. The option is given to either perform the calculation following the rounding/truncation algorithms outlined in the standard or to use full precision.
IP Petroleum Measurement Paper No.2/ IP 200/ ASTM D1250 - Guidelines for Users of the Petroleum Measurement Tables			
F023		API Density Referral 1980-86	To 'convert' density values between standard conditions and operating conditions by applying a correction for the change in temperature (Ctl) and pressure (Cpl). Cpl is calculated using the methods outlined in the petroleum measurement standards and Ctl using the API equations from which the appropriate product

Calc. No.	Standard	Title	Calculation Description
			group can be selected. The option is given to either perform the calculation following the rounding/truncation algorithms outlined in the standard or to use full precision.
ASTM D1250-80 / IP 200/80 / API Manual of Petroleum Measurement Standards Chapter 11.1 - Volume correction factors - Volume X - Background, Development and Program Documentation (1980), API Manual of Petroleum Measurement Standards - Chapter 11.2.1 - Compressibility Factors for Hydrocarbons: 638-1074 Kilograms per Cubic Meter Range (1984), API Manual of Petroleum Measurement Standards - Chapter 11.2.2 - Compressibility Factors for Hydrocarbons: 350-637 Kilograms per Cubic Meter Density (15°) and -46°C to 60°C Metering Temperature (1986)			
F025		Local Gravity Calculation	The local value of gravitation acceleration for a geographical location can be estimated from the latitude and height above sea level. The calculation provides a choice of three accepted formulae for determining this value. In addition to this the option is given to calculate for an offshore or an onshore location which takes applies an additional correction for the density of the rock base.
References: The Geodetic Reference System 1967, The new gravity system - changes in international gravity base values and anomaly values - Woollard G.P. (1979), WGS84 - IAG Developed Geodetic Reference System 1980, leading to World Geodetic Reference System (1984)			
F028	API/Table 54	Density Referral	The calculation 'converts' density values between standard conditions and operating conditions by applying a correction for the change in temperature (Ctl) and pressure (Cpl). Cpl is calculated using the methods outlined in the petroleum measurement standards and Ctl using the petroleum measurement tabled for light hydrocarbons (Table 53/54). The option is given to either perform the calculation following the rounding/truncation algorithms outlined in the standard or to use full precision.
References: ASTM D1250, IP 200 - Report on the Development, Construction, Calculation, and Preparation of the ASTM-IP Petroleum Measurement Tables (1960), API Manual of Petroleum Measurement Standards - Chapter 11.2.1 - Compressibility Factors for Hydrocarbons: 638-1074 Kilograms per Cubic Meter Range (1984), API Manual of Petroleum Measurement Standards - Chapter 11.2.2 - Compressibility Factors for Hydrocarbons: 350-637 Kilograms per Cubic Meter Density (15°) and -46°C to 60°C Metering Temperature (1986)			
F029	IP Paper 2/Table 54	Density Referral	The calculation 'converts' density values between standard conditions and operating conditions by applying a correction for the change in temperature (Ctl) and pressure (Cpl). Cpl is calculated using the methods outlined in IP Paper 2 and Ctl using the petroleum measurement tabled for light hydrocarbons (Table 53/54). The option is given to either perform the calculation following the rounding/truncation algorithms outlined in the standard or to use full precision.
References: IP Petroleum Measurement Paper No.2/ IP 200/ ASTM D1250 - Guidelines for Users of the Petroleum Measurement Tables, ASTM D1250, IP 200 - ASTM-IP Petroleum Measurements Tables - Metric Edition (1952), ASTM D1250, IP 200 - Report on the Development, Construction, Calculation, and Preparation of the ASTM-IP Petroleum Measurement Tables (1960)			

Calc. No.	Standard	Title	Calculation Description
F032	ISO 5167:1991	Wet Gas Venturi (Murdoch)	The calculation is based on the ISO 5167 standard to calculate mass flow rate through a Venturi tube or nozzle extended to include the Dickenson/Jamieson variant of the Murdock correction. The wet gas (saturated) flow rate is calculated along with the flow rate for each phase of the fluid.
References: ISO 5167-1:1991 - Measurement of fluid low by means of pressure differential devices - Part 1: Orifice plates, nozzles and Venturi tubes inserted in circular cross-section conduits running full			
F033	ISO 5167:1991	Wet Gas Venturi (Chisholm/De Leeuw)	The calculation is based on the ISO 5167 standard to calculate mass flow rate through a Venturi tube or nozzle extended to include the Chisholm De Leeuw wet gas correction. The wet gas (saturated) flow rate is calculated along with the flow rate for each phase of the fluid.
ISO 5167-1:1991 - Measurement of fluid low by means of pressure differential devices - Part 1: Orifice plates, nozzles and Venturi tubes inserted in circular cross-section conduits running full			
F034	API MPMS Ch.14:1992	Gas Volume Flowrate (Factors Approach Method)	The calculation calculates the volumetric flow rate of natural gas at standard conditions using the 'Factors Approach' method outlined in the Manual of Petroleum Measurement Standards Chapter 14 Section 3. Appendix 3-B.
AGA Report No.3 - Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids: Part 3 Natural Gas Applications (1992), API Manual of Petroleum Measurement Standards - Chapter 14 - Natural Gas Fluids Measurement - Section 3 Concentric, Square-Edged Orifice Meters: Part 3 Natural Gas Applications (1992)			
F036	ISO 6976/GPA 2145:2000	Calorific Value, Relative Density	The calculation calculates calorific values, standard density, relative density and Wobbe index from a gas composition. Results are calculated for the composition treated as both a real and an ideal gas, inferior (net) and superior (gross) calorific value and Wobbe index are displayed in each case. This version of the standard uses the gas properties given in the GPA 2145:2000 tables.
ISO 6976:1995 - Natural Gas - Calculation of calorific value, density and relative density, GPA 2145:2000 - Table of Physical Constants for Hydrocarbons and Other Compounds of Interest to the Natural Gas Industry			
F037	ISO 5167:2003	Upstream Density Calculation	The calculation corrects density from downstream to upstream conditions for an orifice meter. Options include calculating the density exponent from the isentropic exponent or using the isenthalpic method outlined in 'Implementation of ISO 5167:2003 at Gas Terminals for Sales Gas Metering Systems using Densitometers in the 'bypass' mode.' DTI March 2007.
ISO 5167-1:2003 - Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section closed conduits running full - Part 1: General principles and requirements, ISO/TR 9464:2008 - Guidelines for the use of ISO 5167:2003			
F038	GPA 2172/API	GHV, RD and Compressibility	The calculation uses the procedure for calculating heating value, specific gravity and

Calc. No.	Standard	Title	Calculation Description
	MPMS Ch. 14.5:2009		compressibility factor from the compositional analysis of a natural gas mixture.
GPA 2172-09 / API Manual of Petroleum Measurement Standard Chapter 14.5 - Calculation of Gross Heating Value, Relative Density, Compressibility and Theoretical Hydrocarbon Liquid Content for Natural Gas Mixtures for Custody Transfer (2009)			
Note:	See ASTM, F022, F029, F062, F083, F084, F085, F086		
F039		Instromet - Ultrasonic Meter Flowrate	The calculation calculates the volume flow rate, applying corrections for the elastic distortion of the ultrasonic meter spool due pressure and thermal expansion. Options are also given to apply a linearity correction to include data obtained by calibration and convert the calculated volume flow rate to mass and standard volume.
Instromet International - Temperature and pressure correction for ultrasonic gas flow meters			
F040		Peek (Sarasota) Densitometer Computation	Sarasota/Peek densitometers work on the principle that the natural frequency of the transducers vibrating element is affected by the density of the fluid in which it is submerged. The calculation calculates the density from the measured frequency and densitometer constants obtained from calibration. Options are given to apply corrections for temperature and pressure. An option to calculate the corrected time period for use during an air-check is also included.
Sarasota FD910, FD950 & FD960 Liquid Density Meters - User Guide			
F041		Pressure Calculation - High-line DP	The calculation determines the pressure generated by differential deadweight testers, pressure indicators and gauges. Differential pressure can either be calculated from first principals using mass and piston area (or Kn) or correcting the nominal applied pressure. The calculation can also be reversed to calculate the mass required to generate a required differential pressure.
NPL Report CMAM41 - Development of high-line differential pressure standards - M Hay and D Simpson (1999)			
F042	BS EN 60751:1996/ BS 1904	PRT Calculation	The calculation calculates the temperature from a resistance value or vice versa. The option is given to select either BS EN 60751 or the BS 1904 which it superseded.
BS EN 60751:1996 - Industrial platinum resistance thermometer sensors			
F043	CIPM:2007	Density of Moist Air	The calculation calculates the density of moist air from density pressure and relative humidity using the process outlined by R. S. Davis in metrologia 1992.
CIPM-2007 - Revised formula for the density of moist air - A Picard, R S Davis, M Glaser and K Fujii (2007)			
F047		Hydrocarbon Dew Point Calculation	The calculation calculates the dew point temperature from a composition at a given pressure or the cricondentherm from a

Calc. No.	Standard	Title	Calculation Description
			composition. The calculation can be run using a simple composition or a more complex extended composition which includes aromatics, cycloalkanes and sulphur compounds. The calculations can be performed using either the Peng-Robinson or the Redlich-KwongSoave equation of state.
ASTM DS 4B – Physical Constants of Hydrocarbon and Non-Hydrocarbon Compounds – 2nd Edition (1991), GPA TP-17 – Table of Physical Properties of Hydrocarbons for Extended Analysis of Natural Gases (1998), The Properties of Liquids and Gases - Poling, Prausnitz, O'Connell – 5th Edition (2001)			
F048		Daniel Ultrasonic Meter - Flowrate	The calculation calculates the volume flow rate, applying corrections for the elastic distortion of the ultrasonic meter spool due pressure and thermal expansion. Options are also given to apply a linearity correction to include data obtained by calibration and convert the calculated volume flow rate to mass and standard volume. In addition to this the flow velocity can be calculated from the transit times and geometry of the meter.
F049	ISO 6976/GPA 2145:2003	Calorific Value, Relative Density	The calculation calculates calorific values, standard density, relative density and Wobbe index from a gas composition. Results are calculated for the composition treated as both a real and an ideal gas, inferior (net) and superior (gross) calorific value and Wobbe index are displayed in each case. This version of the standard uses the gas properties given in the GPA 2145:2003 tables.
ISO 6976:1995 - Natural Gas - Calculation of calorific value, density and relative density, GPA 2145:2003 - Table of Physical Constants for Hydrocarbons and Other Compounds of Interest to the Natural Gas Industry			
F051	NX-19:1962	Gas Supercompressibility	The calculation calculates supercompressibility following the methods outlined PAR Research Project NX-19 published in December 1962 by Pipeline Research Council International. All four calculation methods are included; Specific gravity, analysis, methane and heating value method. The calculation will also calculate the volume correction factor and the line density.
PRCI - NX-19 - Manual for the Determination of Supercompressibility Factors for Natural Gas (1962)			
F052	AP09-600	Flow Rate Calculation (Compensation Method)	The calculation calculates the flow rate using a choice of algorithms commonly used by distributed control systems (DCS). The algorithms often referred to as 'simple square route extraction' differ from standard methods such as ISO 5167 in that they do not contain iterative routines.
Honeywell - Advanced Process Manager Control Functions and Algorithms - AP09-600			

Calc. No.	Standard	Title	Calculation Description
F054	ISO 6578:1991	Klosek-McKinley LNG Density Calculation	The calculation calculates the saturated liquid density of LNG mixtures from composition. The equation is valid at temperatures between -180°C and -140°C.
BS 7577:1992 / ISO 6578:1991 - Calculation procedures for static measurement of refrigerated light hydrocarbon fluids			
F056 -		Wagenbreth and Blanke - Water Density Calculation	The calculation calculates the density of water at a given temperature according to the formula published by Wagenbreth and Blanke.
Die Dichte des Wassers im Internationalen Einheitensystem und in der Internationalen Praktischen Temperaturskala von 1968 - H. Wagenbreth, W. Blanke			
F057		Steam Tables	The calculation calculates specific properties of water at temperature and pressure according to the IAPWS Industrial Formulation 1997 including specific volume, enthalpy, entropy, both isochoric and isobaric heat capacity, and speed of sound.
International Association for the Properties of Water and Steam - Revised Release on the IAPWS Industrial Formulation 1997 for the Thermodynamic Properties for Water and Steam (2007)			
F058	GPA TP-15:2007	Vapour Pressure Calculation for NGLs	The calculation uses the GPA Technical Publication TP-15 to calculate vapour pressure.
GPA TP-15/ API Manual of Petroleum Measurement Standards Chapter 11- Section 2 - Part 5 - A Simplified Vapor Pressure Correlation for Commercial NGLs			
F059		COSTALD-Tait Density Calculation	The calculation calculates the density of LNG and LPGs. This calculation comprises four distinct density calculation options. The "standard" COSTALD equation is used to calculate the saturated liquid density of light hydrocarbon mixtures (LPGs) from composition. The "enhanced" COSTALD equation is used to calculate the saturated liquid density of LNG mixtures (i.e. predominantly CH4). The Tait extension to the COSTALD equation (known as COSTALD-Tait) calculates the compressed liquid density of light hydrocarbon mixtures (i.e. density at pressures above the saturation pressure). The Tait extension applies to both the "standard" and "enhanced" COSTALD equations giving four options in total.
IP Petroleum Measurement Manual Part XII - Static and Dynamic Measurement of Light Hydrocarbon Liquids - Section 1: Calculation Procedures (1998)			
F060		API Density Referral 2004	The calculation 'converts' density values between standard conditions and operating conditions by applying a correction for the change in temperature (Ctl) and pressure (Cpl). In this standard both are calculated simultaneously and iteratively since the effects of temperature and pressure are coupled. This

Calc. No.	Standard	Title	Calculation Description
			calculation uses the API product groups to determine the density of the liquid.
ASTM D1250-04 / IP 200/04 / API Manual of Petroleum Measurement Standards Chapter 11 - Physical Properties Data - Section 1 - Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils (2004)			
F061		Gas Relative Density Calculation - Solartron	The calculation calculates the relative density from the Solartron RD transducer constants and the measured time period. The transducer constants can be calculated by entering the known relative densities of two calibration gases along with their corresponding measured time periods.
Solartron NT3096 Specific Gravity Transducer Technical Manual			
F062	ASTM-IP	Table 53:1952	The calculations determine the density at 15°C from an observed density at an observed temperature according to Table 53 from the ATSM-IP Petroleum Measurement Tables.
ASTM D1250, IP 200 - ASTM-IP Petroleum Measurements Tables - Metric Edition (1952), ASTM D1250, IP 200 - Report on the Development, Construction, Calculation, and Preparation of the ASTM-IP Petroleum Measurement Tables (1960)			
F063	AGA 8	Gross Characterisation Methods	The calculation calculates density and compressibility using the SGERG model as detailed in AGA Report No. 8. The calculation gives a choice between the 2 gross characterisation methods and of different reference conditions.
AGA Report No.8 - Compressibility Factors of Natural and Gas and Other Related Hydrocarbon Gases (1994)			
F065		Gas Density Computation PTZ	The calculation determines the density of a non-ideal gas at a given temperature and pressure from known values of pressure temperature and compressibility or molecular weight. Options include solving for either line density, standard density or relative density.
F066		Meter K-Factor Computation	The calculation calculates the K-Factor for a meter which has been 'proved' using either a pipe prover, compact prover or a master meter. Corrections are applied to compensate for changes in the geometry of the 'prover' and changes in the volume of the liquid caused by temperature and pressure. Where applicable these corrections may be calculated using a choice of industry and international standards.
IP Petroleum Measurement Manual Part X - Meter Proving (1989), IP Petroleum Measurement Paper No.2/ IP 200/ ASTM D1250 - Guidelines for Users of the Petroleum Measurement Tables *API Manual of Petroleum Measurement Standards - Chapter 11.2.1 - Compressibility Factors for Hydrocarbons: 638-1074 Kilograms per Cubic Meter Range (1984)* *API Manual of Petroleum Measurement Standards - Chapter 11.2.2 - Compressibility Factors for Hydrocarbons: 350-637 Kilograms per Cubic Meter Density (15°) and -46°C to 60°C Metering Temperature (1986)* *ASTM D1250-04 / IP 200/04 / API Manual of Petroleum Measurement Standards Chapter 11 - Physical Properties Data - Section 1 - Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils (2004)* *GPA TP-27/ API Manual of Petroleum Measurement Standards Chapter 11- Section 2 - Part 4 - Temperature Correction for the Volume of NGL and LPG - Tables 23E, 24E, 53E, 54E, 59E, and 60E*			

Calc. No.	Standard	Title	Calculation Description
F067	ASTM D3588/GPA 2145	Calorific Value and Relative Density	The calculation calculates calorific values, density and relative density from a gas composition. Results are calculated for the composition treated as both a real and an ideal gas, net and gross calorific value are displayed in each case. The option is also included to perform a correction for wet gas either by entering the mole fraction of water or by assuming a saturated gas and approximating water content using Raoult's law.
ASTM D3588 - Standard Practice for Calculating Heat Value, Compressibility Factor, and Relative Density of Gaseous Fuels (1998)			
F068	ISO 5167:1991	Orifice Flow Calculation	The calculation follows the process outlined in the standard to calculate flow rate through an orifice meter. Density and temperature can be entered at up or downstream conditions to mimic the calculations performed by a flow computer and the calculation can iterate to solve for flow, differential pressure or orifice bore size. This version of the standard uses the Stoltz equation to calculate the discharge coefficient.
ISO 5167-1:1991 - Measurement of fluid low by means of pressure differential devices - Part 1: Orifice plates, nozzles and Venturi tubes inserted in circular cross-section conduits running full			
F069	ISO 5167: 1998 Amd 1	Orifice Flow Calculation	The calculation follows the process outlined in the standard to calculate mass flow rate through an orifice meter. Density and temperature can be entered at up or downstream conditions to mimic the calculations performed by a flow computer and the calculation can iterate to solve for flow, differential pressure or orifice bore size. This version of the standard uses the Reader-Harris/Gallagher equation to calculate the discharge coefficient.
ISO 5167-1:1991/Amd 1:1998 - Measurement of fluid low by means of pressure differential devices - Part 1: Orifice plates, nozzles and Venturi tubes inserted in circular cross-section conduits running full			
F070	ISO 5167: 2003	Orifice Flow Calculation	The calculation follows the process outlined in the standard to calculate flow rate through an orifice meter. The calculation can iterate to solve for flow, differential pressure or orifice bore size. This version of the calculation includes the option to calculate the upstream density using the isenthalpic method for densitometers in 'bypass' mode outlined in the 2007 DTI Paper on the implementation of ISO 5167.
ISO 5167-2:2003 - Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section closed conduits running full - Part 2: Orifice Plates			
FO71	ISO 1567	Orifice Plate Validation	The calculation checks the condition and geometry of an orifice plate meets the criteria laid out in the standard. The user can either

Calc. No.	Standard	Title	Calculation Description
			enter measurements taken directly from an Orifice Plate or independently validate an orifice plate certificate produced and issued by a calibration laboratory.
ISO 5167-1:1991 - Measurement of fluid low by means of pressure differential devices - Part 1: Orifice plates, nozzles and Venturi tubes inserted in circular cross-section conduits running full *ISO 5167-2:2003 - Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section closed conduits running full - Part 2: Orifice Plates*			
F072	ISO 5167/TR 12748	Wet Gas Orifice Flow Calculation	This follows the process outlined in the standard to calculate the corrected mass flow rate through an orifice meter encountering wet gas. Uncorrected gas mass flow rate is calculated according to ISO 5167-2:2003.
ISO 5167-2:2003 - Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section closed conduits running full - Part 2: Orifice Plates *ISO TR 12748:2015 - Natural Gas - Wet gas flow measurement in natural gas operations*			
F073	ASTM-IP	Table 54:1952	The calculation is used to determine the temperature correction factor for a crude oil from a standard density at 15°C to an observed temperature according to Table 54 from the ATSM-IP Petroleum Measurement Tables.
ASTM D1250, IP 200 - ASTM-IP Petroleum Measurements Tables - American Edition (1952) *ASTM D1250, IP 200 - Report on the Development, Construction, Calculation, and Preparation of the ASTM-IP Petroleum Measurement Tables (1960)*			
F074	AGA 3	Orifice Flow Calculation 1992	The calculation uses the processes outlined in the American Gas Association standard to solve flow rate, differential pressure or orifice size through an orifice plate metering system.
AGA Report No.3 - Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids (1992) *API Manual of Petroleum Measurement Standards - Chapter 14 - Natural Gas Fluids Measurement - Section 3 Concentric, Square-Edged Orifice Meters (1992)*			
F075	ISO 5167	Venturi Flow Calculation	The calculation follows the process outlined in the standard to calculate flow rate through a Venturi tube or nozzle. The calculation can iterate to solve for flow, differential pressure or Venturi throat size.
ISO 5167-1:1991 - Measurement of fluid low by means of pressure differential devices - Part 1: Orifice plates, nozzles and Venturi tubes inserted in circular cross-section conduits running full			
F076	ISO 5167	2003 Venturi Flow Calculation	The calculation follows the process outlined in the standard to calculate flow rate through a Venturi tube or nozzle. The calculation can iterate to solve for flow, differential pressure or venturi throat size. This version of the calculation includes the option to calculate the upstream density using the isenthalpic method for densitometers in 'bypass' mode outlined in the 2007 DTI Paper on the implementation of ISO 5167.
ISO 5167-3:2003 - Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section closed conduits running full - Part 3: Nozzles and Venturi nozzles *ISO 5167-4:2003 - Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section closed conduits running full - Part 4: Venturi tubes*			

Calc. No.	Standard	Title	Calculation Description
F079	ISO 5167-5	Cone Calculations	The calculation can be set to solve for flow rate, differential pressure or cone diameter using the equations set out in the standard. To utilise calibration data the option is included to enter a characterisation curve showing the change in discharge coefficient with Reynolds number. The calculation can be set to solve for flow rate, differential pressure or cone diameter.
ISO 5167-5:2016 - Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full - Part 5: Cone meters			
F080	ISO 5167	McCrometer Cone Calculations	The calculation is an ISO 5167 flow rate calculation modified by McCrometer for the geometry and characteristics of their VCone meters. The calculation has options to use either the 2000 or 2005 version on the McCrometer calculation the latter of which contains a revised method of determining expansibility. To utilise calibration data the option is included to enter a characterisation curve showing the change in discharge coefficient with Reynolds number. The calculation can be set to solve for flow rate, differential pressure or cone diameter.
ISO 5167-1:2003 - Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full - Part 1: General principles and requirements *McCrometer 24509-5: Flow Calculations for the V-Cone and Wafer-Cone Flow meters* *McCrometer 24517-16: V-Cone Flow Meter Technical Brief*			
F081		Gas Densitometer Calculation – Micro Motion	Micro Motion densitometers work on the principle that the natural frequency of the transducers vibrating element is affected by the density of the fluid surrounding it. The calculation calculates the density from the measured frequency and densitometer constants obtained from calibration. Options are given to apply corrections for temperature and the velocity of sound, a further option is included to correct density from down to upstream conditions.
Micro Motion 7812 Gas Density Meter Technical Manual			
F082		Liquid Densitometer Calculation	Micro Motion densitometers work on the principle that the natural frequency of the transducers vibrating element is affected by the density of the fluid in which it is submerged. The calculation calculates the density from the measured frequency and densitometer constants obtained from calibration. Options are given to apply corrections to compensate for the temperature and pressure of the fluid. This

Calc. No.	Standard	Title	Calculation Description
			calculation also has the option to use revised pressure constants K20C and K21C and the temperature pressure coupling correction.
Micro Motion 7835/45/46/47 Liquid Density Meter Technical Manual			
F083	ASTM-IP	Table 5:1952	The calculation determines the API gravity at 60°F from API gravity at an observed temperature according to Table 5 from the ATSM-IP Petroleum Measurement Tables.
ASTM D1250, IP 200 - ASTM-IP Petroleum Measurements Tables - American Edition (1952) *ASTM D1250, IP 200 - Report on the Development, Construction, Calculation, and Preparation of the ASTM-IP Petroleum Measurement Tables (1960)*			
F084	ASTM-IP	Table 6:1952	The calculation determines the temperature correction factor for a crude oil from an API gravity at 60°F to an observed temperature according to Table 6 from the ATSM-IP Petroleum Measurement Tables.
ASTM D1250, IP 200 - ASTM-IP Petroleum Measurements Tables - American Edition (1952) *ASTM D1250, IP 200 - Report on the Development, Construction, Calculation, and Preparation of the ASTM-IP Petroleum Measurement Tables (1960)*			
F085	ASTM-IP	Table 23:1952	The calculation determines the specific gravity at 60°F from a specific gravity at an observed temperature according to Table 23 from the ATSM-IP Petroleum Measurement Tables.
ASTM D1250, IP 200 - ASTM-IP Petroleum Measurements Tables - American Edition (1952) *ASTM D1250, IP 200 - Report on the Development, Construction, Calculation, and Preparation of the ASTM-IP Petroleum Measurement Tables (1960)*			
F086	ASTM-IP	Table 24: 1952	The calculation determines the temperature correction factor for a crude oil from a specific gravity at 60°F to an observed temperature according to Table 24 from the ATSM-IP Petroleum Measurement Tables.
ASTM D1250, IP 200 - ASTM-IP Petroleum Measurements Tables - American Edition (1952) *ASTM D1250, IP 200 - Report on the Development, Construction, Calculation, and Preparation of the ASTM-IP Petroleum Measurement Tables (1960)*			
F087	AGA 5	2009 Natural Gas Energy Measurement	The calculation calculates calorific values, standard density, relative density and Wobbe index from a gas composition. Results are calculated for the composition treated as both a real and an ideal gas. Net and gross volumetric, molar and mass based calorific values are displayed in along with gas and air compressibility factors and Wobbe index. There is the option of calculating the calorific value from volumetric or molar based heating value data.
AGA Report No.5 - Natural Gas Energy Measurement (2009)			
F088	AGA 7	Turbine Meter Gas Flow Rate Calculation	The calculation uses Appendix B of AGA Report No. 7 to calculate volumetric and mass flow rates for gas flow through a turbine meter.
AGA Report No.7 - Measurement of Natural Gas by Turbine Meters (2006)			

Calc. No.	Standard	Title	Calculation Description
F089	AGA 9	Ultrasonic Meter Gas Flow Rate Calculation	The calculation calculates volumetric and mass flow rates for gas flow through an ultrasonic meter according to AGA Report No. 9.
AGA Report No.9 - Measurement of Gas by Multipath Ultrasonic Meters (2007			
F090	GPA-TP-27	2007-Temperature Correction for NGL and LPG	The calculation calculates the temperature correction factor for NGL and LPG's. This can then be used to obtain a density at standard or line conditions.
GPA TP-27 - Temperature Correction for the Volume of NGL and LPG - Tables 23E, 24E, 53E, 54E, 59E and 60E (2007) *API Manual of Petroleum Measurement Standards Chapter 11 - Physical Properties Data - Section 2, Part 4 - Temperature Correction for the Volume of NGL and LPG - Tables 23E, 24E, 53E, 54E, 59E and 60E (2007)*			
F091	GPA TP-25	NGL and LPG Density Referral Calculation	The calculation 'converts' the density values between standard and operating conditions. The calculation uses the GPA TP-25 for the temperature correction. One of API 11.2.1 or API 11.2.2 is used for the pressure correction depending on the standard density of the mixture. There is also the option to calculate vapour pressure according to GPA TP-15. The temperature and pressure correction going from observed density to standard density is performed as an iterative calculation using a direct substitution method.
GPA TP-25/ API Manual of Petroleum Measurement Standards Chapter 11- Section 2 - Part 4 - Temperature Correction for the Volume of Light Hydrocarbons - Tables 24E and 23E *API Manual of Petroleum Measurement Standards - Chapter 11.2.1 - Compressibility Factors for Hydrocarbons: 638-1074 Kilograms per Cubic Meter Range (1984)* *API Manual of Petroleum Measurement Standards - Chapter 11.2.2 - Compressibility Factors for Hydrocarbons: 350-637 Kilograms per Cubic Meter Density (15°) and -46°C to 60°C Metering Temperature (1986)* *GPA TP-15/ API Manual of Petroleum Measurement Standards Chapter 11- Section 2 - Part 5 - A Simplified Vapor Pressure Correlation for Commercial NGLs*			
F092	GPA TP-27	NGL and LPG Density Referral Calculation	The calculation 'converts' the density values between standard and operating conditions. The calculation uses the GPA TP-27 for the temperature correction. One of API 11.1 or API 11.2.2 is used for the pressure correction depending on the standard density of the mixture. There is also the option to calculate vapour pressure according to GPA TP-15. The temperature and pressure correction going from observed density to standard density is performed as an iterative calculation using a direct substitution method.
GPA TP-27/ API Manual of Petroleum Measurement Standards Chapter 11 - Physical Properties Data - Section 2 , Part 4 - Temperature Correction for the Volume of NGL and LPG - Tables 23E, 24E, 53E, 54E, 59E, and 60E *ASTM D1250-04 / IP 200/04 / API Manual of Petroleum Measurement Standards Chapter 11 - Physical Properties Data - Section 1 - Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils (2004)* *API Manual of Petroleum Measurement Standards - Chapter 11.2.2 - Compressibility Factors for Hydrocarbons: 350-637 Kilograms per Cubic Meter Density (15°) and -46°C to 60°C Metering Temperature (1986)* *GPA TP-15/ API Manual of Petroleum Measurement Standards Chapter 11- Section 2 - Part 5 - A Simplified Vapor Pressure Correlation for Commercial NGLs*			

Calc. No.	Standard	Title	Calculation Description
F093	AGA 10	Velocity of Sound/Isentropic Exponent	The calculation evaluates the velocity of sound and isentropic exponent of a natural gas along with various other gas related properties such as specific heat capacity (at constant pressure and volume), enthalpy and compressibility at line conditions based on the composition, pressure and temperature using the formulae presented in the American Gas Association Report No. 10.
AGA Report No.10 - Speed of Sound in Natural Gas and Other Related Hydrocarbon Gases (2003)			
F094	API	Natural Gas Viscosity Calculation	The calculation calculates the viscosity from the gas composition temperature and pressure following methods outlined in the American Petroleum Institute Technical Data Book.
API Technical Data Book			
F095	ISO 3171	1999 Annex A – Estimating Water in Oil Dispersion	The calculation indicates whether the dispersion of water in oil is likely to be adequate for sampling.
BS EN ISO 3171:1999 / ISO 3171:1988 - Petroleum liquids - Automatic pipeline sampling			
F096	Product Type 7	CPL and Compressibility Calculation	The calculation calculates Cpl and compressibility of a crude oil using what is generally referred to as the Aramco equation for Product Type 7. Details for this equation were taken from the reference below and are consistent with other flow computers.
FMC Energy Systems - Smith Meter GeoProv - Bidirectional Prover Computer Manual. - Bulletin MN09019L			
F097	ISO 8222	Annex A – Density of Water	The calculation calculates the density of water at a given temperature according to the formulae presented in Annex A of ISO 8222.
ISO 8222 - Petroleum measurement systems - Calibration - Temperature corrections for use when calibrating volumetric proving tanks			
F098	AGA 3	2012 – Orifice Flow Calculation	The calculation uses the processes outlined in the American Gas Association standard to solve flow rate, differential pressure or orifice size through an orifice plate metering system. This version of the calculation uses a new equation to calculate the gas expansion factor.
AGA Report No.3 - Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids - Concentric, Square-Edged Orifice Meters - Part 1: General Equations and Uncertainty Guidelines (2012) API Manual of Petroleum Measurement Standards - Chapter 14 - Natural Gas Fluids Measurement - Section 3 Concentric, Square-Edged Orifice Meters - Part 1: General Equations and Uncertainty Guidelines (2012)			
F099	ISO 5167	Wet Gas V-Cone Calculation	The calculation is an ISO 5167 flow rate calculation modified by McCrometer for the geometry and characteristics of their VCone meters. The calculation has options to use either the 2000 or 2005 version on the McCrometer calculation the latter of which contains a revised method of determining expansibility. To utilise calibration data the option is included to enter a characterisation curve showing the change in discharge

Calc. No.	Standard	Title	Calculation Description
			coefficient with Reynolds number. The calculation is set to correct for wet gas using the Steven correction.
ISO 5167-1:2003 - Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full - Part 1: General principles and requirements *McCrometer 24509-5: Flow Calculations for the V-Cone and Wafer-Cone Flow meters* *McCrometer 24517-16: V-Cone Flow Meter Technical Brief* *Wet Gas Metering with V-Cone Meters - R Steven, RJW Peters, D Hodges, D Stewart*			
F100		Water Content in Natural Gas – Bukacek Method	The calculation calculates the water content in natural gas. The calculation has the option to correct for the presence of methanol.
Equilibrium Moisture Content of Natural Gases – Institute of Gas Technology - R.F Bukacek			
F101	ASTM D1555	Volume and Weight of Industrial Aromatics and Cyclohexane	The calculation calculates the volume at a selected reference temperature and the weight (in vacuo and in air) of a specified aromatic or cyclohexane.
ASTM D1555-09 - Standard Test Method for Calculation of Volume and Weight of Industrial of Aromatic Hydrocarbons and Cyclohexane (2009) *ASTM D1555-08ε1 - Standard Test Method for Calculation of Volume and Weight of Industrial of Aromatic Hydrocarbons and Cyclohexane [Metric] (2009)*			
F103	ASTM-IP	Table 24: 1952	This calculation is used to ‘convert’ density values between standard conditions and operating conditions by applying a correction for the change in temperature (C_{tl}) and pressure (C_{pl}). C_{pl} is calculated using the methods outlined API 11.2.1 and C_{tl} using the petroleum measurement table (Table 24). The option is given to either perform the calculation following the rounding/truncation algorithms outlined in the standard or to use full precision.
ASTM D1250, IP 200 - Report on the Development, Construction, Calculation, and Preparation of the ASTM-IP Petroleum Measurement Tables (1960) *API Manual of Petroleum Measurement Standards - Chapter 11.2.1 - Compressibility Factors for Hydrocarbons: 0-90 degrees API Gravity Range (1984)*			
F105		Liquid Flow Rate - Pulse Output Meter	This calculation is used to calculate the flow rate through a flow meter that supplies a pulsed output. Option is available to specify for flow meters which directly measure mass or volume and to correct for temperature and pressure. Options are also given to apply a linearity correction to include data obtained by calibration and convert the calculated flow rate to other types e.g. volume to mass etc
IP Petroleum Measurement Manual Part XII - Static and Dynamic Measurement of Light Hydrocarbon Liquids - Section 1: Calculation Procedures (1998)			
F106		Gas Flow Rate - Pulse Output Meter	This calculation is used to calculate the flow rate through a flow meter that supplies a pulsed output. Option is available to specify for flow meters which directly measure mass or volume and to correct for temperature and pressure. Options are also given to apply a linearity

Calc. No.	Standard	Title	Calculation Description
			correction to include data obtained by calibration and convert the calculated flow rate to other types e.g. volume to mass etc
IP Petroleum Measurement Manual Part XII - Static and Dynamic Measurement of Light Hydrocarbon Liquids - Section 1: Calculation Procedures (1998)			
F109	GPA 2172	Gross Heating Value, SG and Compressibility of Natural Gas from Composition	This calculates real and ideal relative density, Compressibility and real and ideal Gross heating value of natural gas from composition. Various versions of the GPA 2145 tables are available as a user option.
GPA Standard 2172-09 Calculation of Gross Heating Value, Relative Density, Compressibility and Theoretical Hydrocarbon Liquid Content for Natural Gas Mixtures for Custody Transfer			
F110	ISO 6976:2016	Calorific Value and Relative Density	This calculates calorific values, standard density, relative density and Wobbe index from a gas composition. Results are calculated for the composition treated as both a real and an ideal gas, inferior (net) and superior (gross) calorific value and Wobbe index are displayed in each case.
ISO 6976:2016 - Natural Gas - Calculation of calorific values, density and relative density and Wobbe indices from composition			
F111	ISO TR11583	Wet Gas Venturi	This calculates a corrected gas flowrate using an ISO 5167 flowrate calculation and a calculated over-reading correction factor. This correction factor is calculated using the gas density, liquid density, Lockhart-Martinelli parameter and the gas densiometric Froude number.
ISO/TR 11583 2012 Measurement of wet gas flow by means of pressure differential devices inserted in circular cross-section conduits			
F312		Reynolds number calculation	This calculates the Reynolds number of a fluid. Inputs can be in mass flowrate, volume flowrate or velocity. Viscosity input can be kinematic or dynamic.
F315	Norsok – 105 – Annex D	Water in oil calculations	This calculates net oil mass and standard volume using the methods described in Annex D of Norsok I-105. Cto and Cpo are determined using API Chapter 11.1 and 11.2 methods. Cpw is determined using ISO 12916 1995 equation. Ctw is determined using method described in API Chapter 20, section 1, appendix A.2
Norsok Standard I-105 Fiscal measurement systems for hydrocarbon liquid			
F318	AGA 8 - 2017	Gas Density, Compressibility and speed of sound.	AGA Report No. 8 Part 2 provides technical information necessary to compute thermodynamic properties including compressibility factors, densities, speeds of sound, and dew and bubble points for natural gas and related gases. This standard uses the GERG – 2008 equations of state
AGA Report No. 8 Part 2: Thermodynamic Properties of Natural Gas and Related Gases – GERG-2008 Equation of State			

Calc. No.	Standard	Title	Calculation Description
F319		USM – Speed of Sound Bias	This calculates the % error (Bias) between a theoretical and measured speed of sound value.