

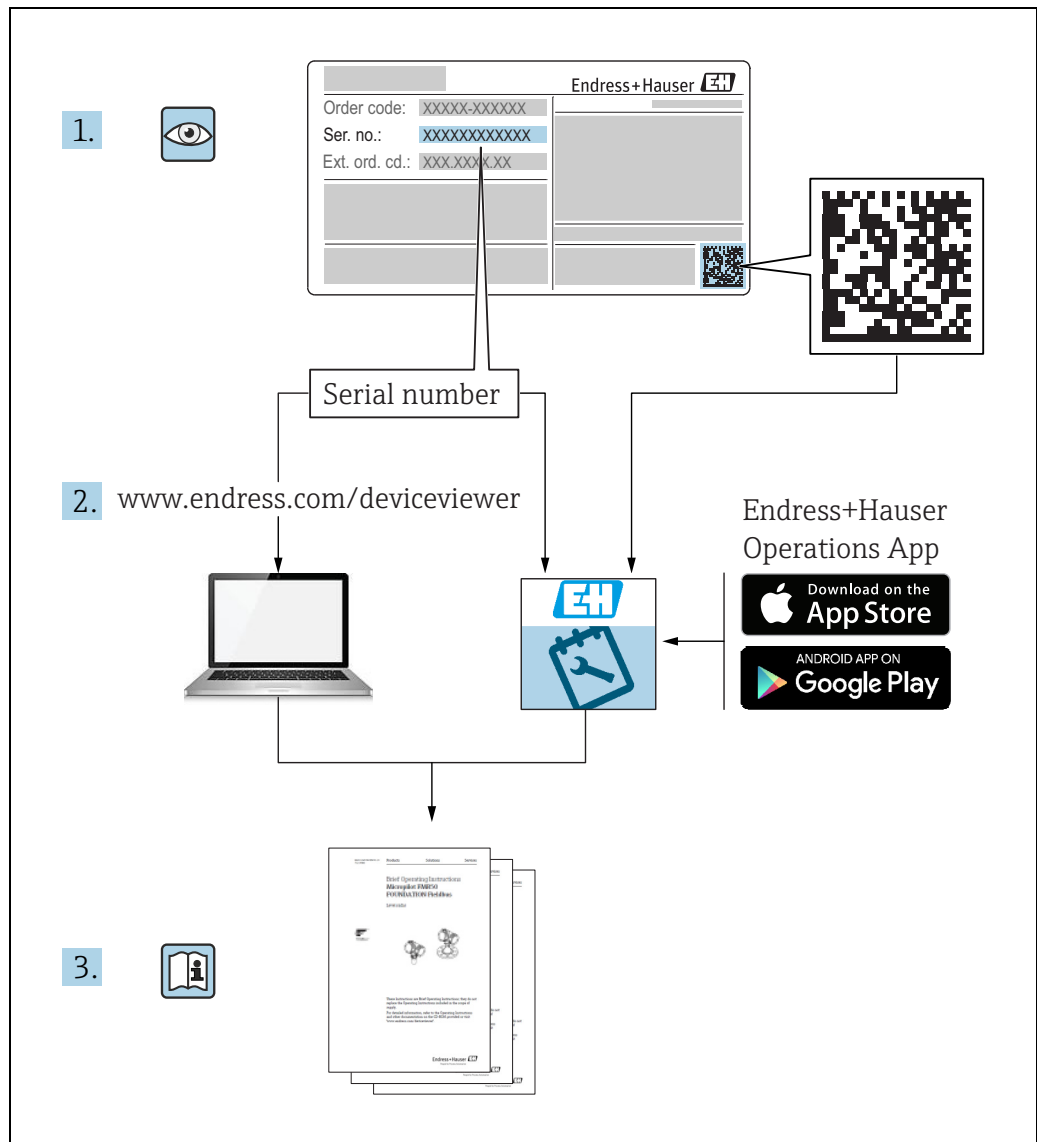
Operating Instructions

Tankvision

Tank Scanner NXA820, Data Concentrator NXA821, Host Link NXA822

System Description





A0023555

Make sure the document is stored in a safe place such that it is always available when working on or with the device.

To avoid danger to individuals or the facility, read the "Basic safety instructions" section carefully, as well as all other safety instructions in the document that are specific to working procedures.

The manufacturer reserves the right to modify technical data without prior notice. Your Endress+Hauser distributor will supply you with current information and updates to these Instructions.

Table of Contents

| | | | | | |
|----------|--|-----------|------|-----------------------------------|-----------|
| 1 | Document information | 4 | 8.7 | JIS calculation flow charts | 63 |
| 1.1 | Version history | 4 | 8.8 | Annex A.1 | 68 |
| 1.2 | Document function | 4 | 8.9 | Annex A.2 | 74 |
| 1.3 | Symbols | 4 | 8.10 | Annex A.3 | 75 |
| 1.4 | Documentation | 6 | 8.11 | Annex A.4 | 76 |
| 1.5 | Registered trademarks | 6 | 8.12 | Annex A.5 | 76 |
| 2 | Basic safety instructions | 7 | 8.13 | Annex A.6 | 78 |
| 2.1 | Requirements for the personnel | 7 | 8.14 | Annex A.7 | 79 |
| 2.2 | Designated use | 7 | 8.15 | Annex A.8 | 79 |
| 2.3 | Workplace safety | 8 | 8.16 | Documentation | 79 |
| 2.4 | Operational safety | 8 | | | |
| 2.5 | Product safety | 8 | | | |
| 2.6 | IT security | 8 | | | |
| 3 | Application | 9 | | | |
| 3.1 | Inventory control | 9 | | | |
| 3.2 | Application areas | 9 | | | |
| 4 | Identifying the components | 10 | | | |
| 4.1 | Nameplate | 10 | | | |
| 4.2 | Tank Scanner NXA820 | 11 | | | |
| 4.3 | Data Concentrator NXA821 | 12 | | | |
| 4.4 | Host Link NXA822 | 14 | | | |
| 4.5 | Explosion picture | 16 | | | |
| 4.6 | Tankvision OPC Server | 16 | | | |
| 4.7 | Tankvision Printer Agent | 16 | | | |
| 4.8 | Tankvision Alarm Agent | 17 | | | |
| 5 | PC recommendations | 18 | | | |
| 5.1 | PC connection for viewing data | 18 | | | |
| 5.2 | Recommendations when using OPC Server, Printer Agent or Alarm Agent | 18 | | | |
| 5.3 | Alternations from the recommendations | 18 | | | |
| 6 | Connections to gauges and host systems | 19 | | | |
| 6.1 | Field instruments and slave devices | 19 | | | |
| 6.2 | Host Systems communication | 24 | | | |
| 7 | Examples | 25 | | | |
| 7.1 | System architecture | 25 | | | |
| 7.2 | Screen examples in Browser | 26 | | | |
| 8 | Calculations | 28 | | | |
| 8.1 | API Flow Charts | 28 | | | |
| 8.2 | GBT calculation flow chart | 42 | | | |
| 8.3 | Mass Measurement | 48 | | | |
| 8.4 | Calculations for liquefied gases | 53 | | | |
| 8.5 | CTSh | 56 | | | |
| 8.6 | Alcohol calculations | 61 | | | |
| | | | | Index | 81 |

1 Document information

1.1 Version history

| Document version | Valid for SW version | Changes to the previous version |
|----------------------|-------------------------|--|
| BA00426G/00/EN/01.12 | 01.02.02-00xxx/01.04.00 | Initial version |
| BA00426G/00/EN/13.13 | 01.05.00 | Initial version |
| BA00426G/00/EN/14.15 | 01.06.00 | Java applets replacement, new layout |
| BA00426G/00/EN/15.17 | 02.00.00 | Introduced Temperature and Density Profile |
| BA00426G/00/EN/16.17 | 02.01.00 | Introduced Floating Roof Weight Correction, Redundancy functionality with NXA820 Interface Only, CH alarm for Volume or Mass |
| BA00426G/00/EN/17.18 | 02.02.00 | Introduced Switch by Gauge redundancy mode for NXA820 Interface Only |

1.2 Document function





This manual is giving detailed information on the system capabilities and architecture. It supports project and sales engineers in designing the system architecture during acquisition and execution phase. Furthermore during operation time of the system all servicing personnel in need of detailed knowledge about the system capabilities.







This manual is not suitable for the Interface only version of NXA820.

1.3 Symbols




1.3.1 Safety symbols

| Symbol | Meaning |
|---|--|
|  <small>A0011189-EN</small> | DANGER! This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury. |
|  <small>A0011190-EN</small> | WARNING! This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury. |
|  <small>A0011191-EN</small> | CAUTION! This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury. |
|  <small>A0011192-EN</small> | NOTICE! This symbol contains information on procedures and other facts which do not result in personal injury. |



1.3.2 Electrical symbols

| Symbol | Meaning |
|---|--|
|  A0011197 | Direct current A terminal to which DC voltage is applied or through which direct current flows. |
|  A0011198 | Alternating current A terminal to which alternating voltage is applied or through which alternating current flows. |
|  A0011200 | Ground connection A grounded terminal which, as far as the operator is concerned, is grounded via a grounding system. |
|  A0011199 | Protective ground connection A terminal which must be connected to ground prior to establishing any other connections. |

1.3.3 Symbols for certain types of information

| Symbol | Meaning |
|---|--|
|  A0011193 | Tip Indicates additional information. |
|  A0011195 | Reference to page Refers to the corresponding page number. |
| 1. , 2. , 3. ... | Series of steps |
|  A0018373 | Result of a sequence of actions |

1.3.4 Symbols in graphics

| Symbol | Meaning |
|---|---|
| 1, 2, 3 ... | Item numbers |
| 1. , 2. , 3. ... | Series of steps |
| A, B, C ... | Views |
|  A0011187 | Hazardous area Indicates a hazardous area. |
|  A0011188 | Indicates a non-hazardous location Safe area (non-hazardous area) |

1.4 Documentation

1.4.1 Operating instructions

| Document number | Instrument | Type of Document |
|-----------------|---|-------------------------------------|
| BA00339G/00 | <ul style="list-style-type: none"> ▪ Tank Scanner NXA820 ▪ Data Concentrator NXA821 ▪ Host Link NXA822 | Description of Instrument Functions |
| BA00340G/00 | | Installation Instructions |
| BA00424G/00 | | System Description |
| BA00426G/00 | | Operator Manual |
| BA01137G/00 | Tankvision NXA820 OPC Server | User Manual |

1.5 Registered trademarks

Microsoft[®], Windows[®] and Internet Explorer[®]
Registered trademarks of the Microsoft Corporation

Modbus[™]
Modbus is a registered trademark of Schneider Electric USA, Inc.

Java[®]
Registered trademark of Oracle[®] Corporation

2 Basic safety instructions

2.1 Requirements for the personnel

The personnel for installation, commissioning, diagnostics and maintenance must fulfill the following requirements:

- Trained, qualified specialists: must have a relevant qualification for this specific function and task
- Are authorized by the plant owner/operator
- Are familiar with federal/national regulations
- Before beginning work, the specialist staff must have read and understood the instructions in the Operating Instructions and supplementary documentation as well as in the certificates (depending on the application)
- Following instructions and basic conditions

The operating personnel must fulfill the following requirements:

- Being instructed and authorized according to the requirements of the task by the facility's owner operator
- Following the instructions in these Operating Instructions

2.2 Designated use

2.2.1 Application

Tankvision is a dedicated tank inventory management system.

Components:

- Tankvision Tank Scanner NXA820
scans parameters from tank gauges and performs tank calculations
- Tankvision Data Concentrator NXA821
summarizes data from various Tank Scanners NXA820
- Tankvision Host Link NXA822
provides data to host systems (such as PLC or DCS) via Modbus

The above mentioned components are operated via a standard web browser. It does not require any proprietary software. Tankvision is based on a distributed architecture on a Local Area Network (LAN). Due to its modular structure it can be adjusted to any application. It is ideally suited for small tank farms with only a couple of tanks, but also for large refineries with hundreds of tanks.

2.3 Workplace safety

For work on and with the device:

- Wear the required personal protective equipment according to federal/national regulations.
- Switch off the supply voltage before connecting the device.

2.4 Operational safety

Risk of injury!

- Operate the device in proper technical condition and fail-safe condition only.
- The operator is responsible for interference-free operation of the device.

Conversions to the device

Unauthorized modifications to the device are not permitted and can lead to unforeseeable dangers

- If, despite this, modifications are required, consult with Endress+Hauser.

Repair

To ensure continued operational safety and reliability,

- Carry out repairs on the device only if they are expressly permitted.
- Observe federal/national regulations pertaining to repair of an electrical device.
- Use original spare parts and accessories from Endress+Hauser only.

2.5 Product safety

The device is designed to meet state-of-the-art safety requirements, has been tested and left the factory in a condition in which it is safe to operate. The device complies with the applicable standards and regulations as listed in the EC declaration of conformity and thus complies with the statutory requirements of the EG directives. Endress+Hauser confirms the successful testing of the device by affixing to it the CE mark.

2.6 IT security

We only provide a warranty if the device is installed and used as described in the Operating Instructions. The device is equipped with security mechanisms to protect it against any inadvertent changes to the device settings.

IT security measures in line with operators' security standards and designed to provide additional protection for the device and device data transfer must be implemented by the operators themselves.

Endress+Hauser can be contacted to provide support in performing this task.

3 Application

3.1 Inventory control

By using Tankvision to monitor the tank level and stored volume of valuable liquids remotely, owners or operators of tank farms or terminals for petroleum products and chemicals (liquids) can visualize the volumes or mass of the stored medium in real time. The data can be used to plan the inventory and distribution. The data can also be used to manage tank farm operations like pumping or transferring products.

Tankvision has its unique concept using network technology. Without using proprietary software, the users can visualize and manage their valuable liquids stored in the tanks by a web browser.

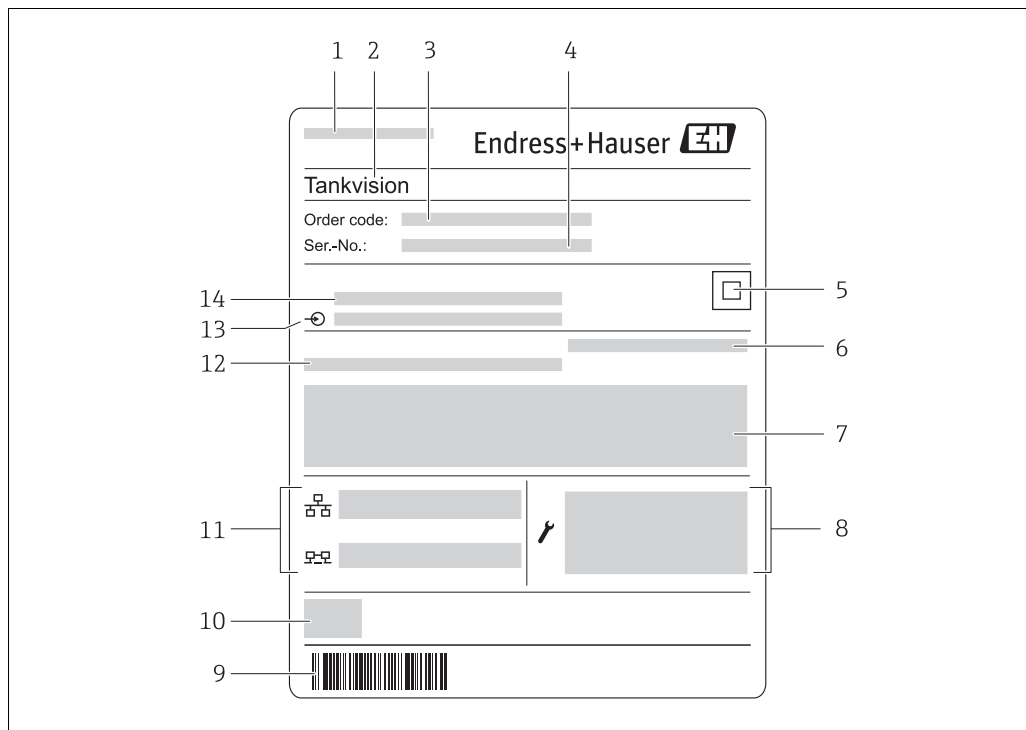
Tankvision is a flexible and cost effective solution due to its scalable architecture. The application coverage goes from small depots with only a few tanks up to refineries.

3.2 Application areas

- Tank farms in refineries
- Ship loading terminals
- Marketing and distribution terminals
- Pipeline terminals
- Logistic terminals for tanks storing products like crude oils, refined white and black products, chemicals, LPGs, fuels, biofuels, alcohols

4 Identifying the components

4.1 Nameplate



nameplate_2

- 1 Address of manufacturer
- 2 Device name
- 3 Order code
- 4 Serial number (Ser. no.)
- 5 Data Matrix Code
- 6 Degree of protection
- 7 Certificate and approval relevant data
- 8 Technical data of the Service LAN port
- 9 Barcode
- 10 CE mark
- 11 MAC address of the System LAN port and Sync LAN port
- 12 Admissible ambient temperature
- 13 Type of fieldbus communication (only for Tank Scanner NXA820)
- 14 Supply voltage

4.2 Tank Scanner NXA820

- The Tank Scanner NXA820 connects multiple tank gauges: from up to 15 tanks via one field-loop. The Tank Scanner NXA820 supports different field protocols (Modbus EIA485, Sakura V1, Whessoe WM550).
- The measured values are transmitted by the network and visualized on HTML pages.
- The Tank Scanner NXA820 can be used stand-alone for small tank farms, but also be integrated into a large system for use in refineries.
- The Tank Scanner NXA820 is equipped with a full set of tank inventory calculations. The calculations are based on various international standards such as API, ASTM, IP and many others. Measured values are used to calculate volume and mass.

4.2.1 Ordering information

Detailed ordering information is available from the following sources:

- In the Product Configuration on the Endress+Hauser website: www.endress.com → Select country → Instruments → Select device → Product page function: Configure this product
- From your Endress+Hauser Sales Center: www.endress.com/worldwide



Product Configurator - the tool for individual product configuration

- Up-to-the-minute configuration data
- Depending on the device: Direct input of measuring point-specific information such as measuring range or operating language
- Automatic verification of exclusion criteria
- Automatic creation of the order code and its breakdown in PDF or Excel output format
- Ability to order directly in the Endress+Hauser Online Shop

4.2.2 Product picture



L00-NXA8xxxx-10-08-06-xx-002

4.3 Data Concentrator NXA821

- The NXA821 Tankvision Data Concentrator is the enhanced solution for large tank farms and refineries. The Data Concentrator is required if:
The plant contains more than one field loop (each of which has its own Tank Scanner NXA820) and tanks of more than one Tank Scanner NXA820 are to be grouped
- The Data Concentrator collects the data of several Tank Scanner units and enables reconciliation and totalization of the tank data of many or all tanks in structured groups.
- Alarms and events from all connected Tank Scanners NXA820 can be shown in a common screen. Any tank of the system can be assigned to any tank group, regardless of the Tank Scanner it is linked to. This ensures the highest possible flexibility for the plant or tank farm.
- An alarm pop-up shows alarms of all connected Tank Scanners NXA820 even if the web browser is closed.
- Direct serial printer connection for report printing (W+M certified acc. PTB)
- 90 tanks (more on request) can be allocated to each Data Concentrator NXA821. Each of these tanks must have been allocated to a Tank Scanner NXA820 beforehand.
- Tanks from up to 6 different Tank Scanners NXA820 (more on request) can be integrated in this way.

4.3.1 Ordering information

Detailed ordering information is available from the following sources:

- In the Product Configuration on the Endress+Hauser website: www.endress.com → Select country → Instruments → Select device → Product page function: Configure this product
- From your Endress+Hauser Sales Center: www.endress.com/worldwide



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4.3.2 Product picture



L00-NXABxxxx-10-08-06-xx-003

4.4 Host Link NXA822

- The Host Link NXA822 collects data from all Tank Scanners NXA820 on a network and transfers them to the host system.
- The MODBUS option supports serial EIA-232(RS) and EIA-485(RS) or MODBUS TCP/IP. The NXA822 is configured as a MODBUS slave. Supported functions are:
 - Coil Status (#01)
 - Read Input Status(#02)
 - Holding Registers (#03)
 - Input Registers (#04)
 - Force Single Coil (#05)
 - Write Modbus Values (#06)
 - Force Multiple Coils (#15)
 - Preset Multiple Registers (#16)
- The MODBUS register map is described via XML files and can easily be adapted to individual MODBUS master requirements.
- Gauge commands for Servo Gauges
- 90 tanks (more on request) can be allocated to each Host Link NXA822. Each of these tanks must have been allocated to a Tank Scanner NXA820 beforehand.
- Tanks from up to 6 different Tank Scanners NXA820 (more on request) can be integrated in this way.
- Per system 2 NXA822 units can be installed.

4.4.1 Ordering information

Detailed ordering information is available from the following sources:

- In the Product Configuration on the Endress+Hauser website: www.endress.com → Select country → Instruments → Select device → Product page function: Configure this product
- From your Endress+Hauser Sales Center: www.endress.com/worldwide



Product Configurator - the tool for individual product configuration

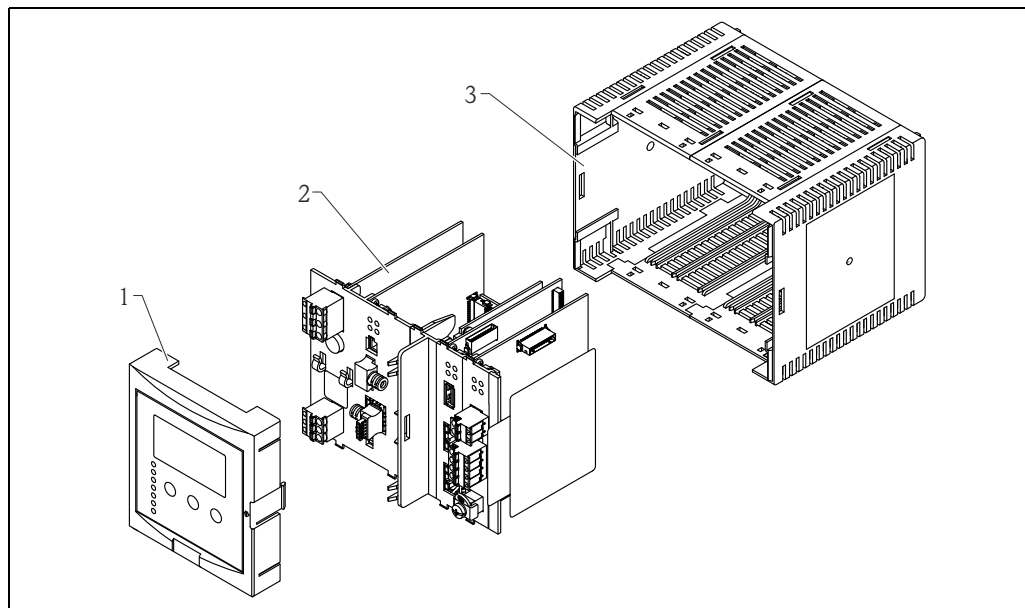
- Up-to-the-minute configuration data
- Depending on the device: Direct input of measuring point-specific information such as measuring range or operating language
- Automatic verification of exclusion criteria
- Automatic creation of the order code and its breakdown in PDF or Excel output format
- Ability to order directly in the Endress+Hauser Online Shop

4.4.2 Product picture



L00-NXABxxxx-10-08-06-xx-004

4.5 Explosion picture



- 1 Cover plate
2 Inner electronics
3 Housing

L00-NXA82xxx-16-00-00-xx-071

4.6 Tankvision OPC Server

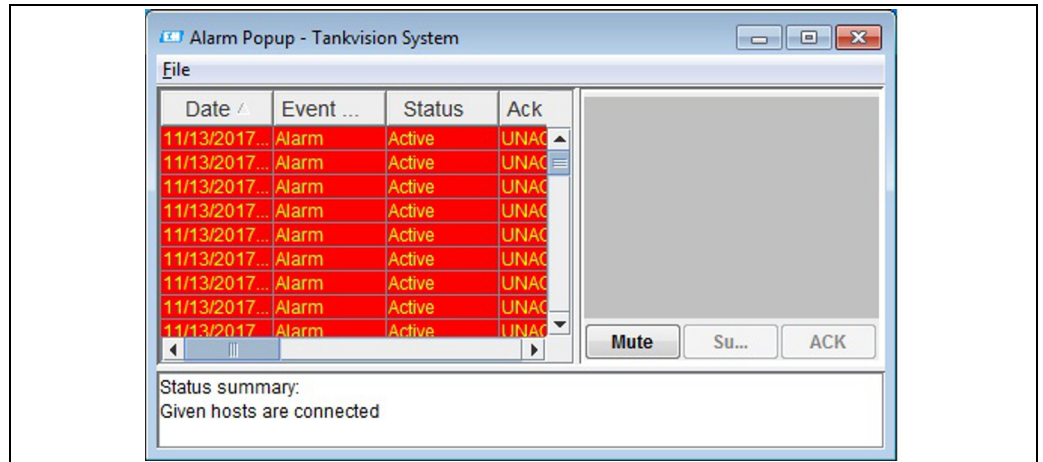
- The OPC Server is a Windows program installed on a PC connecting to NXA820 and allows access to measured and calculated tank parameters.
- The OPC Server connects to OPC clients on the same PC or other PCs via LAN.
- The OPC Server supports browsing tanks and tank parameters on NXA820.
- The OPC Server is included in each NXA820 and can be uploaded to the PC.
- The OPC Server is based on OPC DA V3.0

4.7 Tankvision Printer Agent

- The Printer Agent is a Windows program installed on a PC, connecting to NXA820/ NXA821. Supports up to 2 network connection per PC.
- The program is running in the background and enables (scheduled) printing reports on connected printers.
- Up to 3 printers (directly connected to the PC or network printers) can be assigned to the Printer Agent.
- If a printout can not be performed, a record is kept within the Printer Agent.
- The printer agent software is included in each NXA820 and can be uploaded to the PC (for more information, see document BA00339G).

4.8 Tankvision Alarm Agent

- The Alarm Pop-Up-Agent is a Windows program installed on a PC, connecting to NXA820/NXA821.
- The program is running in the background and scans for alarms generated in NXA820/NXA821.
- If an alarm is present, a pop-up window opens displaying the alarm.
- The alarm can be acknowledged within this window.
- The window can only be closed if no alarm is active.
- The Alarm Agent can be uploaded from NXA820/821 to the PC.
- A single alarm Agent can support multiple NXA820/NXA821.



Alarm-Popup-Agent


For more information, see document BA00339G.

5 PC recommendations

5.1 PC connection for viewing data

Tankvision Tank Scanner NXA820, Tankvision Data Concentrator NXA821 and Tankvision Host Link NXA822 are providing a web server to view and enter data or perform configurations. Viewing the pages requires a web browser and JAVA runtime installed on a PC.

PC and the Tankvision components must be connected within the same Local Area Network (LAN) consisting out of Ethernet lines, switches and/or routers.

 HUBs shall not be used. In secured systems e.g. for W&M purposes, routers cannot be used. If company policies allow a remote connection into the LAN also enables a remote connection to Tankvision components.

5.1.1 Recommendations PC configuration

With all on the market available web browser entering the Tankvision web server is possible. Nevertheless the pages are optimized for Microsoft Internet Explorer (supported version IE9, IE10 and IE11 – Compatibility Mode).

The user interface pages are optimized for a screen resolution of 1280x1024 (or higher).

5.2 Recommendations when using OPC Server, Printer Agent or Alarm Agent

- Windows XP 32 Bit Service Pack 3, Windows 7 32 Bit or Windows 7 64 Bit
- Java 8 or higher

5.3 Alternations from the recommendations

Alternations to the recommendations in the previous chapters might have influences on the proper behaviour of the system especially when communication ports are used by other programs (e.g. other OPC servers). In case of uncertainty consult Endress+Hauser.

| Included Software and Operating System requirements | Windows 7 (32/64 bit) | Windows Server 2008 |
|---|-----------------------|---------------------|
| OPC Server | X | X |
| Alarm Agent | X | - |
| Printer Agent | X | - |
| Tankvision Installation and Recovery Tool | X | - |

6 Connections to gauges and host systems

6.1 Field instruments and slave devices



Please take care that the signal and power cables always are separated to prevent noise and electrical interference between them.

6.1.1 Communication variants

Field instruments or other slave devices are connected to the Tankvision Tank Scanner NXA820. The unit is available in 3 communication versions.

- Modbus RTU RS485

According to "Modbus over serial line specification and implementation guide V1.02" published by the Modbus-IDA organization (www.modbus.org) and based upon the EIA/TIA-485-A physical layer specification.

| | |
|--------------------------|---|
| Characteristic impedance | 135 to 165 Ω at measuring frequency of 3 to 20 MHz |
| Cable capacitance | ≤ 30 pF/m |
| Core cross-section | ≥ 0.34 mm ² (AWG 22) multi-strand cable is preferred |
| Cable type | Single twisted pair + third conductor (for common) or Dual twisted pair (common uses second pair with wire joined together) |
| Cable resistance | ≤ 110 Ω /km |
| Signal damping | Max. 9 dB over the entire length of the cable cross-section |
| Shielding | Copper braided shielding or combined foil and braided shielding |

- Sakura V1

V1 fieldbus is a voltage mode digital communication using up to ± 30 VDC.

| | |
|--------------------|---|
| Cable capacitance | ≤ 50 nF/m |
| Core cross-section | ≥ 0.9 mm ² (AWG 17) multi-strand cable is preferred |
| Cable type | Twisted pair |
| Cable resistance | ≤ 30 Ω /km |
| Shielding | Copper braided shielding or combined foil and braided shielding |
| Insulation | ≥ 60 V _{DC} |

- Whessoe WM550

The WM550 communication protocol works using a current loop principle.

Connection

Please take into consideration that the principle of current loop connection works as follows:

The Tankvision (master) (-) signal point connects to slave 1 (+) signal point. Slave 1 (-) signal point connects to slave 2 (+) signal point until (the last) slave N (-) signal point connects back to the Tankvision (master) (+) signal point closing the current loop.

Cable specification

Please ensure to follow the following recommendations for field installation of the Tankvision with the WM550 protocol variant.

- Cable with twisted and non-shielded pairs
- Cable with at least 0.5 mm² (AWG 20) section
- Maximum total cable resistance: 250 Ω
- Cable with low capacitance

| | Cross section (mm ² (AWG)) | Resistance (Ω/km) | Capacitance (nF/km) |
|---------|---------------------------------------|-------------------|---------------------|
| Cable 1 | 0.5 (20) | 39.2 | 60 |
| Cable 2 | 0.75 (18) | 24.6 | 65 |
| Cable 3 | 1.3 (16) | 14.2 | 75 |

6.1.2 Field devices

The following list gives an overview on possible field instruments which can be connected directly or via system components. Nevertheless the connection possibilities are not limited to these devices.

■ Micropilot NMR8x

Micropilot NMR81 is used for custody transfer and inventory control applications with NMI- and PTB-approvals and meets the requirements according to OIML R85 and API 3.1B. NMR81 is particularly suited for free space applications up to 70 m. The drip-off lens antenna with 79 GHz transmitting frequency produces a sharply focused beam angle of 3° and avoids obstacles even close to tank wall.

Micropilot NMR81 is available with Modbus RS485 and Sakura V1 output.

For more information see TI01252G/00/EN.

Micropilot NMR84 is used for custody transfer and inventory control applications with NMI- and PTB-approvals. It meets the relevant requirements according to OIML R85 and API 3.1B. The NMR84 free space radar with drip-off planar antenna is specifically suited for stilling well applications. The superior drip-off antenna design with proven track record eliminates problems caused by condensation.

Micropilot NMR84 is available with Modbus RS485 and Sakura V1 output.

For more information see TI01253G/00/EN.

■ Proservo NMS8x

The intelligent tank gauge Proservo NMS80 is designed for high accuracy liquid level measurement in custody transfer and inventory control applications with NMI- and PTB-approvals. It meets the relevant requirements according to OIML R85 and API 3.1B. It fulfills the exact demands of tank inventory management and loss control and is optimized in regards of total cost saving and safe operation.

Proservo NMS8x is available with Modbus RS485 and Sakura V1 output.

For more information see TI01248G/00/EN, TI01249G/00/EN or TI01250G/00/EN.

■ Tank Side Monitor NRF8x

The Tank Side Monitor NRF81 is a sensor integration and monitoring unit for bulk storage tank gauging applications. It integrates various level, temperature and pressure tank sensor data into a control host system. Various selectable alarms and outputs.

Tank Side Monitor NRF8x is available with Modbus RS485 and Sakura V1 output.

For more information see TI01251G/00/EN.

■ Proservo NMS5/7

The Proservo NMS5/7 intelligent tank gauges are designed for high accuracy liquid level measurement in storage and process applications. Tank mounted intelligence makes the Proservo NMS5 ideal for single or multi-task installation, converting a wide of measurement functions including beside others:

- Liquid level
- Interface level
- Spot density
- Density profile

Proservo NMS5/7 is beside others available with Modbus RTU RS485, Sakura V1, Whessoe WM550 output. For more information see TI00452G/08/EN.

■ Tank Side Monitor NRF590

The Tank Side Monitor NRF590 is a sensor integration and monitoring unit for bulk storage tank gauging applications. It can be used with Micropilot radar or Proservo level gauges and can be combined with other HART compatible devices.

Connects up to 6 HART devices via intrinsic safe 2 wire, for example Prothermo for average temperature measurement and Cerabar/Deltabar for HTMS density applications. Various industry standard communication protocols, including

- Sakura V1
- EIA-485 Modbus
- Whessoe WM550

For more information see TI00402F/00/EN.

- **Micropilot S FMR53x/FMR540**

The Micropilot S is used for highly accurate level measurement in storage tanks and can be applied in custody transfer applications. It meets the relevant requirements according to OIML R85 and API 3.1B.

The Micropilot S is communicating via the industry standard protocol HART (Standard 5) and can be connected to the Tankvision Tank Scanner via the Tank Side Monitor. For more information see TI00344F/00/EN and TI00412F/00/EN.

- **Prothermo NMT539**

The Prothermo NMT539 is based on API (American Petroleum Institute) Manual of Petroleum Measurement Standard, Chapter 7, and enables high accuracy temperature measurement. At the same time, it is an intelligent average temperature sensor for tank gauging with an optional WB capacitance sensor at the bottom of the temperature probe. For average temperature measurement, it consists of precision multi-spot Pt100 elements. The NMT539 is a highly capable solution that provides both constant average temperature data and water interface data via local HART® communication. For accurate inventory measurement, it is best suited connected to Endress+Hauser's Proservo NMS, Micropilot NMR or Tank Side Monitor NRF with level tank gauge (e.g. Micropilot). For more information see TI00042G/08/EN.

- **Prothermo NMT532**

The Prothermo NMT532 consists of an intelligent local HART® signal converter and average temperature sensor. For average temperature measurement, it consists of precision multi-spot Pt100 (max. 6) elements which have fixed interval (2 m (6.6 ft) or 3 m (9.8 ft)). The NMT532 is a highly capable solution for a variety of tank gauging applications and provides constant average temperature data via local HART® communication. For accurate inventory measurement, it is best suited connected to Endress+Hauser's Proservo NMS, Micropilot NMR or Tank Side Monitor NRF with level tank gauge (e.g. Micropilot). For more information see TI00049G/08/EN.

- **Micropilot M FMR2xx**

The Micropilot M is used for continuous, non-contact level measurement of liquids, pastes, slurries and solids. The measurement is not affected by changing media, temperature changes.

- The FMR230 is especially suited for measurement in buffer and process tanks.
- The FMR231 has its strengths wherever high chemical compatibility is required.
- The FMR240 with the small 40 mm (1½") horn antenna is ideally suited for small vessels. Additionally, it provides an accuracy of ±3 mm (0.12 in).
- The FMR244 combines the advantages of the horn antenna with high chemical resistance.

The 80 mm (3") horn antenna is used additionally in solids.

- The FMR245 - highly resistance up to 200 °C (392 °F) and easy to clean.

The Micropilot M is communicating via the industry standard protocol HART and can be connected to the Tankvision Tank Scanner via the Tank Side Monitor or an HART to Modbus converter e.g. by Moore Industries. For more information see TI000345F/00/EN.

- **Levelflex M FMP4x**

Level Measurement - Continuous level measurement of powdery to granular bulk solids e.g. plastic granulate and liquids.

- Measurement independent of density or bulk weight, conductivity, dielectric constant, temperature and dust e.g. during pneumatic filling.
- Measurement is also possible in the event of foam or if the surface is very turbulent.

Interface measurement

Continuous measurement of interfaces between two liquids with very different dielectric constants, such as in the case of oil and water for example.

The Levelflex M is communicating via the industry standard protocol HART and can be connected to the Tankvision Tank Scanner via the Tank Side Monitor or an HART to Modbus converter e.g. by Moore Industries. For more information see TI00358F/00/EN.

■ Levelflex FMP5x

- FMP51

Premium device for level and interface measurement in liquids.

- FMP52

Premium device with coated probe for the use in aggressive liquids. Material of wetted parts FDA listed and USP Class VI compliant.

- FMP54

Premium device for high-temperature and high-pressure applications, mainly in liquids.

Levelflex is communicating via the industry standard protocol HART and can be connected to the Tankvision Tank Scanner via the Tank Side Monitor or an HART to Modbus converter e.g. by Moore Industries. For more information see TI01001F/00/EN.

■ Cerabar M

The Cerabar M pressure transmitter is used for the following measuring tasks:

- Absolute pressure and gauge pressure in gases, steams or liquids in all areas of process engineering and process measurement technology.

- High reference accuracy: up to $\pm 0.15\%$, as PLATINUM version: $\pm 0.075\%$

Cerabar M is communicating via the industry standard protocol HART and can be connected to the Tankvision Tank Scanner via the Tank Side Monitor or Proservo.

For more information see TI000436P/00/EN.

■ Cerabar S

The Cerabar S pressure transmitter is used for the following measuring tasks:

- Absolute pressure and gauge pressure in gases, steams or liquids in all areas of process engineering and process measurement technology.

- High reference accuracy: up to $\pm 0.075\%$, as PLATINUM version: $\pm 0.05\%$

Cerabar S is communicating via the industry standard protocol HART and can be connected to the Tankvision Tank Scanner via the Tank Side Monitor or Proservo.

For more information see TI000383P/00/EN.

■ Deltabar M

The Deltabar M differential pressure transmitter is used for the following measuring tasks:

- Flow measurement (volume or mass flow) in conjunction with primary elements in gases, vapors and liquids

- Level, volume or mass measurement in liquids

- Differential pressure monitoring, e.g. of filters and pumps

- High reference accuracy: up to $\pm 0.1\%$, as PLATINUM version: $\pm 0.075\%$

Deltabar M is communicating via the industry standard protocol HART and can be connected to the Tankvision Tank Scanner via the Tank Side Monitor or Proservo.

For more information see TI000434P/00/EN.

■ Deltabar S

The Deltabar S differential pressure transmitter is used for the following measuring tasks:

- Flow measurement (volume or mass flow) in conjunction with primary devices in gases, vapors and liquids

- Level, volume or mass measurement in liquids

- Differential pressure monitoring, e.g. of filters and pumps

– High reference accuracy: up to $\pm 0.075\%$, as PLATINUM version: $\pm 0.05\%$
 Deltabar S is communicating via the industry standard protocol HART and can be connected to the Tankvision Tank Scanner via the Tank Side Monitor or an HART to Modbus converter e.g. by Moore Industries. For more information see TI000382P/00/EN.

- **Liquicap M**

The Liquicap M FMI5x compact transmitter is used for the continuous level measurement of liquids.

– Suitable for interface measurement

Liquicap M is communicating via the industry standard protocol HART and can be connected to the Tankvision Tank Scanner via the Tank Side Monitor or an HART to Modbus converter e.g. by Moore Industries. For more information see TI00401F/00/EN.

- **Whessoe ITGs**

- **Sakura Endress Float&Tape Transmitter TMD**

- **Sakura Endress TGM5000**

- **Sakura Endress TGM4000**

- **SWG70: Wireless HART gateway**

- **Modbus slave devices**

As Modbus is an open protocol there are various system components available which can be connected to Tankvision Tank Scanner. To do so the so called gauge definition file and the Modbus map file need to be adapted to the needs. This is a standard procedure and described in BA00339G/00/EN. Examples for such devices are HART to Modbus converters, PLCs or other protocol converters e.g. Gauge Emulator by MHT.



Remote service access via the Endress+Hauser device configuration tool FieldCare is supported for the following device combination:

- **Tankvision Tank Scanner with Modbus or Sakura V1 communication**

- **Tank Side Monitor Modbus or Sakura V1 communication and SW version 02.04.00 or later**

- **HART devices connected to Tank Side Monitor intrinsic safe HART bus and supporting FDT/DTM**

or

- **Tankvision Tank Scanner with Modbus or Sakura V1 communication**

- **Proservo NMS5/7 (Modbus or Sakura V1 communication) with**

- TCB-6 version 4.27E

- Graphical display operation module

- Modbus communication module COM-5, version 2.0 or

- V1 communication module COM-1 (SRAM-mounted), version 5.01

- HART devices connected to Proservo cannot be reached by FieldCare

6.2 Host Systems communication

To transfer and receive data to/from host system the communication variants OPC DA (version 3.0) and Modbus RS232, Modbus RS485 and Modbus TCP are available.

6.2.1 OPC DA server

See "Tankvision OPC Server", → [16](#).

For available parameters see A.1 Parameter list.

6.2.2 Modbus slave via Host Link NXA822

See "Host Link NXA822", → [14](#).

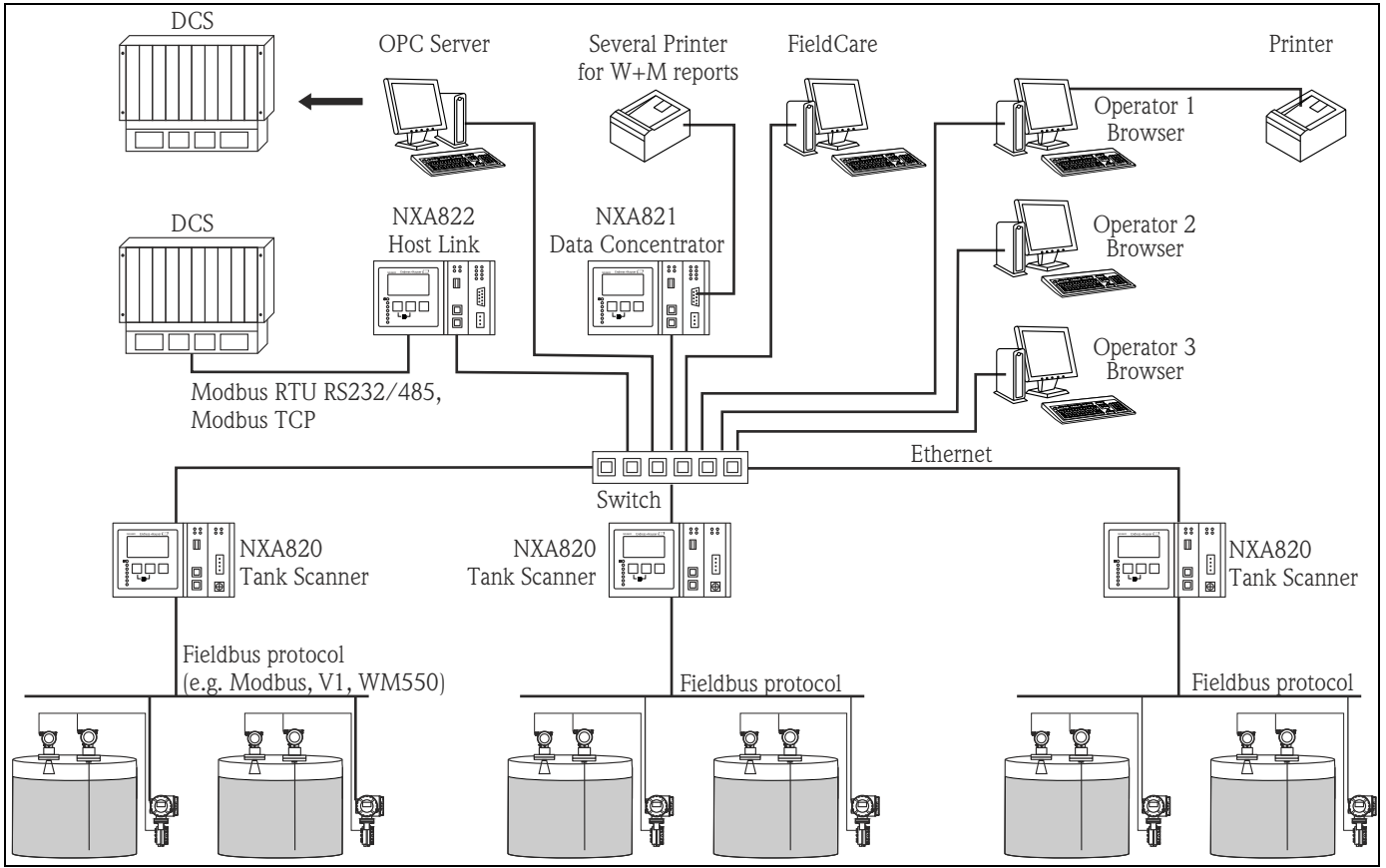
For available parameters see A.1 Parameter list.

6.2.3 Connection to Tankvision Professional

To connect to Tankvision Professional a dedicated communication is available. In this case measured data are transferred as the calculations are performed in Tankvision Professional.

7 Examples

7.1 System architecture



7.2 Screen examples in Browser

| Tank Name | Product Name | Product Level | Secondary Level | Product Temperature | Pressure | Total Observed Volume |
|-----------|--------------|---------------|-----------------|---------------------|-----------|-----------------------|
| Tank-1 | Petrol | +77.500 m | +0.000 m | +25.5 °C | +0.00 kPa | +7750.000 m³ |
| Tank-10 | No Product | +0.700 m | +0.000 m | +25.5 °C | +0.00 kPa | +70.000 m³ |
| Tank-11 | Ethanol | +0.700 m | +0.000 m | +25.5 °C | +0.00 kPa | +70.000 m³ |
| Tank-12 | No Product | +0.500 m | +0.000 m | +22.5 °C | +0.00 kPa | +50.000 m³ |
| Tank-13 | No Product | +0.500 m | +0.000 m | +22.5 °C | +0.00 kPa | +50.000 m³ |
| Tank-14 | No Product | +0.700 m | +0.000 m | +25.5 °C | +0.00 kPa | +70.000 m³ |
| Tank-15 | No Product | +0.700 m | +0.000 m | +25.5 °C | +0.00 kPa | +70.000 m³ |
| Tank-2 | Petrol | +9.511 m | +0.000 m | +25.5 °C | +0.00 kPa | +951.100 m³ |
| Tank-3 | No Product | +0.700 m | +0.000 m | +25.5 °C | +0.00 kPa | +70.000 m³ |
| Tank-4 | No Product | +0.500 m | +0.000 m | +22.5 °C | +0.00 kPa | +50.000 m³ |
| Tank-5 | No Product | +0.700 m | +0.000 m | +25.5 °C | +0.00 kPa | +70.000 m³ |
| Tank-6 | No Product | +0.700 m | +0.000 m | +25.5 °C | +0.00 kPa | +70.000 m³ |
| Tank-7 | No Product | +0.700 m | +0.000 m | +25.5 °C | +0.00 kPa | +70.000 m³ |
| Tank-8 | No Product | +0.700 m | +0.000 m | +25.5 °C | +0.00 kPa | +70.000 m³ |

Tank tabular view

Tank-1 SIMULATION MODE

Tank Location: Terminal-1 In Operation | Tank Height: +12.000 m | Roof Status: No Floating Roof N/A | Field Scan: Started INACTIVE

Tank Status: Max Tank Capacity: +0.000 m³ | Leg Status: W&M Status: Unused

Tank Overview

| Alarm Set Points | Value |
|------------------|----------|
| HI | +9.925 m |
| HA | +9.500 m |
| MF | +9.000 m |
| LA | +2.000 m |
| LI | +1.423 m |

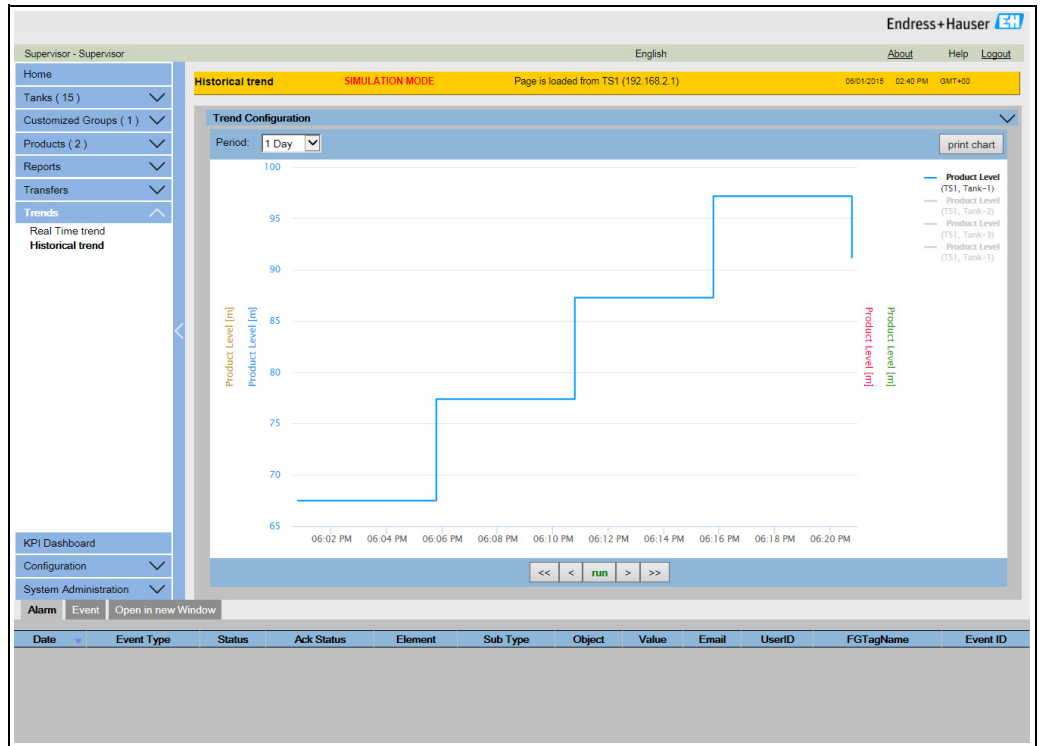
Main Values

| | | | | | |
|---------------------|------|------------|------------------|------|---------------|
| Product Level | Ok | +1.300 m | Secondary Level | Ok | +1.300 m |
| Product Temperature | Ok | +20.00 °C | Gauge Error | INIT | +0.0000000 |
| Gauge Status | INIT | +0.0000000 | Observed Density | Ok | +733.21 kg/m³ |

Secondary Values

| | | | | | |
|-----------------------|----|-------------|-----------------------|----|------------|
| Total Observed Volume | Ok | +130.000 m³ | Gross Observed Volume | Ok | +80.000 m³ |
| Total Mass | Ok | +88.657 Ton | | | |

Tank details



Trend view

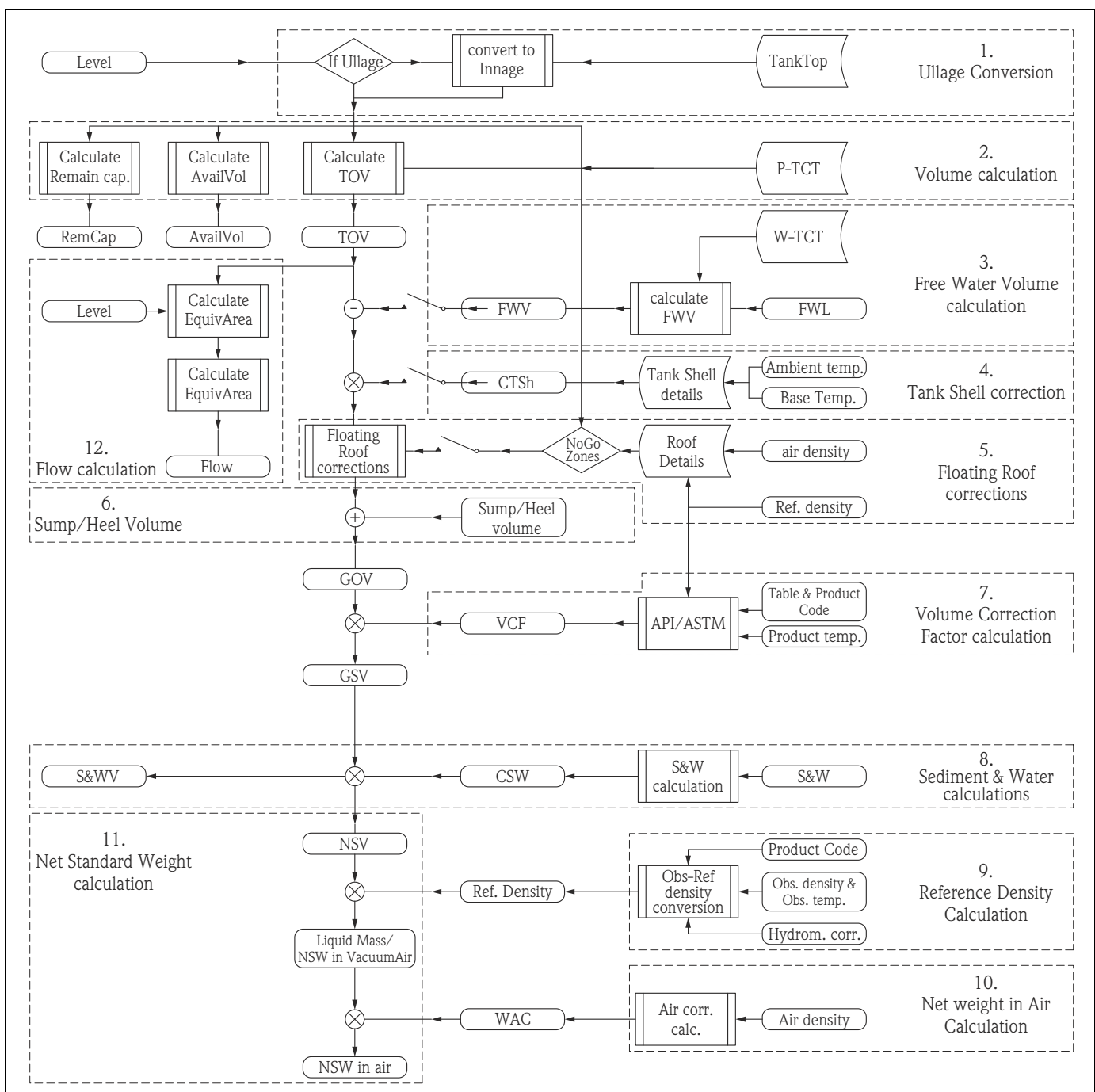
Trend

8 Calculations

Tankvision Tank Scanner can perform various kinds of calculations which are described in the following chapters. The inventory calculations allow the conversion from measured data like level and temperature to standard data (e.g. Net standard volume or mass). There are various standards for these calculations available differing in the sequence of the calculation or the way compensation factors are determined (from tables or formula). Today calculations from API (see Text → 29) and GB/T (see Text → 29) are implemented in Tankvision Tank Scanner.

8.1 API Flow Charts

The chart shows the sequence calculations are done according to the API. The different steps are explained in the following chapters.



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API (American Petroleum Institute)

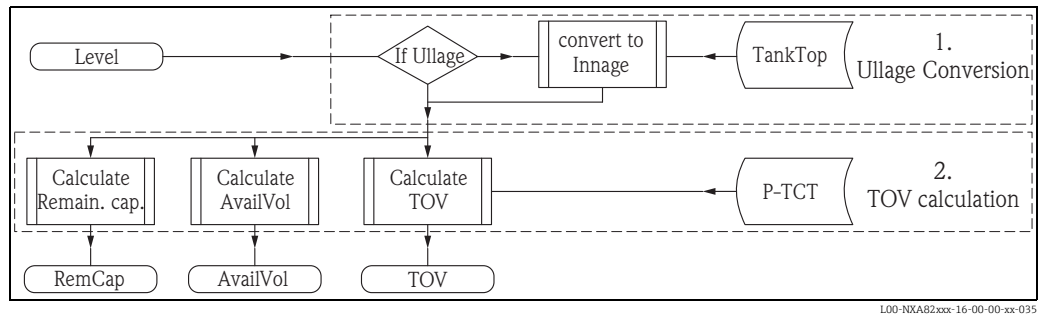
The American Petroleum Institute, commonly referred to as API, is the largest U.S trade association for the oil and natural gas industry. It claims to represent about 400 corporations involved in production, refinement, distribution and many other aspects of the petroleum industry.

The association's chief functions on behalf of the industry include advocacy and negotiation with governmental, legal and regulatory agencies; research into economic, toxicological and environmental effects; establishment and certification of industry standards; and education outreach. API both funds and conducts research related to many aspects of the petroleum industry.

GB (Chinese national standards)

GB standards are the Chinese national standards issued by the Standardization Administration of China (SAC), the Chinese National Committee of the ISO and IEC. GB stand for Guobiao, Chinese for national standard. Mandatory standards are prefixed "GB". Recommended standards are prefixed "GB/T". A standard number follows "GB" or "GB/T".

8.1.1 Total Observed Volume - TOV



The Total Observed Volume (TOV) is determined with the level information and the Tank Capacity Table (TCT). The TOV is the volume observed at the present (temperature) conditions.

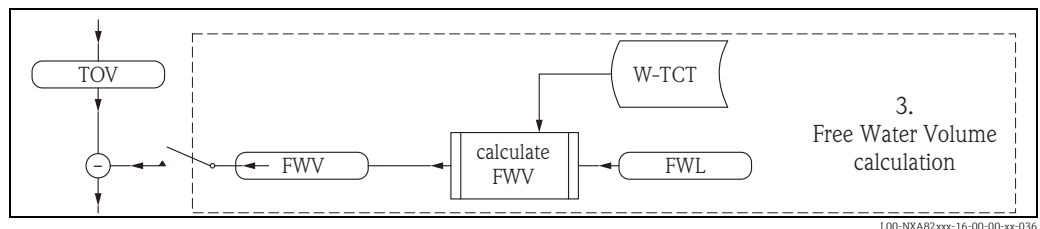
The TCT is a tank specific table created by calibration holding the level to volume transfer information. To differentiate the TCT for the Product and for the Water the TCT gets marked with a P (P-TCT).

The level information needed for this step is in innage which is the normal way the level is transferred from the gauge. In case the gauge inputs ullage to the system a calculation into innage is necessary beforehand (Ullage subtracted from Mounting position).

Two more information can be derived from TCT and level:

- Remaining Capacity (RemCap) shows how much more product could be pumped into the tank safely.
- Available Volume (AvailVol) indicates how much product can be pumped out of the tank to the lowest (defined) possible point e.g. the tank outlet.

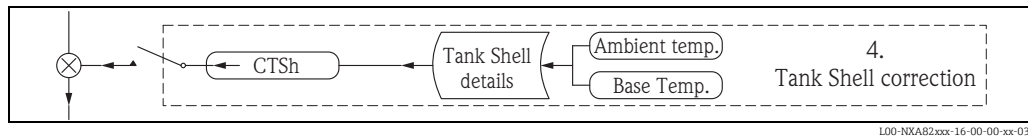
8.1.2 Free Water Volume - FWV



In some cases the tank can also contain water. It can derive from the delivered crude oil, the processing or by tank breathing. The (innage) water level information together with a Water Tank Capacity Table (W-TCT) result in the Free Water Volume. It is subtracted from the TOV.

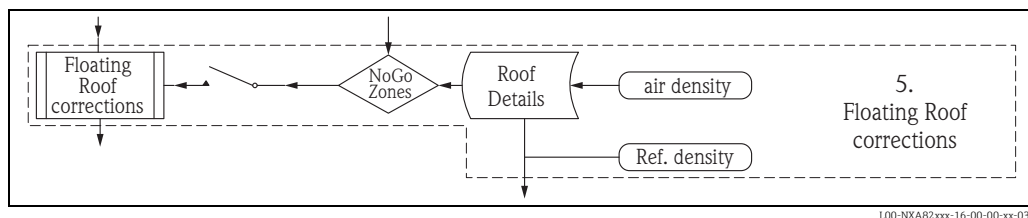
8.1.3 Tank Shell Correction - CTSh

- The Tank Shell expands and contracts with temperature changes (compared to TCT calibration temperature)
- Some countries require CTSh (Correction for Tank Shell temperature effects)
- For heated products the CTSh can be in excess of 0.3% TOV



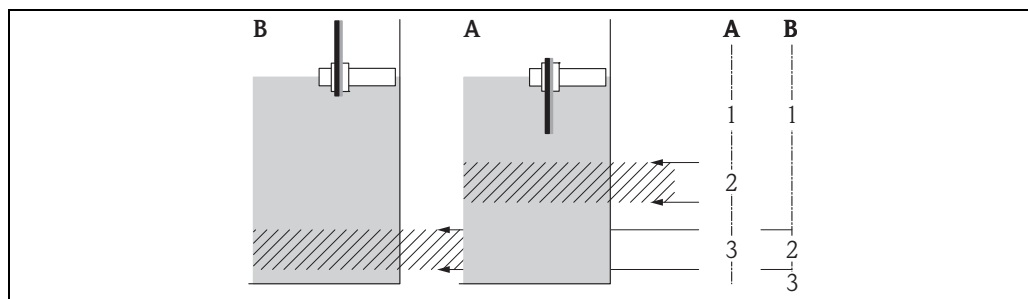
i For more details see → 56, Chapter "CTSh".
 The Tank Shell Correction is a factor which is multiplied with the TOV reduced by the FWV.

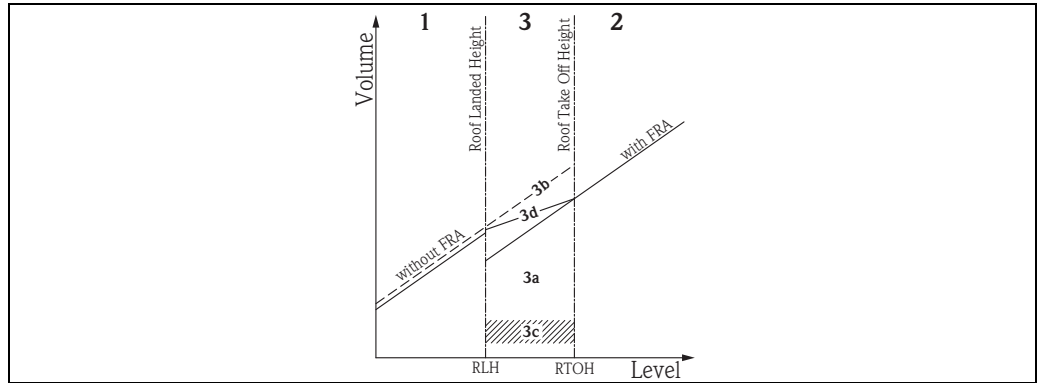
8.1.4 Floating Roof Correction - FRC



A tank can often have a floating roof. A floating roof is called so because it floats on the product stored in the tank. The roof moves up or down along with product level. Since the roof is floating on the tank, it displaces some amount of product depending on the weight of the roof and the density of the product. This displacement in product level results in a different apparent level, introducing an error into the volume calculations. The product volume therefore needs to be corrected.

A floating roof often has supporting legs. The roof can be rested on these legs when the level is too low or the tank is empty. This allows maintenance staff to enter below the roof for carrying on tank maintenance. Based on the product level, the floating roof can be landed on the legs or floating on the product. However, in a certain range of product level, the floating roof can be partially landed. This zone is called "critical zone". In the Tankvision system there can be two critical zones related to the position of the floating roof legs.





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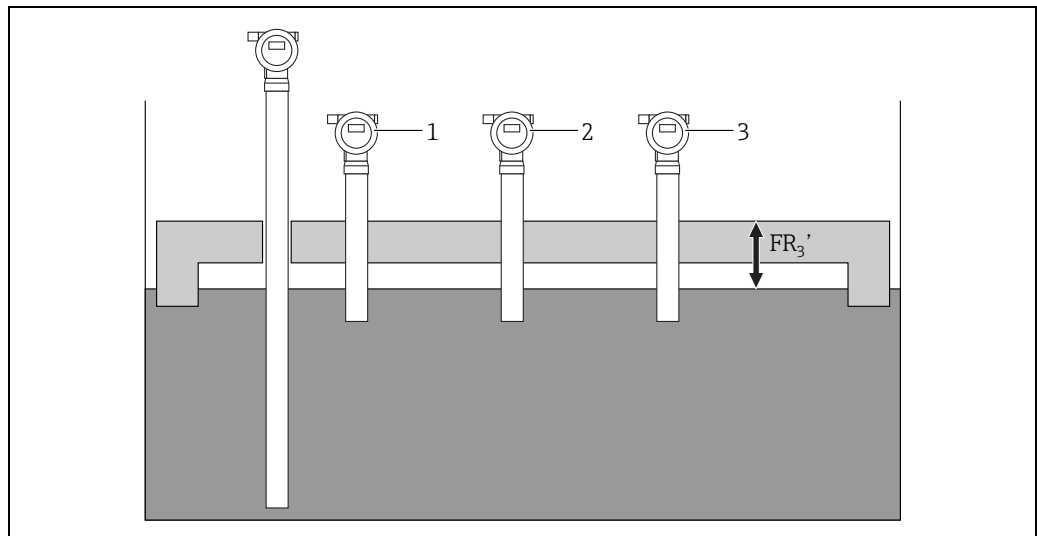
- Inside critical zone:
- 3a Apply full FRA
 - 3b Do not Apply FRA
 - 3c Do not calculate FRA
 - 3d Use partial FRA (interpolate)

i Floating roofs can already be considered in the TCT.

8.1.5 Weight correction of the floating roof

The Floating roof position can be changed due to heavy snowfall, rain, sand or during unloading which triggers the roof to fluctuate that may cause variations in the stock inventory calculation. It's required to compensate Floating Roof immersion and also to compensate changing weight on floating roof.

The floating roof position can be monitored with 3 additional level sensors mounted on top of the floating roof. The level devices are connected to gauges which will be connected to Tankvision NXA820.



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- 1 FR Level 1
- 2 FR Level 2
- 3 FR Level 3

To measure the submersion or elevation of a floating roof it is required to monitor the level of the roof. If the gauges are on the floating roof, then the average of the distances FR1/2/3 compared to the average of the Reference FR1/2/3 provide:

$$\Delta FR_1 = FR_1' - FR_1$$

$$\Delta FR_2 = FR_2' - FR_2$$

$$\Delta FR_3 = FR_3' - FR_3$$

$$\Delta FR = \frac{\Delta FR_1 + \Delta FR_2 + \Delta FR_3}{3}$$

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If $\Delta FR < 0$ then we have an elevation
 If $\Delta FR > 0$ then we have a submersion
 Additional volume and mass of the floating roof calculated as:

$$\Delta V = \Delta FR \times A_{FR}$$

$$\Delta m = \Delta FR \times A_{FR} \times \rho$$

A_{FR} : The numerical value of the horizontal cross-sectional area floating roof
 Δm : Additional Mass of the floating roof (Mass of snow, sand, rain or others)
 ρ : Observer Density
 ΔV : Addition Volume displaced in floating roof due to snow/rain/sand or others

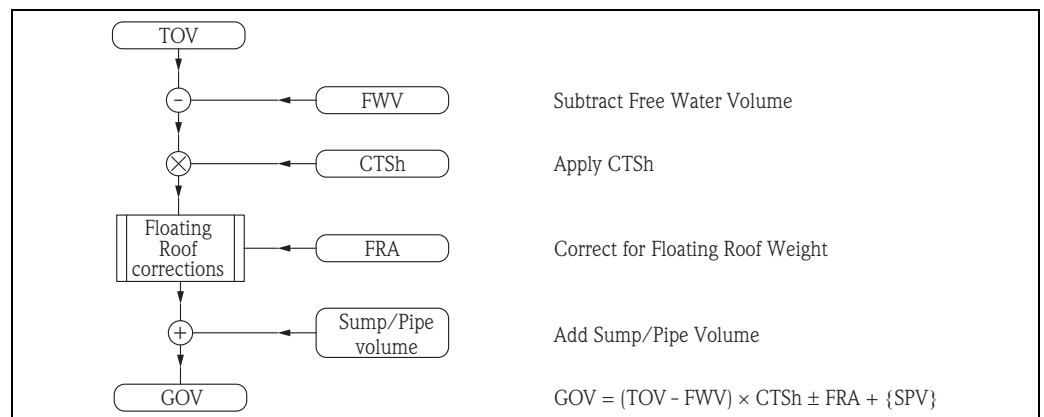
Total mass of the roof = Original mass of the Floating roof (m') + Additional Mass of the floating roof due to snow, rain etc. (Δm)
 $m = m' + \Delta m$
 $m = m' + \Delta FR * A_{FR} * \rho$

This equation can be used to calculate the GOV of the tank.
 $GOV = TOV - (\Delta FR * A_{FR} + m / \rho)$

8.1.6 Sump/Heel/Pipe volume

Volume of the Sump and Pipes are added.

8.1.7 Gross Observed Volume - GOV



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8.1.8 Volume Correction Factor - VCF

The VCF corrects for the temperature expansion of the liquid. Especially hydrocarbons have a large expansion factor. The most common VCF corrections were developed by American Society for Testing and Materials (ASTM), USA and Institute of Petroleum, UK and updated regularly. There are more authorities issuing VCF corrections. Most of them are derived from the ASTM/IP tables.

VCF Implementation

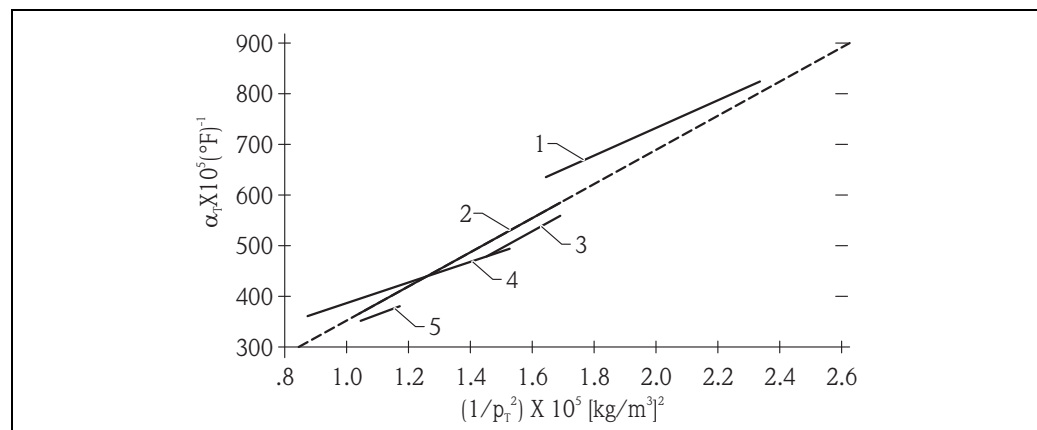
- Calculations are based on "representative samples" ("generalized products")

$$\text{VCF} = e^{-\alpha_{60}\Delta t(1.0+0.8\alpha_{60}\Delta t)}$$

- The "Tables" are based on specific calculation procedures

$$\alpha_{60} = \frac{K_0 + K_1 p + K_2 p^2}{p^2} = \frac{K_0}{p^2} + \frac{K_1}{p} + K_2$$

- Calculation is complex and rounding and truncating unique. There are many small but significant differences - exact requirements and needs depend on application, country and company.



- 1 Gasolines
- 2 Crudes
- 3 Jets
- 4 Fuel oils
- 5 Lube oils

VCF Tables

- The formulas are too complex for direct use - hence the "Tables" were printed
- There are specific tables for:
 - Products (crudes, refined products, lube oils, alcohols, palm oil, chemicals, etc.)
 - Different measurement units (kg/m^3 vs. $^\circ\text{API}$, $^\circ\text{C}$ vs. $^\circ\text{F}$, etc.)
 - Different "Reference" or standard temperature (60°F , vs. 15°C , 25°C or 30°C)
 - Each table has range limits
 - Tables for VCF and for density correction are available

Most known VCF "Tables"

The Tables are normally grouped in pairs:

- Tables 5 and 6 - ODC resp. VCF °API at 60 °F
- Tables 53 and 54 - ODC resp. VCF kg/m³ at 15 °C
- Tables 24 and 25 - ODC resp. VCF RD 60/60 °F at 60 °F
- Tables 50 and 60 - ODC resp. VCF kg/m³ at 20 °C

Most tables have so called Product Codes:

- A = for generalized crude's
- B = for refined products
- C = for chemicals
- D = for lube oils
- E = liquefied gases

For chemicals normally a "polynomial equation" is used.

Typical table example: 54B (1980)

The range of application:

| Density, kg/m ³ | Temperature, °C |
|----------------------------|-----------------|
| 653.0 to 778.5 | -18.0 to 90.0 |
| 779.0 to 824.0 | -18.0 to 125.0 |
| 824.5 to 1075.0 | -18.0 to 150.0 |

$$VCF = \text{EXP} [-\alpha_{15}\Delta t(1.0+0.8\alpha_{15}\Delta t)]$$

$$\text{where: } \Delta t = \text{DEGC} - 15.0$$

$$\alpha_{15} = \frac{K_0}{p_{15}^2} + \frac{K_1}{p_{15}}$$

$$K_0 = 346.4228$$

$$K_1 = 0.4388$$

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Special corrections*VCF Chemical 1*

$$VCF = (D_{\text{Ref}} - A \times 10E3 \times (T_{\text{Obs}} - T_{\text{Ref}}) - B \times 10E3 \times (T_{\text{Obs}} - T_{\text{Ref}})^2 - C \times 10E3 \times (T_{\text{Obs}} - T_{\text{Ref}})^3 - D \times 10E3 \times (T_{\text{Obs}} - T_{\text{Ref}})^4 - E \times 10E3 \times (T_{\text{Obs}} - T_{\text{Ref}})^5) / D_{\text{Ref}}$$

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with:

- D_{Ref} = Reference density
- T_{Obs} = Actual or observed temperature
- T_{Ref} = Reference Temperature
- A-E = Configurable coefficients

TCF Method

$$TCF = K_0 + K_1 \times \Delta t + K_2 \times \Delta t^2 + K_3 \times \Delta t^3 + K_4 \times \Delta t^4$$

$$\Delta t = t - T_{\text{Ref}}$$

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with:

- K_0, K_1, K_2, K_3, K_4 = Customer coefficients
- t = Actual product temperature
- T_{Ref} = Reference Temperature

For the VCF we can write:

$$TCF = 1 - TCF \times (T_{\text{Obs}} - T_{\text{Ref}})$$

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With the TCF method the p_{Ref} can be calculated with p_{Obs} / VCF (when manual p_{Obs} is provided) and an actual p_{Obs} can be calculated with $p_{\text{Ref}} \times VCF$, when p_{Ref} is known and no actual p_{Obs} is available.

Palm oil

$$D_{Obs} = K_0 + K_1 \times T_{Obs} + K_2 \times (T_{Obs})^2 + K_3 \times (T_{Obs})^3 + K_4 \times (T_{Obs})^4$$

$$D_{ref} = K_0 + K_1 \times T_{ref} + K_2 \times (T_{ref})^2 + K_3 \times (T_{ref})^3 + K_4 \times (T_{ref})^4$$

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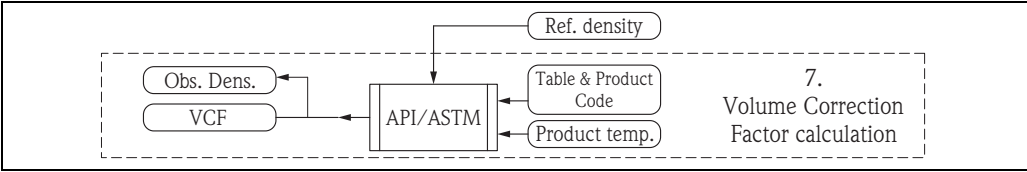
For the VCF we can easily derive: $VCF = D_{Obs}/D_{ref}$

$$VCF = \frac{K_0 + K_1 \times T_{Obs} + K_2 \times (T_{Obs})^2 + K_3 \times (T_{Obs})^3 + K_4 \times (T_{Obs})^4}{K_0 + K_1 \times T_{ref} + K_2 \times (T_{ref})^2 + K_3 \times (T_{ref})^3 + K_4 \times (T_{ref})^4}$$

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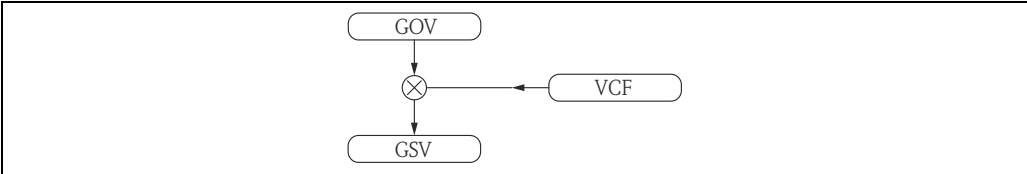
VCF Calculation

- The API/ASTM Tables are a "primary" need for any Tank Inventory system



The correct table for the product must be chosen. Together with the Product temperature and reference density the VCF can be calculated. In addition to the VCF the observed density can be calculated.

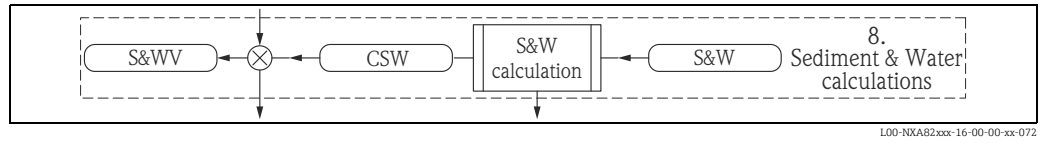
8.1.9 Gross Standard Volume - GSV



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The Gross Standard Volume is calculated by applying the VCF to the GOV.

8.1.10 Sediment & Water - S&W



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- Some products have entrained (suspended) sediment and water (S&W)
 - i.e. crudes
- S&W is determined from sample by laboratory method ("Karl-Fisher"-method). The Sediment and Water percentage (S&W%) determined with the sample is transferred in the Sediment and Water Fraction (SWF). A correction factor for the product is determined.

As second result the Sediment and Water Volume can be calculated.

Sediment & Water calculation methods

There are 6 methods to calculate S&W

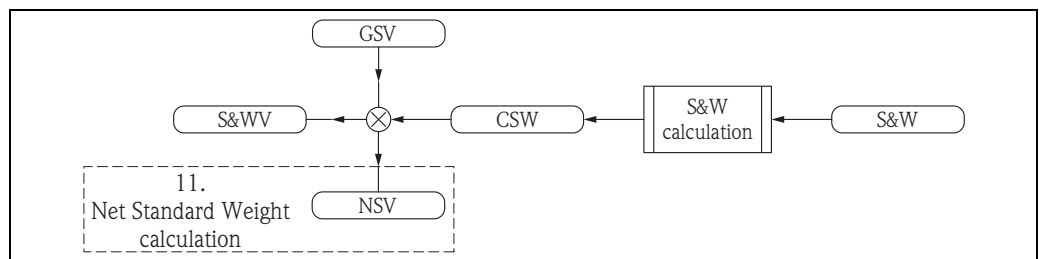
1. $SWV = 0$
2. $SWV = TOV \times SWF$
3. $SWV = (TOV - FWV) \times SWF$
4. $SWV = \{(TOV - FWV) \times CTSh\} \times SWF$
5. $SWV = GOV \times SWF$
6. $SWV = GSV \times SWF$ ("standard" or "default" method)

Where the sediment and water fraction (SWF) is:

$$SWF = 1 - (100 - S\&W\%) / 100 = S\&W\% / 100$$

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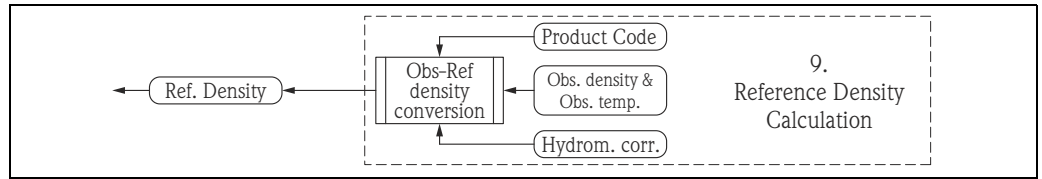
8.1.11 Net Standard Volume - NSV



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Subtracting the SWV from the GSV result in Net Standard Volume.

8.1.12 Density calculations



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We have to distinguish between: observed and reference density

- Observed density is the density of the product at actual (observed) temperature
- Reference density is the density the product would have if we heat/cool it until the reference temperature (usually 15 °C/60 °F)
- Reference density is used to calculate VCF, FR and mass
- If you know the RefDens you can easily get the ObsDens
ObsDens = RefDens x VCF
- If you know the ObsDens you need (API/ATSM) tables and the sample temperature to get the RDC (reference density correction factor).
- You can also correct for the thermal expansion of the hydrometer glass (HYC)
RefDens = RDC x ObsDens x HYC

Hydrometer Correction - HYC

$$HYC = 1.0 - A_{HYC} \times (t - T_{Cal}) - B_{HYC} \times (t - T_{Cal})^2$$

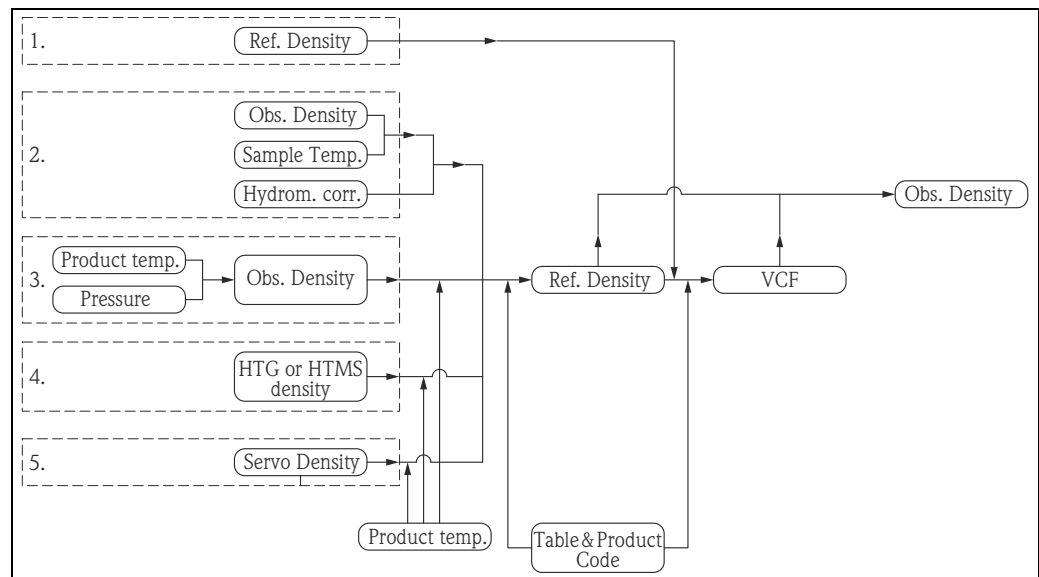
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with:

- HYC = Hydrometer correction
- A_{HYC} , B_{HYC} = Thermal expansion coeff. for glass
- t = Temperature of sample
- T_{Cal} = Calibration temperature of glass hydrometer

| T_{Cal} | A_{HYC} | B_{HYC} |
|-----------|--------------|---------------|
| 15 °C | 0.000 0230 0 | 0.000 000 020 |
| 60 °F | 0.000 0127 8 | 0.000 000 062 |

Density handling in NXA820



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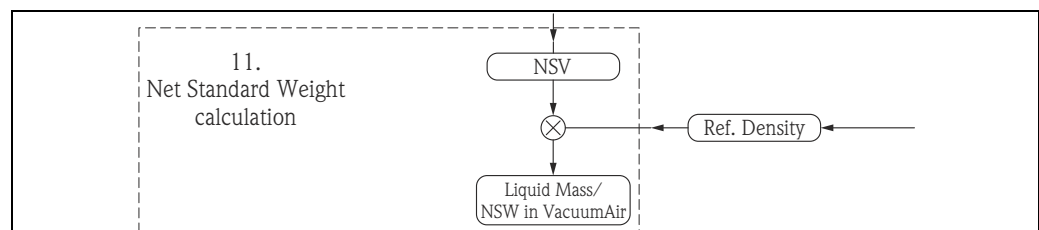
NXA820 offers various possibilities to enter and further process density information:

1. Manual entry of Reference density (from laboratory)
2. Manual entry of Observed density with the according sample temperature (from laboratory) is required corrected for the hydrometer. With the above information and the according Product information and ASTM/IP table (for density correction) the reference density can be calculated.
3. Product pressure, temperature, density table (PTD table): look up table for observed density with the use of measured product temperature and pressure. With the from the table derived Observed density, the product temperature and the according Product information and ASTM/IP table (for density correction) the reference density can be calculated.
4. Density from HTG or HTMS calculation (→ 48). With the from the calculations derived Observed density, the product temperature and the according Product information and ASTM/IP table (for density correction) the reference density can be calculated.
5. Density measured by Servo gauge. With the by the servo gauge measured Observed density, the product temperature and the according Product information and ASTM/IP table (for density correction) the reference density can be calculated.

Having the reference density and the according Product information and ASTM/IP table (for volume correction) the VCF can be determined.

Observed density can be calculated by multiplying reference density with VCF.

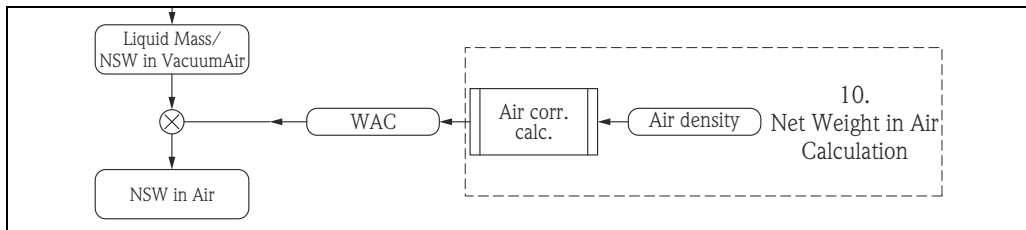
8.1.13 Mass/Net Weight in Vacuum



L00-NXA82xxx-16-00-00-xx-074

- Mass in temperature and product property independent
- Mass is needed for "Loss Reconciliation" required for every refinery and terminal
- Mass is calculated out of NSV and the reference density (or GOV and observed density)

8.1.14 Net Weight in Air - NWA



L00-NXAB2xxx-16-00-00-xx-075

- The flotation of a body is based on the principle discovered by Archimedes on century 3 BC "Every submerged body in a liquid experience a vertical upper force that is equal to the weight of the liquid displaced"
- Considering the liquid displaced is air
- The flotation is related to the liquid density where the body is floating because:
Weight = Vol x Dens.

Calculation formula:

$$WAC = \frac{1 - \left(\frac{Dens_{Air}}{Dens_{Ref}}\right)}{1 - \left(\frac{Dens_{Vap}}{Dens_{Brass}}\right)}$$

$$NWA = WAC \times Mass$$

L00-NXAB2xxx-16-00-00-xx-075

DensAir Air density

DensRef Product reference density

DensVap vapor density

DensBrass Brass density used to calibrate the weight scale

Net weight in Air methods

| WAC Methods | Calculated | AirDen | VapDen | BrassDen |
|-----------------------|------------|--------|--------|----------|
| Weight in vacuum | No | 0 | 0 | 0 |
| OIML R85 | Yes | 1.2 | 1.2 | 8000 |
| Table 56 | Yes | 1.22 | 1.22 | 8100 |
| Table 57 (short tons) | Yes≈ | 1.2194 | 1.2194 | 8393.437 |
| Table 57 (long tons) | Yes | 1.224 | 1.224 | 8135.8 |
| Simplified | Yes | 1.1 | 0 | 1 |
| Custom | Yes | 1.225 | 1.225 | 8553 |

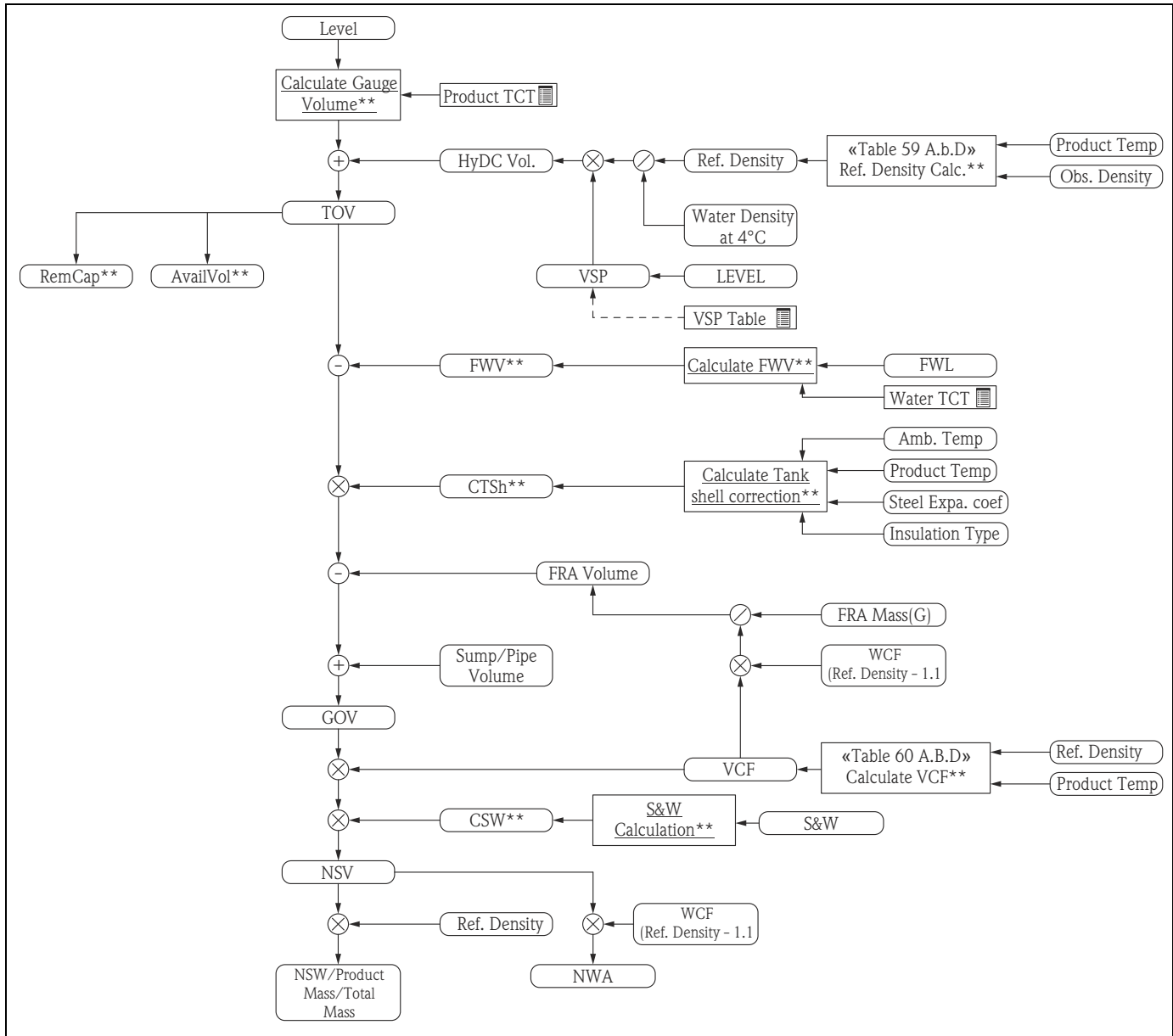


The Net Standard Weight in Air is in some countries called Mass.

8.2 GBT calculation flow chart

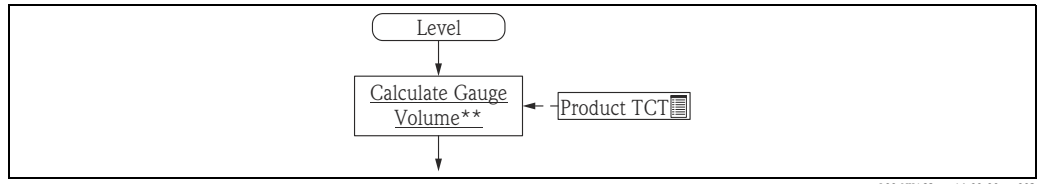
The GBT standard is the standard for China.

Main difference is the hydrostatic deformation of the tank not being part of the product TCT but in a separate table. The VCF and density calculations are based on the same ASTM/IP tables like the API calculations.



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8.2.1 Calculated Gauge Volume



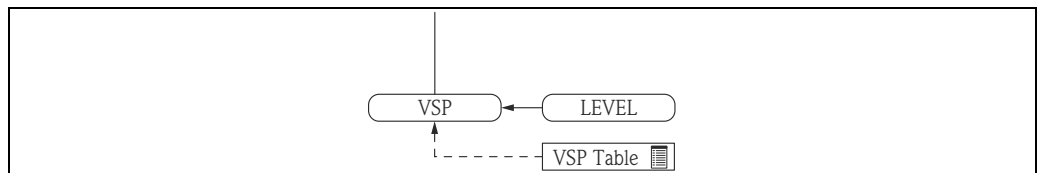
L00-NXA82xxx-16-00-00-xx-093

The Calculated Gauge Volume is determined with the level information and the Tank Capacity Table (TCT). The Calculated Gauge Volume is the volume observed at the present (temperature) conditions without considering the hydrostatic deformation of the tank.

The TCT is a tank specific table created by calibration holding the level to volume transfer information. To differentiate the TCT for the Product and for the Water the TCT gets marked with a P (P-TCT).

The level information needed for this step is in innage which is the normal way the level is transferred from the gauge. In case the gauge inputs ullage to the system a calculation into innage is necessary beforehand (Ullage subtracted from Mounting position).

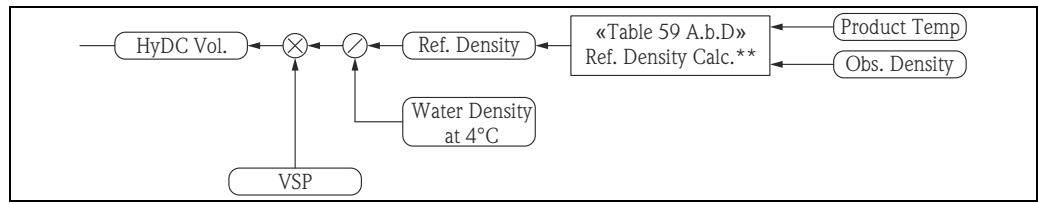
8.2.2 Static Pressure Correction Volume - VSP



L00-NXA82xxx-16-00-00-xx-094

The VSP is determined with the level information and the static pressure correction table (VSP-table). The VSP is the volume the tank expands at the actual level if it would be filled with water (wet calibration).

8.2.3 Hydrostatic Deformation Correction Volume - HyDC Vol



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The Hydrostatic Deformation Correction Volume is the real from the product fill level created hydrostatic volume.

It is calculated by correcting the VSP with the ratio of the density of the product versus the water density.

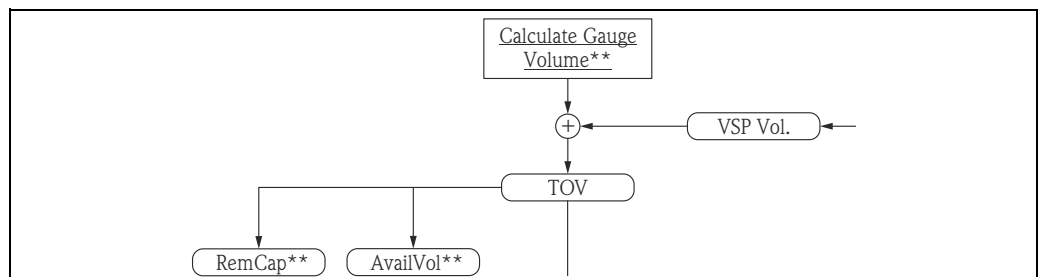
$$HyDC = [Vsp \times \rho_r]$$

$$\rho_r = [\rho_{20} / \rho_{w4}]$$

ρ_{20} Reference Density at 20 °C (68 °F)
 ρ_{w4} Water Density at 4 °C (39 °F)

The reference density of the Product can be calculated (if not known) with the Observed Density, the Product/Sample Temperature and the Reference Density Table for the Product.

8.2.4 Total Observed Volume - TOV



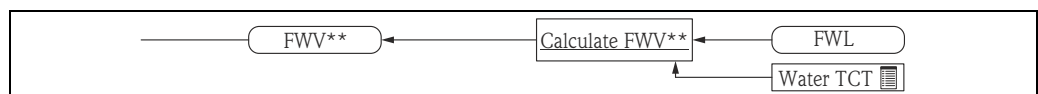
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The Total Observed Volume is calculated from the Calculated Gauge Volume and the Hydrostatic Deformation Correction Volume.

Two more information can be derived from TCT and level:

- Remaining Capacity (RemCap) shows how much more product could be pumped into the tank safely
- Available Volume (AvailVol) indicates how much product could be pumped out of the tank to the lowest (defined) possible point e.g. the tank outlet.

8.2.5 Free Water Volume - FWV

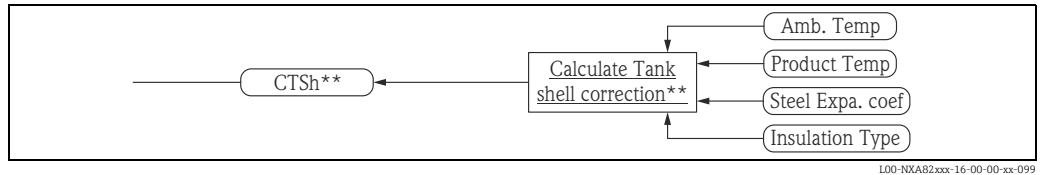


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In some cases the tank can also contain water. It can derive from the delivered crude oil, the processing or by tank breating.

The (innage) water level information together with a Water Tank Capacity Table (W-TCT) result in the Free Water Volume. It is subtracted from the TOV.

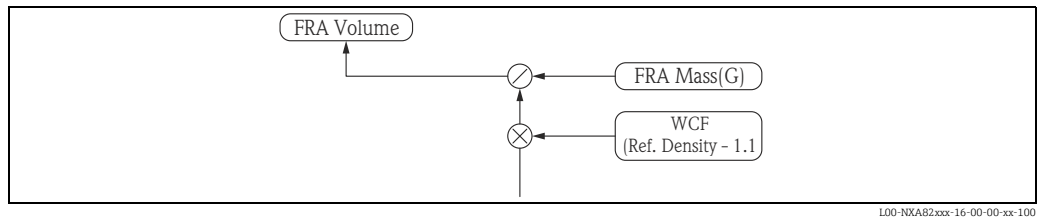
8.2.6 Correction for the thermal Expansion of the tank shell - CTSh



- The Tank Shell expands and contracts with temperature changes (compared to TCT calibration temperature)
- Some countries require CTSh (Correction for Tank Shell temperature effects)

i For more details see → 56, Chapter "CTSh".

8.2.7 Floating roof adjustment - FRA



i Additional displacement due to the air is considered, see Net Weight in Air calculation.

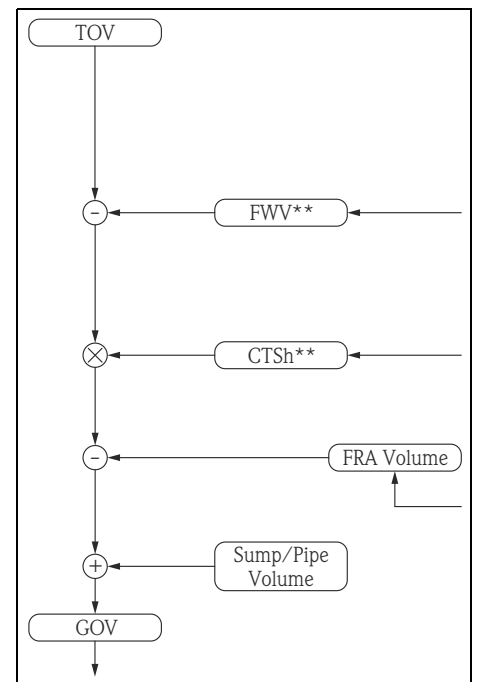
8.2.8 Sump/pipe volume

The Volume of the sump and pipes is added.

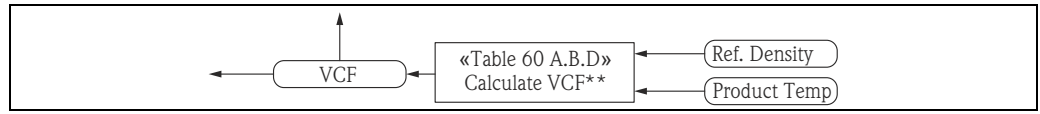
8.2.9 Gross Observed Volume - GOV

GOV is calculated like follows:

- Starting from the TOV
- Subtract FWV
- Multiply by the thermal expansion correction factor
- Subtract the floating roof adjustment volume and
- Add the Sump/pipe volume

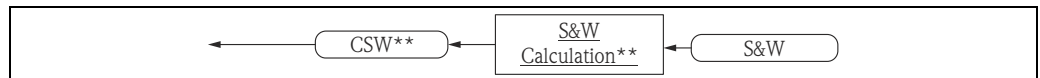


8.2.10 Volume Correction Factor - VCF



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8.2.11 Sediment and Water



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- Some products have entrained (suspended) sediment and water (S&W)
 - i. e. crudes
- S&W is determined from sample by laboratory method ("Karl-Fisher"-method). The Sediment and Water percentage (S&W%) determined with the sample is transferred in the Sediment and Water Fraction (SWF). A correction factor for the product is determined.

As second result the Sediment and Water Volume can be calculated.

Sediment & Water calculation methods

There are 6 methods to calculate S&W

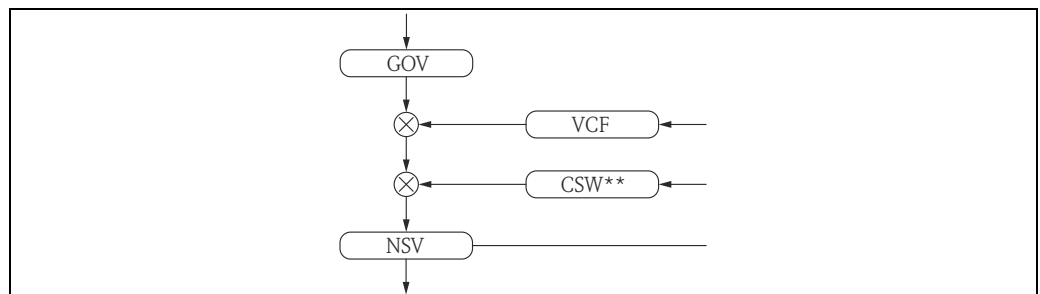
1. SWV = 0
2. SWV = TOV x SWF
3. SWV = (TOV - FWV) x SWF
4. SWV = {(TOV - FWV) x CTSh} x SWF
5. SWV = GOV x SWF
6. SWV = GSV x SWF ("standard" or "default" method)

Where the sediment and water fraction (SWF) is:

$$SWF = 1 - (100 - S\&W\%) / 100 = S\&W\% / 100$$

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8.2.12 Net Standard Volume - NSV

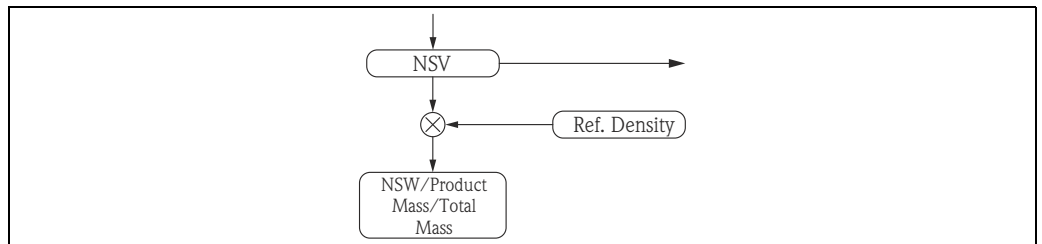


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Net Standard Volume is calculated like follows:

- Starting from GOV
- Multiply by the Volume Correction Factor and
- Multiply by the S&W correction factor

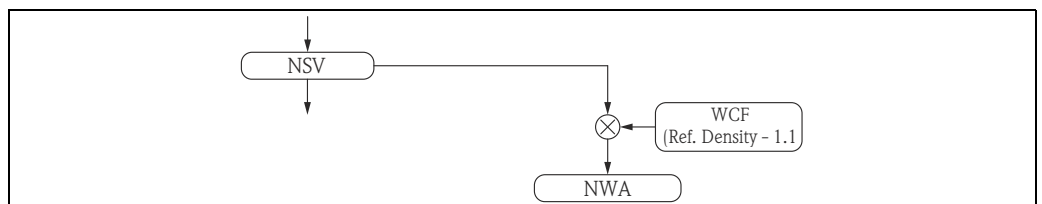
8.2.13 Net Standard Weight - NSW / Product Mass



L00-NXA82xxx-16-00-00-xx-105

Mass is calculated by multiplying NSV with the Reference density.

8.2.14 Net Standard Weight in air - NWA



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The Net Standard Weight in Air is calculated by multiplying the NSV with the Reference Density reduced by the influence of the Air buoyancy (Reference density - 1.1).

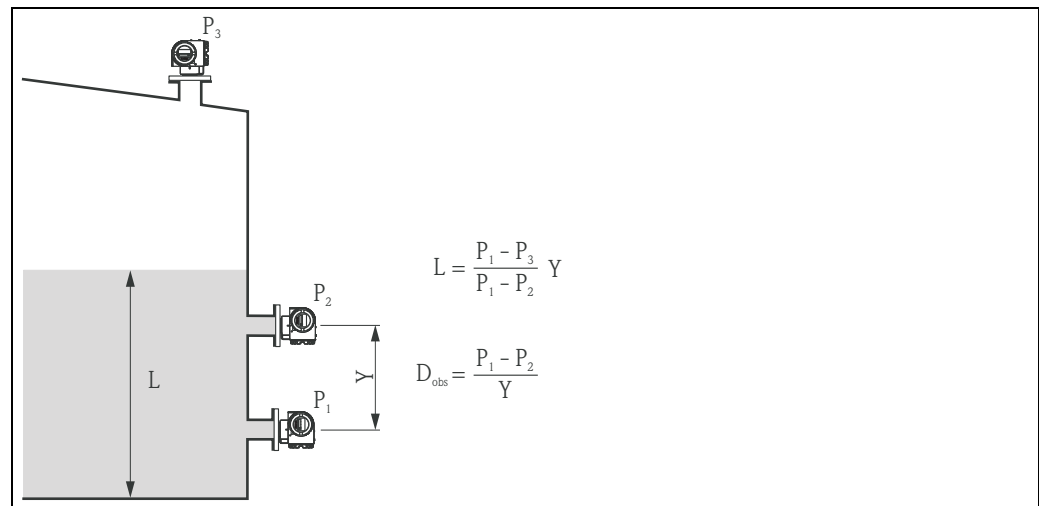
8.3 Mass Measurement

Today, most hydrocarbons in the western world are bought and sold using volume measurement. However, in many eastern countries and in some specialised industries, product are sold based on mass due to traditions in particular markets, so mass calculation can be important in those areas of trade. Mass-based measurement offers other advantages, since mass is independent of product temperature and other parameters. For custody transfer, high accuracy tank gauging is required, and mass-based calculation is often used.

8.3.1 Hydrostatic Tank Gauging

The advantage of HTG is that it provides direct mass measurement with only pressure transmitters to measure hydrostatic pressure in determining density via a fixed distance and vapor pressure. Therefore, it is a low-cost solution for mass measurement. However, there are substantial disadvantages:

- Level and volume measurements are less accurate, especially when density stratification occurs.
- Density is only measured at the between the two pressure sensors.
- Difficult to verify, commission and calibrate



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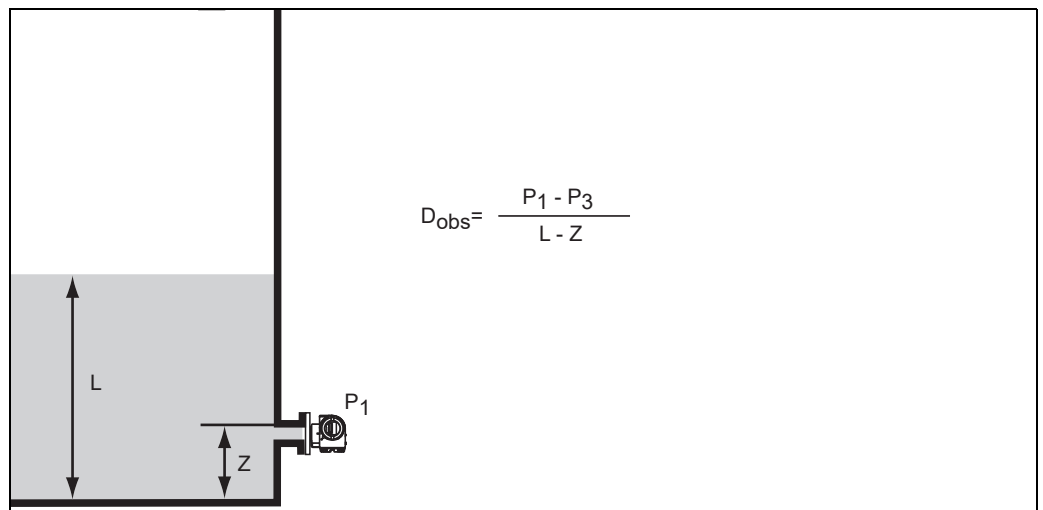
The middle or P_2 transmitter is unique to Hydrostatic Tank Gauging.

8.3.2 Hybrid Tank Measurement Systems

A Hybrid Tank Management System (HTMS) is a combination of conventional level gauging, enhanced with one or two pressure transmitters for continuous measurement of the actual observed density in a bulk liquid storage tank. Or otherwise stated, it is a combination of level and hydrostatic pressure measurement. Pressure measurement, combined with level, provides true average density measurement over the entire product level height. Normally, the vapor (top) pressure is identified as P_3 and the hydrostatic (bottom) pressure is identified as P_1 .

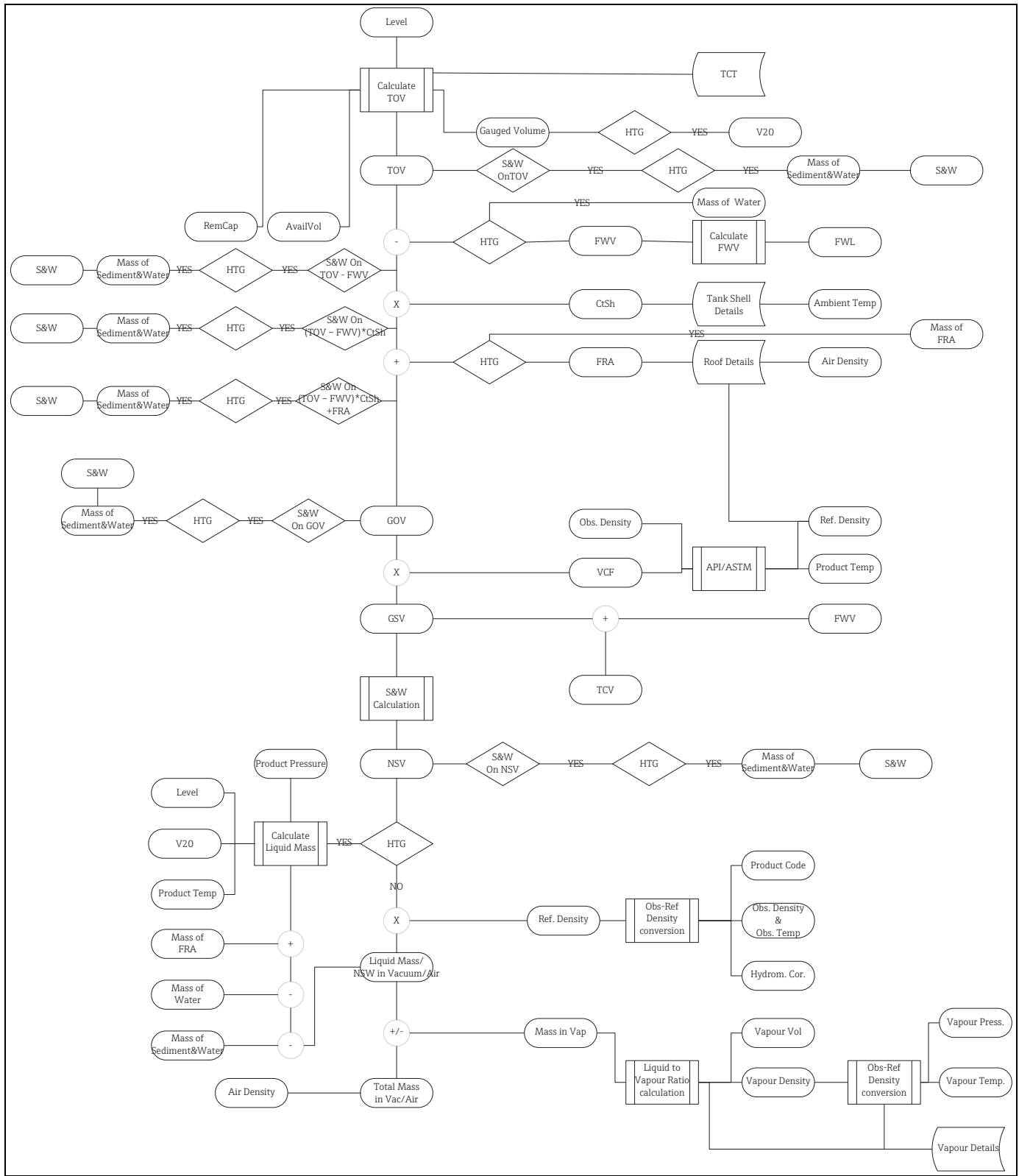
Advantage of HTMS

- Accurate level measurement
- Continuous density measurement
- Excellent mass and volume measurements



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8.3.3 HTG Calculation according to GOST R 8.595-2004



Enhanced-HTG-calculation

In case of indirect method based on hydrostatic principle, the product mass in capacity measures shall be determined by the measurement results of:

- Hydrostatic pressure of a product column – with aid of stationary measuring instrument of hydrostatic pressure.
- The product level – with aid of portable or other means of level measurement.

The stock-tank oil net mass shall be determined as a difference of a stock-tank oil gross mass and a dead matter mass. The dead matter mass shall be determined as a total mass of water, salts and mechanical impurities in stock-tank oil. For this purpose the mass fractions of water, mechanical impurities and chloride salts shall be determined in stock-tank oil and their masses calculated.

The stock-tank net mass shall be calculated using the formula:

$$m = m_{\text{total}} - m_{\text{dead matter}}$$

Where:

- m_{total} = the stock-tank gross mass, determined as described below
- $m_{\text{dead matter}}$ = the dead mass, calculated as described below.

Formula Details

This calculation is based on the correction of volume to 20 °C, in the Tankvision system 15 °C is the default temperature for reference condition – not 20 °C as per requirement for the GOST R 8.595-2004 standard.



The formula is fixed for 20 °C reference condition, configure VCF to use also 20 °C as reference.

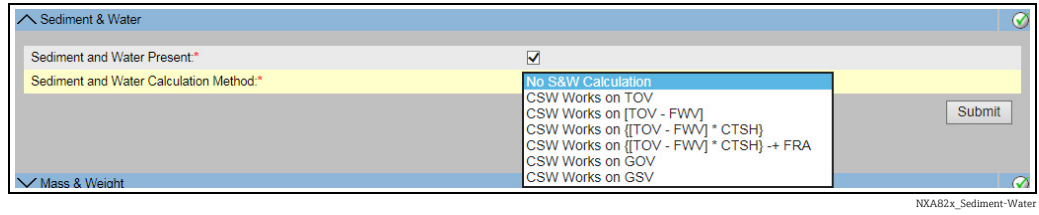
$$m = m_{\text{total}} - m_{\text{dead matter}}$$

Where:

$$m_{\text{total}} = (1 / g) \times P \times V_{20}(1 + 2\alpha(T_{\text{CT}} - 20)) / H$$

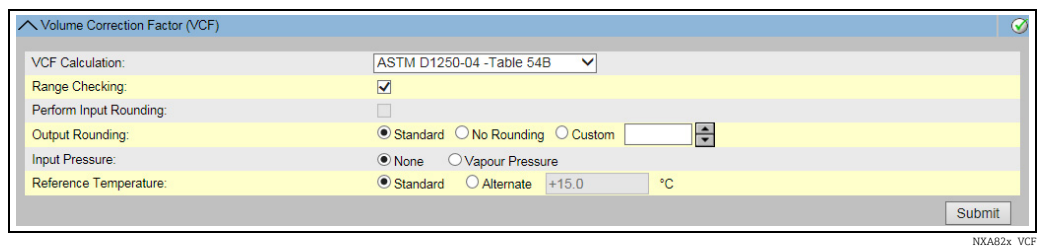
And

- V_{20} = TOV
- $m_{\text{dead matter}} = m_{\text{Water}} - m_{\text{FloatingRoof}} + m_{\text{Sediment\&Water}}$
- $m_{\text{Water}} = \text{FWV} \times \text{Wat. Density}$
- $m_{\text{Sediment\&Water}} = \text{SW_Volume} \times \text{S\&W\%} \times \text{Ref. Density}$
- $m_{\text{FloatingRoof}} = \text{FRA} \times \text{Obs. Density}$
- $g = 9.81 \text{ m/sec}^2$ (adjustabel system environment setting)
- P = Product Pressure (P_PRESS)
- α = Temperature expansion factor (Fixed value shall be used: $12.5 \times 10^{-6} \text{ 1/}^\circ\text{C}$)
- V_{20} = Gauged Volume corrected to 20 °C (TOV shall be used)
- T_{CT} = tank wall temperature (PROD_TEMP Product Temperature shall be used)
- H = Product level (P_LEVEL)
- FRA = Floating Roof Adjustment
- Obs. Density = Observed Density
- TOV = Tank Observed Volume
- VCF = Volume Correction Factor
- FWV = Free Water Volume
- Wat. Density = Density of Water
- NSV = Net Standard Volume
- Ref. Density = Reference Density
- S&W% = Percentage of Sediment and Water
- SW_Volume = the volume used according to the configuration set by the user to define how to apply the sediment and water effect, according to this setting it could be equal to:
 - TOV
 - TOV - FWV
 - (TOV - FWV)*CtSh, with CtSh is Tank Shell Correction factor
 - (TOV - FWV)*CtSh +FRA
 - GOV = Gross Observed Volume
 - NSV



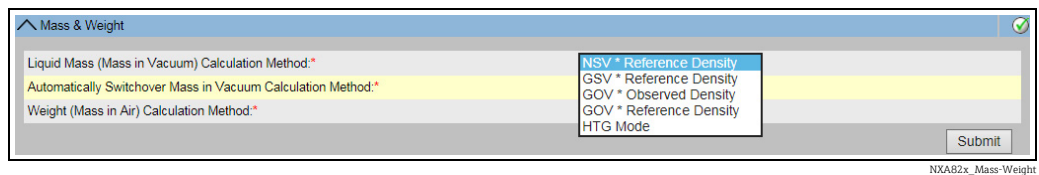
i REF_TEMP = default 15 °C

REF_TEMP will be set from the **Reference Temperature** setting from the VCF setting (see figure below: Reference Temperature setting used as calculation input). **Standard** is equal to 15 °C. To change the reference condition to 20 °C, select the **Alternate** setting, which shall be the new REF_TEMP.



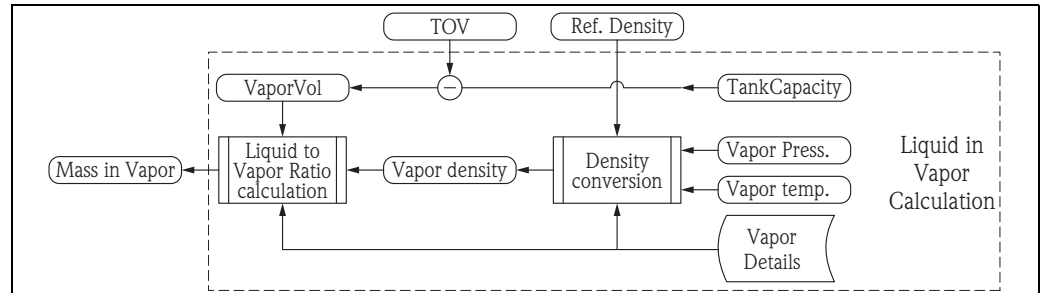
System Integration

The selection when to use the HTG method to calculate the mass is placed in the product settings in the sub section **Mass & Weight**. In the **Liquid Mass (Mass in Vacuum) Calculation Method** dropdown menu you can find an entry called **HTG Mode**.



8.4 Calculations for liquefied gases

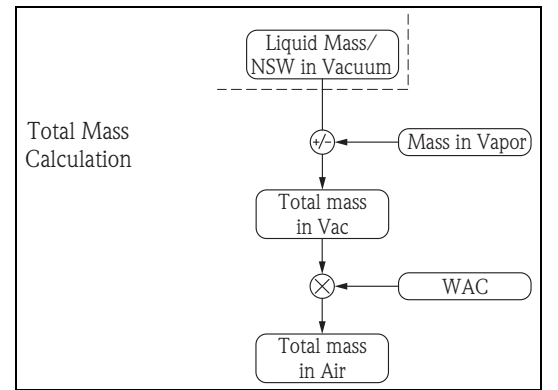
The mayor difference in the calculation for liquefied gases compared to liquids is that the gas phase must be considered. Therefore a calculation for the mass of the product in the gas phase must be applied.



L00-NXA82xxx-16-00-00-xx-107

8.4.1 Total Mass

Total Mass = Liquid Mass + Vapor Mass



L00-NXA82xxx-16-00-00-xx-108

8.4.2 MBR method

- The method is based on a specific done by "Moore, Barrett & Redwood" in November 1985. The calculation procedure was specified for "Whessoe Systems and Controls Ltd."
- Apart from the gas calculation, MBR defines a whole process to calculate VCF and RDC.
- This method is intended only for LPGs, but it might also give acceptable results for other Chemical gases - as long as the density and temperature are within the specified range.
- Density Input Range: 470 to 610 kg/m³.
- Temperature Input Range: -85 to 65 °C (-121 to 149 °F).
- It is not possible to use the M, B & R method for other Reference Temperatures than 15 °C.

The method is based on 10 steps:

1. Measure and input the data
2. VCF Calculation
3. Observed Density calculation
4. Calculate GSV
5. Calculate Liquid Mass
6. Calculate Vapor Volume
7. Calculate Vapor Density
8. Calculate Vapor Mass
9. Calculate Total Mass
10. Calculate Total Weight

MBR - Data to be measured (1)

For the LPG application the following data should be real-time measured on the tank(s):

- Product level
- Product Temperature (spot or average)
- Vapor Temperature (spot or average)
- Vapor space pressure - also called "Vapor pressure"

Input data

- The liquid density at 15 °C (60 °F) has to be input by the operator. This density can either be obtained from a pressurized hydrometer and corrected via an appropriate table or should be established on basis of chemical analysis.
- The method as implemented in Tankvision also allows the operator to enter Observed or Actual density as a manual value. Tankvision will then calculate the corresponding Reference Density.

MBR - VCF Calculation (2)

The following formula shows the calculation method.

$$\begin{aligned}
 X &= (\text{DENL15} - 500) / 25 \\
 Y1 &= 0.296 - 0.2395 * X + 0.2449167 * X * X - 0.105 * X * X * X + 0.01658334 * X * X * X * X \\
 Y2 &= 368.8 + 4.924927 * X + 13.66258 * X * X - 6.375 * X * X * X + 1.087503 * X * X * X * X \\
 TR &= 298.2 / Y2 \\
 TT &= (1 - TR)^{(1/3)} \\
 VO &= 1 - 1.52816 * TT / 1.43907 * TT * TT - 0.81446 * TT * TT * TT / 0.190454 * TT * TT * TT * TT \\
 VD &= (-0.296123 + 0.386914 * TR - 0.0427258 * TR * TR - 0.0480645 * TR * TR * TR) / (TR - 1.00001) \\
 V1 &= VO * (1 - Y1 * YD) \\
 TR &= (TL + 273.2) / Y2 \\
 TT &= (1 - TR)^{(1/3)} \\
 VO &= 1 - 1.52816 * TT / 1.43907 * TT * TT - 0.81446 * TT * TT * TT / 0.190454 * TT * TT * TT * TT \\
 VD &= (-0.296123 + 0.386914 * TR - 0.0427258 * TR * TR - 0.0480645 * TR * TR * TR) / (TR - 1.00001) \\
 V2 &= VO * (1 - Y1 * VD) \\
 VCF &= V1 / V2
 \end{aligned}$$

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MBR - Observed density (3)

The observed density is calculated using the reference density and the VCF:

- Observed density = Density at 15 °C (60 °F) x VCF



The above equation can not be used to calculate the density under reference conditions (i.e. 15 °C (60 °F)).

MBR - Calculate GSV (4)

The gross standard volume is calculated using the Total observed volume and the VCF

- G.S.V = T.O.V x VCF

MBR - Calculate Liquid Mass (5)

The liquid mass is calculated out of the gross standard volume and the reference density:

- Liquid Mass = G.S.V. x Density at 15 °C (60 °F)

MBR - Calculate Vapor Volume (6)

The vapor volume is obtained using the total tank volume and the liquid total observed volume:

- Vapor volume = Total Tank Volume - TOV

MBR - Calculate Vapor Density (7)

There are some steps to be followed to get the vapor density

- Molecular weight (MW)

$$X = (D.\text{Ref} - 500 / 33.3333)$$

$$MW = 43 + 4.4 \times X + 1.35 \times X^2 - 0.15 \times X^3$$

- Critical temperature and pressure

$$TC = 364 + 13.33 \times X + 8.5 \times X^2 - 1.833 \times X^3$$

$$PC = 43 - 2.283 \times X + 0.05 \times X^2 - 0.0667 \times X^3$$

- Reduced temperature and pressure

$$TR = (TV + 273.2) / TC$$

$$PR = (VP + 1.103) / PC$$

- Compressibility

$$W = 0.214 - 0.034333 \times X + 0.005 \times X^2 - 0.0001667 \times X^3$$

Locate smallest root of:

$$Z^3 - Z^2 + Z \times (A - b - B^2) - A \times B$$

With:

$$A = 0.42747 \times L^2 \times PR/TR^2$$

$$B = 0.08664 \times PR/TR$$

$$L = 1 + (0.48 + 1.574 \times W - 0.176 \times W^2) \times (1 - \text{SORT}(TR))$$

Compressibility Z should be in the range of 0.2 to 1 for typical LPG applications.

- Vapor density

$$\text{VapDen} = (MW \times (VP + 1.013)) / (0.08314 \times (TV + 273.2) \times Z)$$



The Vapor density is calculated in [kg/m³]

MBR - Calculate Vapor Mass (8)

- The vapor mass (VM) can now be calculated:

$$MV = \text{Vapor Space} \times \text{VapDens}$$

- Calculate Total Mass:

$$\text{Total Mass} = \text{Liquid Mass} + \text{Vapor Mass}$$

- Equivalent Vapor Liquid Volume

$$\text{EVLV} = \text{Vapor Mass} / \text{Liq. Ref. Density}$$

8.5 CTSh

8.5.1 What is CTSh

CTSh stands for "Correction for Temperature of the Tank Shell". CTSh is about correcting for when the temperature of the tank shell is different than the calibration temperature of the tank.

This temperature influence affects the calculated Inventory via (1) the gauge reading, and (2) via a change in the capacity of the tank as the tank diameter has changed under the temperature effect.

| Temperature difference | Volume change | Temperature difference | Volume change |
|------------------------|---------------|------------------------|---------------|
| 1.0 °C (34 °F) | 0.002% | 50.0 °C (122 °F) | 0.110% |
| 5.0 °C (41 °F) | 0.011% | 60.0 °C (140 °F) | 0.132% |
| 10.0 °C (50 °F) | 0.022% | 70.0 °C (158 °F) | 0.154% |
| 20.0 °C (68 °F) | 0.044% | 80.0 °C (176 °F) | 0.176% |
| 30.0 °C (86 °F) | 0.066% | 90.0 °C (194 °F) | 0.198% |
| 40.0 °C (104 °F) | 0.088% | 100.0 °C (212 °F) | 0.220% |

Temperature Effect on Tank Volume for a given height of liquid (based tec for steel: $22 \times 10^{-6} / ^\circ\text{C}$)

Temperature effect on gauge reading

The temperature effect via the Gauge Reference Height (GRH) affect the level reading and depends on:

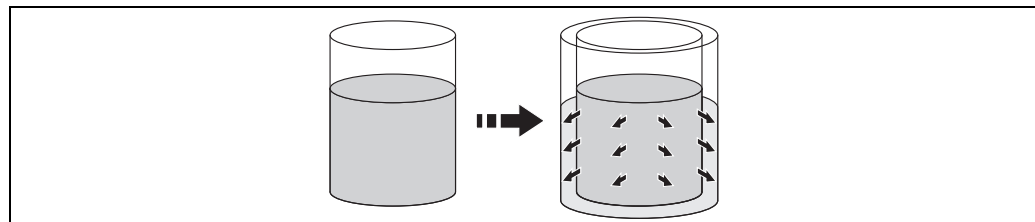
- The actual product level in relation to the Gauge Reference Height (GRH),
- The gauge type, for example radar and servo are differently affected,
- The thermal expansion coefficient of the tank steel,
- and the actual tank shell temperature in relation to the tanks shell calibration temperature.

The temperature correction for the Gauge Level reading should be corrected in the Level gauge and NOT corrected in the Tank Inventory System.

Reason is that it makes more sense to this correction in the gauge itself:

- Level reading in Gauge and System should be identical with the same correction applied.
- The required correction depends on the gauge type. A servo, needs for example a different correction as the temperature effects on the measuring wire in the tank partly compensates the temperature effects of the tank shell. For a Radar this is not the case.
- Why burden the Tank Inventory system with corrections that are gauge specific.

Temperature effect on tank capacity



L00-NXA82xxx-15-00-00-xx-001

The temperature effects also the tank capacity via the tank shell diameter. With the changed diameter, the surface area is changed, and as result the tank can contain more or less liquid product depending on whether the tank shell temperature is higher or respectively lower than the tank shell calibration temperature.

While the Level gauge is affected by two influences, one related to the thermal effects on the "wet" part of the tank shell, and one for the "dry" part of the tank shell, the tank capacity is only affected by the "wet" part of the tank shell.

Hence we also only have to establish the temperature of the "wet" part, i.e. the part in direct contact with the liquid product.

Wet tank shell temperature

It is unpractical to measure the tank shell temperature for each and individual tank. Hence one common "estimate" method is used for all tanks. This method is based on the ambient temperature (T_{amb}) and the actual liquid product temperature. For most tanks the following expression is specified in the standards:

$$T_{shell} = 7/8 * T_{product} + 1/8 * T_{ambient}$$

L00-NXA82xxx-16-00-00-xx-002

Unfortunately there are also tanks which behave differently. This can be tanks with a real thermal insulation, but they can also be buried. Hence we had re-write the above equation so we could use a "insulation factor" I_f .

$$T_{shell} = I_f * T_{product} + (1 - I_f) * T_{ambient}$$

L00-NXA82xxx-16-00-00-xx-003

Where:

- T_{shell} = Temperature of "wet" tank shell
- $T_{product}$ = Temperature of liquid product in tank
- $T_{ambient}$ = Ambient temperature
- I_f = Insulation Factor

Now we can use the I_f and use one common equation. Selecting the Insulation factor is simple:

- $I_f = 1.0$ for all tanks where the tank is somehow insulated, and
- $I_f = 7/8$ for all other tanks

Of course you can modify this setting in the configuration of Tankvision.



Observe the following information!

- In Appendix B you can find a table with some examples as illustration.
- How to obtain the ambient temperature is discussed further on.

Thermal expansion

With the Shell temperature we can now calculate the expansion of the tank capacity. This factor is indicated with the name CTSh. Later we will see how it is applied to the calculated volume.

The CTSh equation depends on the tank type.

Vertical cylindrical tanks

The equation for vertical cylindrical tanks for the volumetric CTSh is relative easy:

$$CTSh = 1 + 2 * \alpha * \delta T + \alpha^2 * \delta T^2$$

L00-NXA82xxx-16-00-00-xx-004

Where:

- α = Linear thermal expansion coefficient of tank shell material
- δT = Tank Shell Temperature - Tank Calibration temperature

The complexity starts with inconsistencies between the CTSh calculation as specified in various International standards.

In IP PMP No. 11 (paragraph C.2, page 20) the above equation (1) is simplified to:

$$CTSh = 1 + 2 * \alpha * \delta T$$

L00-NXA82xxx-16-00-00-xx-005

In order to be able to combine both equations, we have rewritten the equations to:

$$CTSh = 1 + 2 * \alpha_1 * \delta T + \alpha_s * \delta T^2$$

L00-NXA82xxx-16-00-00-xx-007

Where:

- α_1 = Linear thermal expansion coefficient
- α_s = Area or surface thermal expansion coefficient
- $\delta T = T_{shell} - T_{calib}$

Spherical tanks

Temperature correction for Spherical Tanks is calculated using the following equation:

$$CTSh = 1 + \alpha_1 * \delta T * f'$$

L00-NXA82xxx-16-00-00-xx-008

Where:

- f' = non-dimension factor representing change in partial volume, corresponding with $h/2$

The factor f' can be calculated with:

$$f' = (h^2 * r) / (h^2 * r - (h^3 / 3))$$

L00-NXA82xxx-16-00-00-xx-009

Where:

- h = liquid depth
- r = vessel radius



Observe the following information!

- This calculation is conform to IP PMP No. 11
- Refer to Appendix A3 for values of f'

Horizontal cylindrical tanks (bullets)

Temperature correction for Horizontal Cylindrical Tanks is calculated using the following equation:

$$CTSh = 1 + \alpha_1 * \delta T * f''$$

L00-NXA82xxx-16-00-00-xx-010

Where:

- f'' = non-dimension factor representing change in partial volume, corresponding with $h/r2$

The factor f'' can be calculated with:

$$F'' = 1 + \{2 * (\theta - \sin \theta) / (\theta - \sin \theta * \cos \theta)\}$$

L00-NXA82xxx-16-00-00-xx-011

Where:

- h = liquid depth
- r = vessel radius
- θ = angle subtended by liquid surface at the centre of the circular cross-section



Refer to Appendix A3 for values of f'' .

Thermal expansion coefficient(s)

In the previous equations we have used two thermal expansion coefficients:

- α_1 = Linear thermal expansion coefficient
- α_s = Area or surface thermal expansion coefficient

The first one represents the linear thermal expansion of the material of which the tank shell is made. The second factor represents the squared or area thermal expansion coefficient.

It is of paramount importance that the factor used is in the correct engineering units, i.e. as fraction per °C or fraction per °F.

The method for this calculation depends on what equation is to be emulated:

- In case of equation CTS_h (3) = $1 + 2 * \alpha * \delta T + \alpha^2 * \delta T^2$
In this case " α_s " can be derived from " α_1 " by squaring, i.e. "a_tec" = "1_tec"
- In case of equation CTS_h (4) = $1 + 2 * \alpha * \delta T$
In this case " α_s " should be set to zero.
- For spherical and horizontal cylindrical tanks " α_s " should be set to zero.

Please also make sure that the exponent value is considered when entering the value in Tankvision.

For example if " α_1 " is set to be equal to " $1.6 \cdot 10^{-5}$ ", while as engineering units shown is " $10E-7/^\circ C$ ", the " α_1 " value to be entered is "160".

8.5.2 Measurement of ambient temperature

The CTSh should be calculated automatically, which is only possible if we also have the actual ambient temperature measured automatically.

Tankvision is capable of integration of this temperature from field equipment. It can redistribute this information over the whole or part of the Tank Farm. This makes it possible to use one ambient temperature sensor and use the measure temperature for one or more tanks within the same Tankvision system.

Automatic measurement of ambient temperature on site

Exact recommendations on the location, installation and accuracy of the Ambient Temperature sensor are vague. The sensor should be located in the outside environment, be protected from direct sun shine, rain and wind, and preferable be approximately 1 meter (3 ft) from any building or large object.

An external Ambient Temperature sensor can be connected via:

- NRF590 – for example by adding an extra HART converter with temperature sensor, or by using the optional RTD input
- Proservo NMS53x – as above

Other methods may also possible be possible, depending on installed equipment and used field protocol. Please consult Endress+Hauser.

Later we will also see that there is a special setting in Tankvision where we can disable fail propagation if the ambient temperature doesn't work. After all it would be pretty horrific if the calculated inventory data of all tanks is suddenly useless, just because one sensor fails.

Manual entry of ambient temperature

It is also possible to enter the ambient Temperature manual.

This could be used, for either verifying the CTSh calculations, or in the unlikely case the ambient temperature is in fail.

8.6 Alcohol calculations


8.6.1 The OIML R22

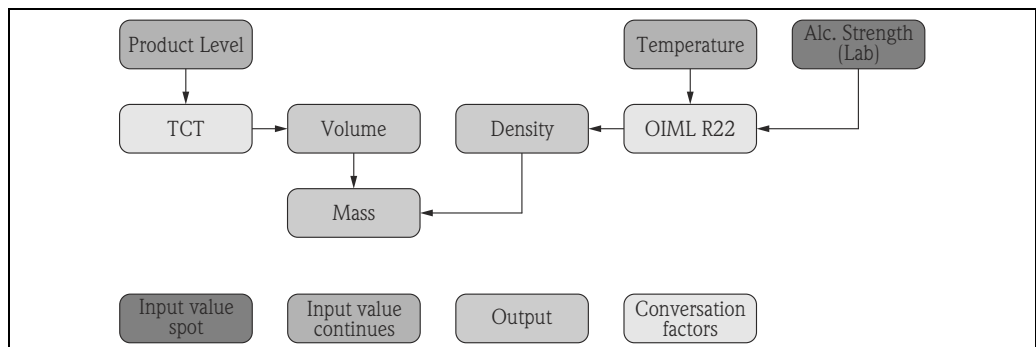
The OIML R22, as issued in 1975 deals with the calculations for the basic data "relating to the density and to the alcoholic strengths by mass and by volume of mixtures of water and ethanol". As per OIML R22 standards the range is -20 to +40 °C (-4 to +104 °F) and defines the following:

- Table I:
Gives the Observe density as a function of the temperature and the alcohol strength by mass
- Table II:
Gives the Observe density as a function of the temperature and the alcohol strength by volume
- Table IIIA and IIIB:
Gives the standard (reference) density at 20 °C (68 °F) (Table IIIA) and the alcoholic strength by volume (Table IIIB) as a function of the alcoholic strength by mass
- Table IVA and IVB:
Gives the standard density at 20 °C (68 °F) (Table IVA) and the alcoholic strength by mass (Table IVB) as a function of the alcohol strength by volume
- Table VA and VB:
Gives the acloholic strength by mass (Table VA) and the alcoholic strength by volume (Table VB) as a function of the observe density at 20 °C (68 °F)
- Table VI:
Gives the alcoholic strength by mass as a function of the observe density and temperature
- Table VII:

Gives the alcoholic strength by volume as a function of the observe density and temperature

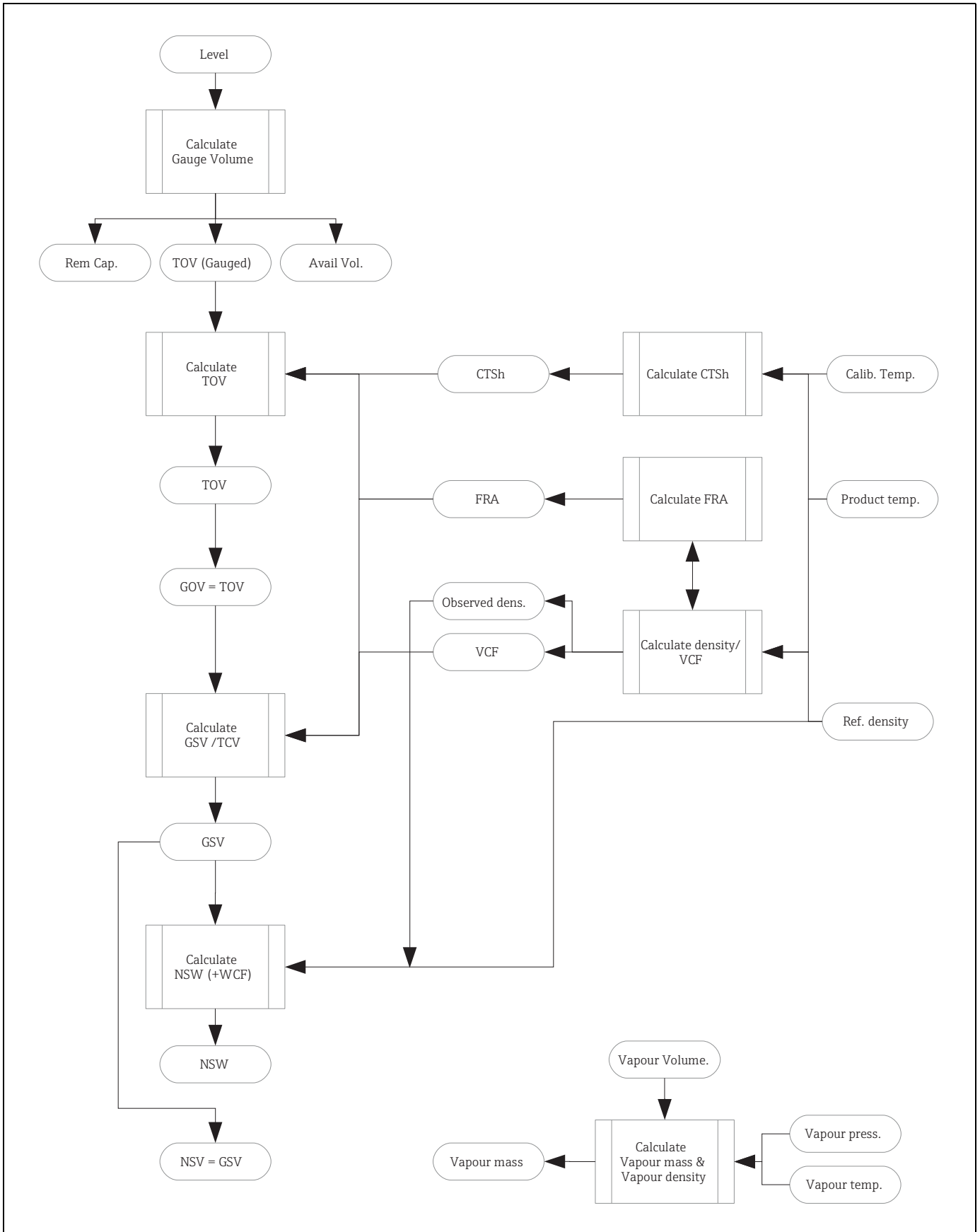
- Table VIIIA and VIIIB:
Gives the alcoholic strength by mass (Table VIIIA) and the alcoholic strength by volume (Table VIIIB) as a function of the observe density (density is read from alcoholmeter of soda lime glass at 20 °C (68 °F)) and temperature. Density at a given temperature is calculated by the given formula.
- Table IXA and IXB:
Gives the alcoholic strength by mass (Table IXA) and the alcoholic strength by volume (Table IXB) as a function of the observe density (taken from hydrometer) and temperature
- Table XA and XB
Gives the alcoholic strength by mass (Table XA) and the alcoholic strength by volume (Table XB) as a function of the observe density (taken from a instrument made of borosilicate glass) and temperature
- Table XIA and XIB
Calculates volume using alcohol strength by mass (Table XIA) or alcohol strength by volume (Table XIB)
- Table XIIA and XIIB:
Calculates volume using alcohol strength by mass (Table XIIA) or alcohol strength by volume (Table XIIB)

 Currently Table I, II, IIIA, IVA, VI and VII are implemented in Tankvision NXA820.



8.7 JIS calculation flow charts

The JIS standard is the Japanese Industrial Standard.



JIS_calculation_flow-chart

8.7.1 Main differences to the API standard

JIS is only available for the following product types:

- Generalized Crudes
- Generalized Refined Products
- Generalized Lubricants
- LPG

8.7.2 Volume Correction Factor - VCF

The following VCF table is implemented:

- JIS K 2249 2A

8.7.3 Density Calculation - RDC

If the user wants to calculate the Observed Density, RDC_JIS has to be selected in the RDC settings of the product:

- Observed Density = Reference Density x VCF

8.7.4 Floating roof adjustment - FRA

The following new options are available for the floating roof adjustments:

- (JIS) No FRA:

$$FRA = 0$$

JIS_FRA_No-FRA

- (JIS) Nippon Kaiji:

$$FRA = (FRW / \rho_{ref}) \times FRP$$

JIS_FRA_Nippon-Kaiji

- (JIS) Shin Nihon 1:

$$FRA = ((1 / \rho_{ref}) - (F / BSG)) \times FRW \times FRP$$

JIS_FRA_Shin-Nihon-1

- (JIS) Shin Nihon 2:

$$FRA = ((1 / \rho_{ref}) - (1 / BSG)) \times FRW \times FRP$$

JIS_FRA_Shin-Nihon-2

- (JIS) Shin Nihon 3:

$$FRA = 0$$

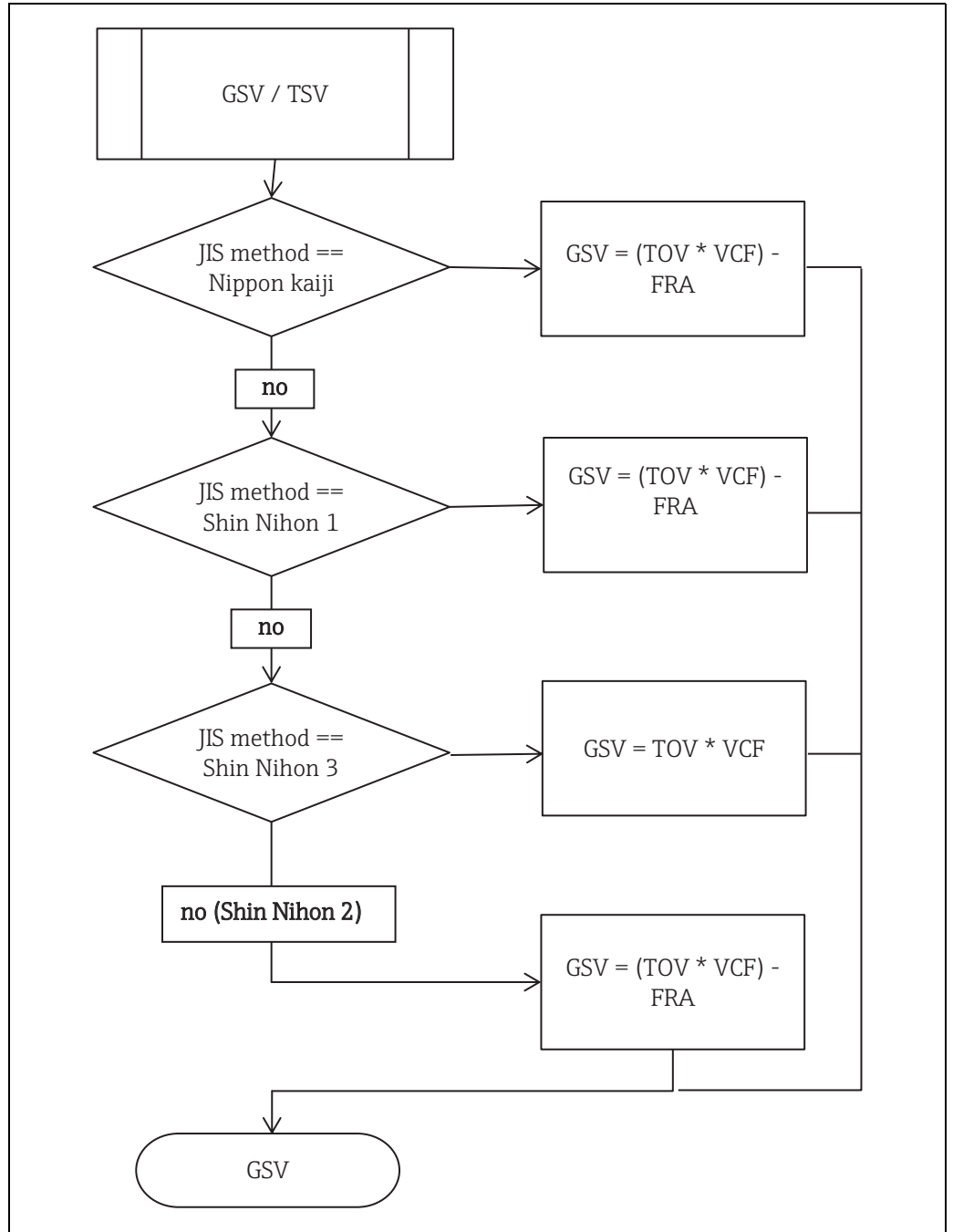
JIS_FRA_No-FRA

Where:

- FRW = Floating Roof Weight

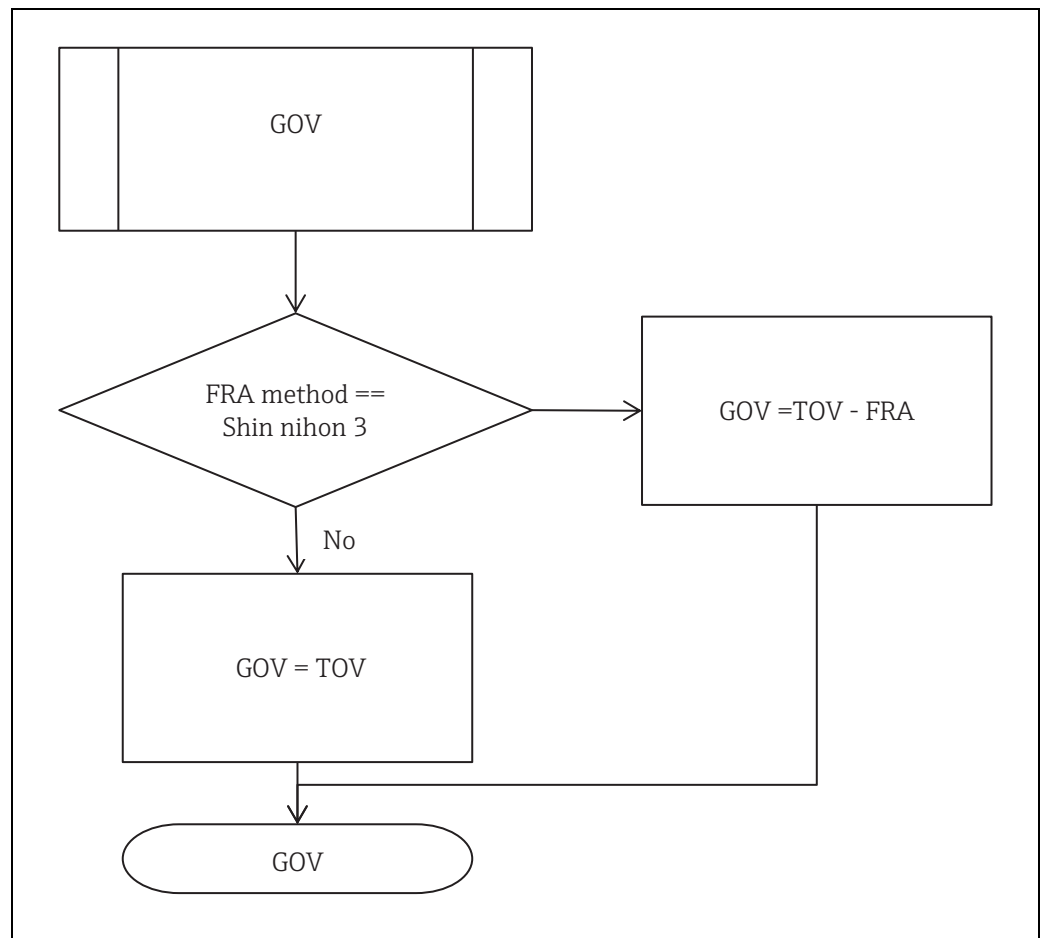
- FRP = Floating Roof Position
- ρ_{ref} = Reference Density
- BSG = calibration density from TCT
- F = VCF (Volume Correction Factor)

Dependent on this selection GSV is calculated in the following way.

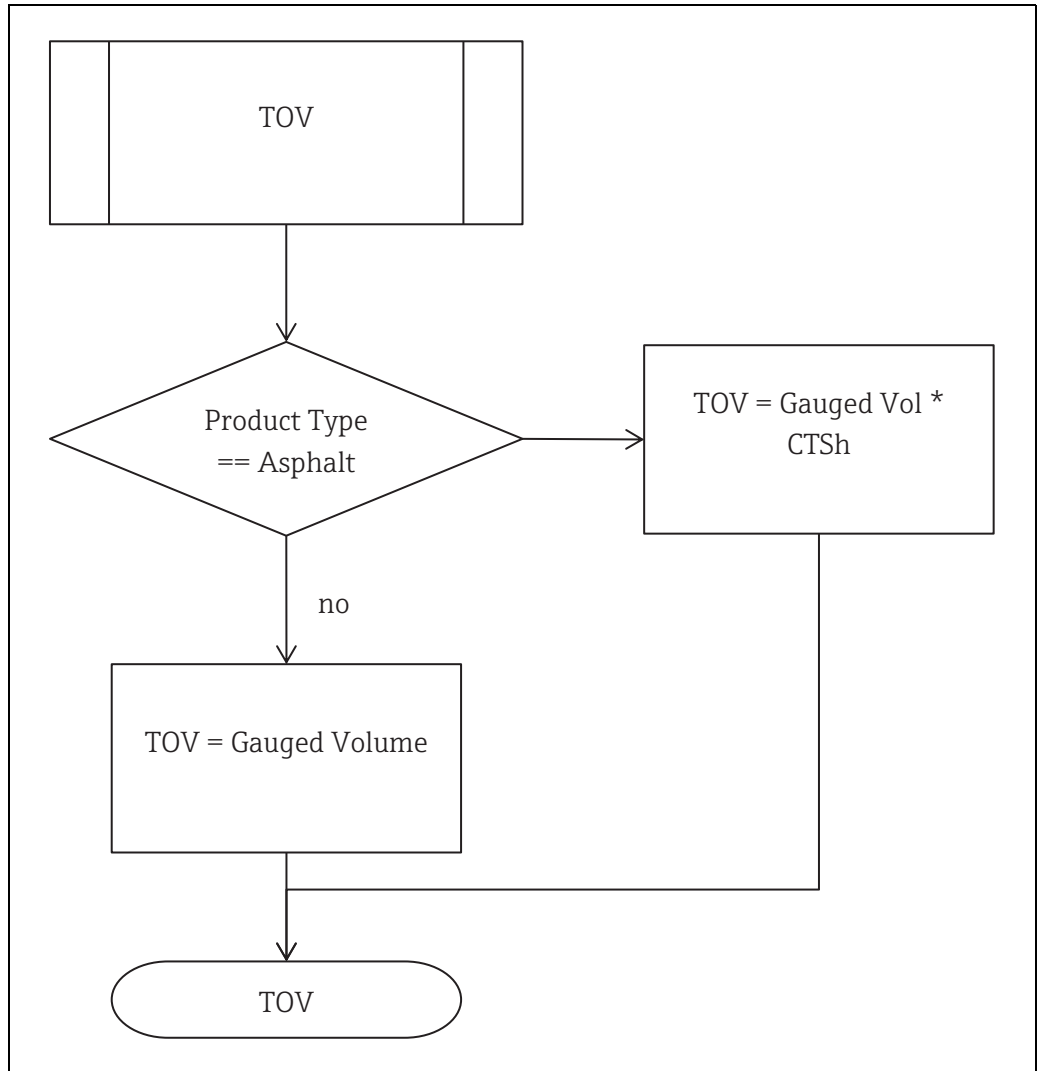


JIS_GSV-calculation

This selection influences also the GOV (Gross Observed Volume) calculation:



8.7.5 Tank Shell Correction - CTSh



JIS_TOV-calculation

If the product type is not Asphalt, CTSh is not calculated. CTSh uses the following formula:

To calculate CF,

$$CF = 1 + 3 \times \alpha \times (T - T_0)$$

JIS_CTSh_CF

Where:

- α = Thermal expansion coefficient
- T = Measured temperature (°C)
- T_0 = Calibration temperature (15 °C)

8.8 Annex A.1

| Parameter Name | Gauge Map File Name/ HostLink Param Name | Report Tag Name | Parameter ID/ OPC Server Comm ID | SI Unit | Param Type |
|---------------------------------|---|--------------------|--|---------------------|----------------------|
| Product Level | P_LEVEL | PROD_LVL | 622 | m | Measured |
| Secondary Level | S_LEVEL | SECONDARY_LVL | 623 | m | Measured |
| Free Water Level | W_LEVEL | FREE_WATER_LEVEL | 624 | m | Measured |
| Product Temperature | P_TEMP | PROD_TEMP | 625 | °C | Measured |
| Vapour Temperature | V_TEMP | VAPOUR_TEMP | 626 | °C | Measured |
| Ambient Temperature | A_TEMP | AMBIENT_TEMP | 660 | °C | Measured |
| Vapour Pressure | V_PRESS | VAPOUR_PRESS | 627 | kPa | Measured |
| Observed Density | P_OBS_D | OBS_DENSITY | 628 | kg/m ³ | Measured /Calculated |
| Reference Density | P_REF_D | REF_DENSITY | 661 | kg/m ³ | Measured /Calculated |
| Lab Density | P_LAB_D | LAB_DENSITY | 2887 | kg/m ³ | Measured |
| Product Pressure | P_PRESS | PRESSURE | 692 | kPa | Measured |
| Total Observed Volume | TOT_OBS_VOL | TOV | 717 | m ³ | Calculated |
| Rem. Tank Capacity (Dead Stock) | REM_CAP_TANK | REM_CAP | 718 | m ³ | Calculated |
| Available Volume | AVAIL_VOL | AVAIL_PROD | 719 | m ³ | Calculated |
| Sediment and Water Volume | SED_W_VOL | SED_WATER_LEVEL | 720 | m ³ | Calculated |
| Product Level Change Rate | P_LVLCHNG_RATE | PROD_LVL_CNG_RATE | 721 | mm/sec | Calculated |
| Volume Flow Rate | TOTOBS_FLW_RATE | TOV_FLOW_RATE | 722 | m ³ /min | Calculated |
| Net Standard Flowrate | NETSTD_FLW_RATE | NSV_FLOW_RATE | 723 | m ³ /min | Calculated |
| Mass Flow Rate | TOTMASS_FLW_RATE | TOT_MASS_FLOW_RATE | 724 | m ³ /min | Calculated |
| Free Water Volume | FREE_W_VOL | FWV | 725 | m ³ | Calculated |
| Gross Observed Volume | GROSS_OBS_VOL | GOV | 726 | m ³ | Calculated |
| Total Standard Volume | TOT_STD_VOL | TSV | 752 | m ³ | Calculated |
| Volume Correction Factor (VCF) | VCF | VOL_CORR_FACT | 754 | N.A. | Calculated |
| Vapour Mass | MASS_VAPR | MASS_IN_VAP | 756 | kg | Calculated |
| Net Weight in Air | NET_WGHT_AIR | NWA | 760 | kg | Calculated |
| Net Standard Weight | NET_STD_WGHT | NSW | 761 | kg | Calculated |
| Floating Roof Correction | F_ROOF_ADJUS | ROOF_CORRECTION | 762 | m ³ | Calculated |
| Floating Roof Position | F_ROOF_POS | ROOF_POS | 763 | N.A. | Calculated |
| Tank Shell Correction Factor | TNK_SHELL_CORR | TSHELL_CORR_FACTOR | 774 | N.A. | Calculated |
| Gross Standard Volume | GROSS_STD_VOL | GSV | 727 | m ³ | Calculated |
| Net Standard Volume | NET_STD_VOL | NSV | 728 | m ³ | Calculated |
| Product Mass | P_MASS | MASS_IN_LIQ | 729 | kg | Calculated |
| Total Mass | TOT_MASS | TOT_MASS | 730 | kg | Calculated |
| Vapour Room Volume | VAPOUR_ROOM_VOL | VAPOUR_ROOM_VOL | 1592 | m ³ | Calculated |
| Temperature Element 1 | TEMP_1 | TEMP_1 | 1634 | °C | Measured |
| Temperature Element 2 | TEMP_2 | TEMP_2 | 1635 | °C | Measured |
| Temperature Element 3 | TEMP_3 | TEMP_3 | 1636 | °C | Measured |
| Temperature Element 4 | TEMP_4 | TEMP_4 | 1637 | °C | Measured |
| Temperature Element 5 | TEMP_5 | TEMP_5 | 1638 | °C | Measured |

| Parameter Name | Gauge Map File Name/ HostLink Param Name | Report Tag Name | Parameter ID/ OPC Server Comm ID | SI Unit | Param Type |
|-------------------------|---|-----------------|--|---------|------------|
| Temperature Element 6 | TEMP_6 | TEMP_6 | 1639 | °C | Measured |
| Temperature Element 7 | TEMP_7 | TEMP_7 | 1640 | °C | Measured |
| Temperature Element 8 | TEMP_8 | TEMP_8 | 1641 | °C | Measured |
| Temperature Element 9 | TEMP_9 | TEMP_9 | 1642 | °C | Measured |
| Temperature Element 10 | TEMP_10 | TEMP_10 | 1643 | °C | Measured |
| Temperature Element 11 | TEMP_11 | TEMP_11 | 1644 | °C | Measured |
| Temperature Element 12 | TEMP_12 | TEMP_12 | 1645 | °C | Measured |
| Temperature Element 13 | TEMP_13 | TEMP_13 | 1646 | °C | Measured |
| Temperature Element 14 | TEMP_14 | TEMP_14 | 1647 | °C | Measured |
| Temperature Element 15 | TEMP_15 | TEMP_15 | 1648 | °C | Measured |
| Temperature Element 16 | TEMP_16 | TEMP_16 | 1649 | °C | Measured |
| Temperature Element 17 | TEMP_17 | TEMP_17 | 1652 | °C | Measured |
| Temperature Element 18 | TEMP_18 | TEMP_18 | 1653 | °C | Measured |
| Temperature Element 19 | TEMP_19 | TEMP_19 | 1654 | °C | Measured |
| Temperature Element 20 | TEMP_20 | TEMP_20 | 1655 | °C | Measured |
| Temperature Element 21 | TEMP_21 | TEMP_21 | 1656 | °C | Measured |
| Temperature Element 22 | TEMP_22 | TEMP_22 | 1657 | °C | Measured |
| Temperature Element 23 | TEMP_23 | TEMP_23 | 1658 | °C | Measured |
| Temperature Element 24 | TEMP_24 | TEMP_24 | 1659 | °C | Measured |
| Temperature Position 1 | TEMP_POS_1, | TEMP_POS_1 | 1660 | m | Measured |
| Temperature Position 2 | TEMP_POS_2, | TEMP_POS_2 | 1661 | m | Measured |
| Temperature Position 3 | TEMP_POS_3, | TEMP_POS_3 | 1662 | m | Measured |
| Temperature Position 4 | TEMP_POS_4, | TEMP_POS_4 | 1663 | m | Measured |
| Temperature Position 5 | TEMP_POS_5, | TEMP_POS_5 | 1664 | m | Measured |
| Temperature Position 6 | TEMP_POS_6, | TEMP_POS_6 | 1665 | m | Measured |
| Temperature Position 7 | TEMP_POS_7, | TEMP_POS_7 | 1666 | m | Measured |
| Temperature Position 8 | TEMP_POS_8, | TEMP_POS_8 | 1667 | m | Measured |
| Temperature Position 9 | TEMP_POS_9, | TEMP_POS_9 | 1668 | m | Measured |
| Temperature Position 10 | TEMP_POS_10 | TEMP_POS_10 | 1669 | m | Measured |
| Temperature Position 11 | TEMP_POS_11 | TEMP_POS_11 | 1670 | m | Measured |
| Temperature Position 12 | TEMP_POS_12 | TEMP_POS_12 | 1671 | m | Measured |
| Temperature Position 13 | TEMP_POS_13 | TEMP_POS_13 | 1672 | m | Measured |
| Temperature Position 14 | TEMP_POS_14 | TEMP_POS_14 | 1673 | m | Measured |
| Temperature Position 15 | TEMP_POS_15 | TEMP_POS_15 | 1674 | m | Measured |
| Temperature Position 16 | TEMP_POS_16 | TEMP_POS_16 | 1675 | m | Measured |
| Temperature Position 17 | TEMP_POS_17 | TEMP_POS_17 | 1676 | m | Measured |
| Temperature Position 18 | TEMP_POS_18 | TEMP_POS_18 | 1677 | m | Measured |
| Temperature Position 19 | TEMP_POS_19 | TEMP_POS_19 | 1678 | m | Measured |
| Temperature Position 20 | TEMP_POS_20 | TEMP_POS_20 | 1679 | m | Measured |
| Temperature Position 21 | TEMP_POS_21 | TEMP_POS_21 | 1680 | m | Measured |
| Temperature Position 22 | TEMP_POS_22 | TEMP_POS_22 | 1681 | m | Measured |

| Parameter Name | Gauge Map File Name/ HostLink Param Name | Report Tag Name | Parameter ID/ OPC Server Comm ID | SI Unit | Param Type |
|-----------------------------|---|--------------------|--|-------------------|----------------------|
| Temperature Position 23 | TEMP_POS_23 | TEMP_POS_23 | 1682 | m | Measured |
| Temperature Position 24 | TEMP_POS_24 | TEMP_POS_24 | 1683 | m | Measured |
| Alcohol Content in Mass | ALCOHOL_BY_MASS | ALCOHOL_BY_MASS | 2101 | % | Calculated |
| Alcohol Content in Volume | ALCOHOL_BY_VOLUME | ALCOHOL_BY_VOLUME | 2102 | % | Calculated |
| Sample Temperature | SAMPLE_TEMPERATURE | SAMPLE_TEMPERATURE | 1551 | °C | Measured |
| General Purpose Register 01 | GP01 | GP01 | 2601 | N.A. | Measured |
| General Purpose Register 02 | GP02 | GP02 | 2602 | N.A. | Measured |
| General Purpose Register 03 | GP03 | GP03 | 2603 | N.A. | Measured |
| General Purpose Register 04 | GP04 | GP04 | 2604 | N.A. | Measured |
| General Purpose Register 05 | GP05 | GP05 | 2605 | N.A. | Measured |
| General Purpose Register 06 | GP06 | GP06 | 2606 | N.A. | Measured |
| General Purpose Register 07 | GP07 | GP07 | 2607 | N.A. | Measured |
| General Purpose Register 08 | GP08 | GP08 | 2608 | N.A. | Measured |
| General Purpose Register 09 | GP09 | GP09 | 2609 | N.A. | Measured |
| General Purpose Register 10 | GP10 | GP10 | 2610 | N.A. | Measured |
| General Purpose Register 11 | GP11 | GP11 | 2611 | N.A. | Measured |
| General Purpose Register 12 | GP12 | GP12 | 2612 | N.A. | Measured |
| General Purpose Register 13 | GP13 | GP13 | 2613 | N.A. | Measured |
| General Purpose Register 14 | GP14 | GP14 | 2614 | N.A. | Measured |
| General Purpose Register 15 | GP15 | GP15 | 2615 | N.A. | Measured |
| General Purpose Register 16 | GP16 | GP16 | 2616 | N.A. | Measured |
| Protocol Alarm 1 | PROTOCOL_ALARM_1 | PROTOCOL_ALARM_1 | 2650 | N.A. | Measured |
| Protocol Alarm 2 | PROTOCOL_ALARM_2 | PROTOCOL_ALARM_2 | 2651 | N.A. | Measured |
| Protocol Alarm 3 | PROTOCOL_ALARM_3 | PROTOCOL_ALARM_3 | 2652 | N.A. | Measured |
| Protocol Alarm 4 | PROTOCOL_ALARM_4 | PROTOCOL_ALARM_4 | 2653 | N.A. | Measured |
| Percentage Level | PERCENTAGE_LEVEL | PERCENTAGE_LEVEL | 2654 | % | Measured /Calculated |
| VSP Volume | VSP_VOLUME,2 | VSP_VOLUME | 2700 | m ³ | Calculated |
| Gauge Error | GAUGE_ERROR | GAUGE_ERROR | 2755 | N.A. | Measured |
| Gauge Status | GAUGE_STATUS | GAUGE_STATUS | 2756 | N.A. | Measured |
| Analog Input | ANALOG_INPUT | ANALOG_INP | 2841 | % | Measured |
| HTMS Product Temperature | HTMS_P_TEMP | HTMS_P_TEMP | 2201 | °C | Calculated |
| Density Element 1 | DENS_1 | DENS_1 | 3001 | kg/m ³ | Measured |
| Density Element 2 | DENS_2 | DENS_2 | 3002 | kg/m ³ | Measured |
| Density Element 3 | DENS_3 | DENS_3 | 3003 | kg/m ³ | Measured |
| Density Element 4 | DENS_4 | DENS_4 | 3004 | kg/m ³ | Measured |
| Density Element 5 | DENS_5 | DENS_5 | 3005 | kg/m ³ | Measured |
| Density Element 6 | DENS_6 | DENS_6 | 3006 | kg/m ³ | Measured |
| Density Element 7 | DENS_7 | DENS_7 | 3007 | kg/m ³ | Measured |
| Density Element 8 | DENS_8 | DENS_8 | 3008 | kg/m ³ | Measured |
| Density Element 9 | DENS_9 | DENS_9 | 3009 | kg/m ³ | Measured |
| Density Element 10 | DENS_10 | DENS_10 | 3010 | kg/m ³ | Measured |

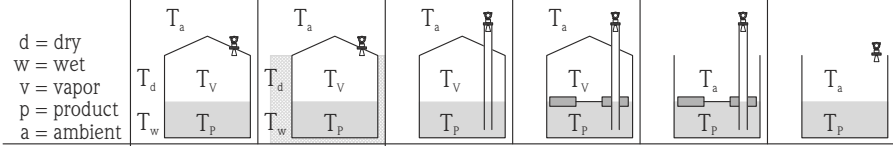
| Parameter Name | Gauge Map File Name/ HostLink Param Name | Report Tag Name | Parameter ID/ OPC Server Comm ID | SI Unit | Param Type |
|---------------------|---|-----------------|--|-------------------|------------|
| Density Element 11 | DENS_11 | DENS_11 | 3011 | kg/m ³ | Measured |
| Density Element 12 | DENS_12 | DENS_12 | 3012 | kg/m ³ | Measured |
| Density Element 13 | DENS_13 | DENS_13 | 3013 | kg/m ³ | Measured |
| Density Element 14 | DENS_14 | DENS_14 | 3014 | kg/m ³ | Measured |
| Density Element 15 | DENS_15 | DENS_15 | 3015 | kg/m ³ | Measured |
| Density Element 16 | DENS_16 | DENS_16 | 3016 | kg/m ³ | Measured |
| Density Element 17 | DENS_17 | DENS_17 | 3017 | kg/m ³ | Measured |
| Density Element 18 | DENS_18 | DENS_18 | 3018 | kg/m ³ | Measured |
| Density Element 19 | DENS_19 | DENS_19 | 3019 | kg/m ³ | Measured |
| Density Element 20 | DENS_20 | DENS_20 | 3020 | kg/m ³ | Measured |
| Density Element 21 | DENS_21 | DENS_21 | 3021 | kg/m ³ | Measured |
| Density Element 22 | DENS_22 | DENS_22 | 3022 | kg/m ³ | Measured |
| Density Element 23 | DENS_23 | DENS_23 | 3023 | kg/m ³ | Measured |
| Density Element 24 | DENS_24 | DENS_24 | 3024 | kg/m ³ | Measured |
| Density Element 25 | DENS_25 | DENS_25 | 3025 | kg/m ³ | Measured |
| Density Element 26 | DENS_26 | DENS_26 | 3026 | kg/m ³ | Measured |
| Density Element 27 | DENS_27 | DENS_27 | 3027 | kg/m ³ | Measured |
| Density Element 28 | DENS_28 | DENS_28 | 3028 | kg/m ³ | Measured |
| Density Element 29 | DENS_29 | DENS_29 | 3029 | kg/m ³ | Measured |
| Density Element 30 | DENS_30 | DENS_30 | 3030 | kg/m ³ | Measured |
| Density Element 31 | DENS_31 | DENS_31 | 3031 | kg/m ³ | Measured |
| Density Element 32 | DENS_32 | DENS_32 | 3032 | kg/m ³ | Measured |
| Density Element 33 | DENS_33 | DENS_33 | 3033 | kg/m ³ | Measured |
| Density Element 34 | DENS_34 | DENS_34 | 3034 | kg/m ³ | Measured |
| Density Element 35 | DENS_35 | DENS_35 | 3035 | kg/m ³ | Measured |
| Density Element 36 | DENS_36 | DENS_36 | 3036 | kg/m ³ | Measured |
| Density Element 37 | DENS_37 | DENS_37 | 3037 | kg/m ³ | Measured |
| Density Element 38 | DENS_38 | DENS_38 | 3038 | kg/m ³ | Measured |
| Density Element 39 | DENS_39 | DENS_39 | 3039 | kg/m ³ | Measured |
| Density Element 40 | DENS_40 | DENS_40 | 3040 | kg/m ³ | Measured |
| Density Element 41 | DENS_41 | DENS_41 | 3041 | kg/m ³ | Measured |
| Density Element 42 | DENS_42 | DENS_42 | 3042 | kg/m ³ | Measured |
| Density Element 43 | DENS_43 | DENS_43 | 3043 | kg/m ³ | Measured |
| Density Element 44 | DENS_44 | DENS_44 | 3044 | kg/m ³ | Measured |
| Density Element 45 | DENS_45 | DENS_45 | 3045 | kg/m ³ | Measured |
| Density Element 46 | DENS_46 | DENS_46 | 3046 | kg/m ³ | Measured |
| Density Element 47 | DENS_47 | DENS_47 | 3047 | kg/m ³ | Measured |
| Density Element 48 | DENS_48 | DENS_48 | 3048 | kg/m ³ | Measured |
| Density Element 49 | DENS_49 | DENS_49 | 3049 | kg/m ³ | Measured |
| Density Element 50 | DENS_50 | DENS_50 | 3050 | kg/m ³ | Measured |
| Density Position 01 | DENS_POS_1 | DENS_POS_1 | 3051 | m | Measured |

| Parameter Name | Gauge Map File Name/ HostLink Param Name | Report Tag Name | Parameter ID/ OPC Server Comm ID | SI Unit | Param Type |
|---------------------|---|-----------------|--|---------|------------|
| Density Position 02 | DENS_POS_2 | DENS_POS_2 | 3052 | m | Measured |
| Density Position 03 | DENS_POS_3 | DENS_POS_3 | 3053 | m | Measured |
| Density Position 04 | DENS_POS_4 | DENS_POS_4 | 3054 | m | Measured |
| Density Position 05 | DENS_POS_5 | DENS_POS_5 | 3055 | m | Measured |
| Density Position 06 | DENS_POS_6 | DENS_POS_6 | 3056 | m | Measured |
| Density Position 07 | DENS_POS_7 | DENS_POS_7 | 3057 | m | Measured |
| Density Position 08 | DENS_POS_8 | DENS_POS_8 | 3058 | m | Measured |
| Density Position 09 | DENS_POS_9 | DENS_POS_9 | 3059 | m | Measured |
| Density Position 10 | DENS_POS_10 | DENS_POS_10 | 3060 | m | Measured |
| Density Position 11 | DENS_POS_11 | DENS_POS_11 | 3061 | m | Measured |
| Density Position 12 | DENS_POS_12 | DENS_POS_12 | 3062 | m | Measured |
| Density Position 13 | DENS_POS_13 | DENS_POS_13 | 3063 | m | Measured |
| Density Position 14 | DENS_POS_14 | DENS_POS_14 | 3064 | m | Measured |
| Density Position 15 | DENS_POS_15 | DENS_POS_15 | 3065 | m | Measured |
| Density Position 16 | DENS_POS_16 | DENS_POS_16 | 3066 | m | Measured |
| Density Position 17 | DENS_POS_17 | DENS_POS_17 | 3067 | m | Measured |
| Density Position 18 | DENS_POS_18 | DENS_POS_18 | 3068 | m | Measured |
| Density Position 19 | DENS_POS_19 | DENS_POS_19 | 3069 | m | Measured |
| Density Position 20 | DENS_POS_20 | DENS_POS_20 | 3070 | m | Measured |
| Density Position 21 | DENS_POS_21 | DENS_POS_21 | 3071 | m | Measured |
| Density Position 22 | DENS_POS_22 | DENS_POS_22 | 3072 | m | Measured |
| Density Position 23 | DENS_POS_23 | DENS_POS_23 | 3073 | m | Measured |
| Density Position 24 | DENS_POS_24 | DENS_POS_24 | 3074 | m | Measured |
| Density Position 25 | DENS_POS_25 | DENS_POS_25 | 3075 | m | Measured |
| Density Position 26 | DENS_POS_26 | DENS_POS_26 | 3076 | m | Measured |
| Density Position 27 | DENS_POS_27 | DENS_POS_27 | 3077 | m | Measured |
| Density Position 28 | DENS_POS_28 | DENS_POS_28 | 3078 | m | Measured |
| Density Position 29 | DENS_POS_29 | DENS_POS_29 | 3079 | m | Measured |
| Density Position 30 | DENS_POS_30 | DENS_POS_30 | 3080 | m | Measured |
| Density Position 31 | DENS_POS_31 | DENS_POS_31 | 3081 | m | Measured |
| Density Position 32 | DENS_POS_32 | DENS_POS_32 | 3082 | m | Measured |
| Density Position 33 | DENS_POS_33 | DENS_POS_33 | 3083 | m | Measured |
| Density Position 34 | DENS_POS_34 | DENS_POS_34 | 3084 | m | Measured |
| Density Position 35 | DENS_POS_35 | DENS_POS_35 | 3085 | m | Measured |
| Density Position 36 | DENS_POS_36 | DENS_POS_36 | 3086 | m | Measured |
| Density Position 37 | DENS_POS_37 | DENS_POS_37 | 3087 | m | Measured |
| Density Position 38 | DENS_POS_38 | DENS_POS_38 | 3088 | m | Measured |
| Density Position 39 | DENS_POS_39 | DENS_POS_39 | 3089 | m | Measured |
| Density Position 40 | DENS_POS_40 | DENS_POS_40 | 3090 | m | Measured |
| Density Position 41 | DENS_POS_41 | DENS_POS_41 | 3091 | m | Measured |
| Density Position 42 | DENS_POS_42 | DENS_POS_42 | 3092 | m | Measured |

| Parameter Name | Gauge Map File Name/ HostLink Param Name | Report Tag Name | Parameter ID/ OPC Server Comm ID | SI Unit | Param Type |
|--------------------------------|---|-----------------|--|---------|------------|
| Density Position 43 | DENS_POS_43 | DENS_POS_43 | 3093 | m | Measured |
| Density Position 44 | DENS_POS_44 | DENS_POS_44 | 3094 | m | Measured |
| Density Position 45 | DENS_POS_45 | DENS_POS_45 | 3095 | m | Measured |
| Density Position 46 | DENS_POS_46 | DENS_POS_46 | 3096 | m | Measured |
| Density Position 47 | DENS_POS_47 | DENS_POS_47 | 3097 | m | Measured |
| Density Position 48 | DENS_POS_48 | DENS_POS_48 | 3098 | m | Measured |
| Density Position 49 | DENS_POS_49 | DENS_POS_49 | 3099 | m | Measured |
| Density Position 50 | DENS_POS_50 | DENS_POS_50 | 3100 | m | Measured |
| Floating Roof Tilt Level 1 | FRT_LEVEL_1 | FRT_LEVEL_1 | 3111 | m | Measured |
| Floating Roof Tilt Level 2 | FRT_LEVEL_2 | FRT_LEVEL_2 | 3112 | m | Measured |
| Floating Roof Tilt Level 3 | FRT_LEVEL_3 | FRT_LEVEL_3 | 3113 | m | Measured |
| Floating Roof Tilt Delta Level | FRT_DELTA_LEVEL | FRT_DELTA_LEVEL | 3114 | m | Calculated |
| Floating Roof Tilt Delta Mass | FRT_DELTA_MASS | FRT_DELTA_MASS | 3115 | kg | Calculated |

8.9 Annex A.2

Insulation factors for various tank geometries

| | Fixed Roof Tank | Insulated Tank | Tank with Still. Well (SW) | Tank with Internal FR & SW | External Floating Roof Tank with SW | Floating or No Roof - Direct measurement |
|---|---|----------------|----------------------------|----------------------------|-------------------------------------|--|
| <p>d = dry w = wet v = vapor p = product a = ambient</p>  | | | | | | |
| TS = | $\frac{7}{8} * T_p + \frac{1}{8} * T_a$ | T_p | T_p | T_p | T_p | $\frac{7}{8} * T_p + \frac{1}{8} * T_a$ |
| Recommended Insulation Factor (IFw) | $IFw = \frac{7}{8} (.825)$ | $IFw = 1.0$ | $IFw = 1.0$ | $IFw = 1.0$ | $IFw = 1.0$ | $IFw = \frac{7}{8}$ |

L00-NXA82xxx-16-00-00-xx-014

8.10 Annex A.3

Correction factors for CTSh (spheres (F') and horizontal cylindrical tanks (F''))

| h/2r | Spherical f' | Horiztl. Cylinder f'' | h/2r | Spherical f' | Horiztl. Cylinder f'' |
|------|--------------|-----------------------|------|--------------|-----------------------|
| 0.00 | | | 0.40 | 1.364 | 1.664 |
| 0.01 | 1.007 | 1.503 | 0.41 | 1.376 | 1.670 |
| 0.02 | 1.014 | 1.506 | 0.42 | 1.389 | 1.676 |
| 0.03 | 1.020 | 1.509 | 0.43 | 1.402 | 1.682 |
| 0.04 | 1.027 | 1.512 | 0.44 | 1.415 | 1.688 |
| 0.05 | 1.034 | 1.516 | 0.45 | 1.429 | 1.694 |
| 0.06 | 1.042 | 1.519 | 0.46 | 1.442 | 1.700 |
| 0.07 | 1.049 | 1.522 | 0.47 | 1.446 | 1.707 |
| 0.08 | 1.056 | 1.525 | 0.48 | 1.471 | 1.713 |
| 0.09 | 1.064 | 1.529 | 0.49 | 1.485 | 1.720 |
| 0.10 | 1.071 | 1.532 | 0.50 | 1.500 | 1.727 |
| 0.11 | 1.079 | 1.536 | 0.51 | 1.515 | 1.734 |
| 0.12 | 1.087 | 1.539 | 0.52 | 1.531 | 1.741 |
| 0.13 | 1.095 | 1.543 | 0.53 | 1.546 | 1.748 |
| 0.14 | 1.103 | 1.546 | 0.54 | 1.563 | 1.756 |
| 0.15 | 1.111 | 1.550 | 0.55 | 1.579 | 1.764 |
| 0.16 | 1.119 | 1.554 | 0.56 | 1.569 | 1.772 |
| 0.17 | 1.128 | 1.557 | 0.57 | 1.613 | 1.780 |
| 0.18 | 1.136 | 1.561 | 0.58 | 1.630 | 1.788 |
| 0.19 | 1.145 | 1.565 | 0.59 | 1.648 | 1.796 |
| 0.20 | 1.154 | 1.569 | 0.60 | 1.667 | 1.805 |
| 0.21 | 1.163 | 1.573 | 0.61 | 1.685 | 1.814 |
| 0.22 | 1.172 | 1.577 | 0.62 | 1.705 | 1.823 |
| 0.23 | 1.181 | 1.581 | 0.63 | 1.724 | 1.833 |
| 0.24 | 1.190 | 1.586 | 0.64 | 1.744 | 1.843 |
| 0.25 | 1.200 | 1.590 | 0.65 | 1.765 | 1.853 |
| 0.26 | 1.210 | 1.594 | 0.66 | 1.786 | 1.863 |
| 0.27 | 1.220 | 1.599 | 0.67 | 1.807 | 1.874 |
| 0.28 | 1.230 | 1.603 | 0.68 | 1.829 | 1.885 |
| 0.29 | 1.240 | 1.608 | 0.69 | 1.852 | 1.896 |
| 0.30 | 1.250 | 1.613 | 0.70 | 1.875 | 1.907 |
| 0.31 | 1.261 | 1.617 | 0.71 | 1.899 | 1.920 |
| 0.32 | 1.271 | 1.622 | 0.72 | 1.923 | 1.932 |
| 0.33 | 1.282 | 1.627 | 0.73 | 1.948 | 1.945 |
| 0.34 | 1.293 | 1.632 | 0.74 | 1.974 | 1.958 |
| 0.35 | 1.304 | 1.637 | 0.75 | 2.000 | 1.972 |
| 0.36 | 1.316 | 1.642 | 0.76 | 2.027 | 1.986 |
| 0.37 | 1.327 | 1.648 | 0.77 | 2.055 | 2.001 |
| 0.38 | 1.339 | 1.653 | 0.78 | 2.083 | 2.017 |
| 0.39 | 1.351 | 1.658 | 0.79 | 2.113 | 2.033 |

8.11 Annex A.4

Example CTSh calculations

| Tank Type | Vertical Cylindrical | Vertical Cylindrical | Vertical Cylindrical | Spherical | Vertical Cylindrical |
|-------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| Vessel Radius | n.a. | n.a. | n.a. | 17.253 | n.a. |
| Product Level | n.a. | n.a. | n.a. | 4.6 | n.a. |
| α_1 (apha) | 6.2×10^{-6} | 6.2×10^{-6} | 0.000011 | 110×10^{-7} | 6.2×10^{-6} |
| α_s | 4.01E-09 | 0 | 0 | n.a. | 4.01E-09 |
| Tcal | 60 °F | 60 °F | 15 °C | 20 °C | 60 °F |
| Tprod | 300 °F | 300 °F | -43 °C | 23.5 °C | 88.3 °F |
| Tamb | 70 °F | 70 °F | | n.a. | 74.5 °F |
| I _{fs} | 0.875 | 0.875 | 1 | 1 | 0.875 |
| CTSh | 1.00279801 | 1.0026195 | 0.998724 | 1.000047 | 1.00032 |

8.12 Annex A.5

API Calculation VCF Tables

| VCF TABLE | Reference Temperature | Reference Temperature Unit | Generalized Crudes | Generalized Refined Products | Special Application | Generalized Lubricants | Asphalts | Palm Oil | Chemicals | Industrial Aromatics | LPG |
|--------------------------------|-----------------------|----------------------------|--------------------|------------------------------|---------------------|------------------------|----------|----------|-----------|----------------------|-----|
| ASTM D1250-80 -Table 24A | 60 | F | X | | | | | | | | |
| ASTM D1250-80 -Table 24B | 60 | F | | X | | | | | | | |
| ASTM D1250-80 -Table 24C | 60 | F | | | X | | | | | | |
| ASTM D1250-80 -Table 24D | 60 | F | | | | X | | | | | |
| ASTM D1250-80 -Table 54A | 15 | C | X | | | | | | | | |
| ASTM D1250-80 -Table 54B | 15 | C | | X | | | | | | | |
| ASTM D1250-80 -Table 54C | 15 | C | | | X | | | | | | |
| ASTM D1250-80 -Table 54D | 15 | C | | | | X | | | | | |
| IP PMP No. 3 (1988) -Table 60A | 20 | C | X | | | | | | | | |
| IP PMP No. 3 (1988) -Table 60B | 20 | C | | X | | | | | | | |
| IP PMP No. 3 (1988) -Table 60C | 20 | C | | | X | | | | | | |
| IP PMP No. 3 (1988) -Table 60D | 20 | C | | | | X | | | | | |
| ASTM D1250-80 -Table 6A | 60 | F | X | | | | | | | | |
| ASTM D1250-80 -Table 6B | 60 | F | | X | | | | | | | |
| ASTM D1250-80 -Table 6C | 60 | F | | | X | | | | | | |
| ASTM D1250-80 -Table 6D | 60 | F | | | | X | | | | | |
| GPA TP-25 Table 24E | 60 | F | | | | | | | | | X |
| GPA TP-27 Table 24E | 60 | F | | | | | | | | | X |
| GPA TP-27 Table 54E | 15 | C | | | | | | | | | X |
| GPA TP-27 Table 60E | 20 | C | | | | | | | | | X |

| VCF TABLE | Reference Temperature | Reference Temperature Unit | Generalized Crudes | Generalized Refined Products | Special Application | Generalized Lubricants | Asphalts | Palm Oil | Chemicals | Industrial Aromatics | LPG |
|--------------------------------------|-----------------------|----------------------------|--------------------|------------------------------|---------------------|------------------------|----------|----------|-----------|----------------------|-----|
| TCF Method | 15 | -1 | X | X | X | X | X | | X | X | |
| ASTM D4311-96M | 15 | C | | | | | X | | | | |
| ASTM D4311-96I | 60 | C | | | | | X | | | | |
| ASTM D1555 - Industrial Aromatic HC | 60 | F | | | | | | | | X | |
| ASTM D1555M - Industrial Aromatic HC | 15 | C | | | | | | | | X | |
| ASTM D1250-1953 - Table 54 for LHC | 15 | C | | | | | | X | | | |
| M B & Redwood VCF | 15 | C | | | | | | | | | X |
| Chemical 1 | 15 | -1 | | | | | | | X | | |
| Palm Oil | 15 | -1 | | | | | | X | | | |
| 1/DCF | 0 | C | X | X | X | X | X | X | X | X | X |
| ASTM D1250-04 -Table 24A | 60 | F | X | | | | | | | | |
| ASTM D1250-04 -Table 24B | 60 | F | | X | | | | | | | |
| ASTM D1250-04 -Table 24C | 60 | F | | | X | | | | | | |
| ASTM D1250-04 -Table 24D | 60 | F | | | | X | | | | | |
| ASTM D1250-04 -Table 54A | 15 | C | X | | | | | | | | |
| ASTM D1250-04 -Table 54B | 15 | C | | X | | | | | | | |
| ASTM D1250-04 -Table 54C | 15 | C | | | X | | | | | | |
| ASTM D1250-04 -Table 54D | 15 | C | | | | X | | | | | |
| ASTM D1250-04 -Table 60A | 20 | C | X | | | | | | | | |
| ASTM D1250-04 -Table 60B | 20 | C | | X | | | | | | | |
| ASTM D1250-04 -Table 60C | 20 | C | | | X | | | | | | |
| ASTM D1250-04 -Table 60D | 20 | C | | | | X | | | | | |
| ASTM D1250-04 -Table 6A | 60 | F | X | | | | | | | | |
| ASTM D1250-04 -Table 6B | 60 | F | | X | | | | | | | |
| ASTM D1250-04 -Table 6C | 60 | F | | | X | | | | | | |
| ASTM D1250-04 -Table 6D | 60 | F | | | | X | | | | | |
| ASTM D1250-80 -Table 24A | 60 | F | X | | | | | | | | |
| ASTM D1250-80 -Table 24B | 60 | F | | X | | | | | | | |
| ASTM D1250-80 -Table 24C | 60 | F | | | X | | | | | | |
| ASTM D1250-80 -Table 24D | 60 | F | | | | X | | | | | |
| ASTM D1250-80 -Table 54A | 15 | C | X | | | | | | | | |
| ASTM D1250-80 -Table 54B | 15 | C | | X | | | | | | | |
| ASTM D1250-80 -Table 54C | 15 | C | | | X | | | | | | |
| ASTM D1250-80 -Table 54D | 15 | C | | | | X | | | | | |
| IP PMP No. 3 (1988) -Table 60A | 20 | C | X | | | | | | | | |

8.13 Annex A.6

API Calculation RDC Tables

| RDC TABLE | Ref. Temp. | Ref. Temp. Unit | Gen. Crudes | Gen. Refined Products | Spec. Appl. | Gen. Lubricants | Asphalts | Palm Oil | Chemicals | Ind. Aromatics | LPG |
|--------------------------|------------|-----------------|-------------|-----------------------|-------------|-----------------|----------|----------|-----------|----------------|-----|
| ASTM D1250-80 -Table 23A | 60 | F | X | | | | | | | | |
| ASTM D1250-80 -Table 23B | 60 | F | | X | | | | | | | |
| ASTM D1250-80 -Table 23D | 60 | F | | | | X | | | | | |
| ASTM D1250-80 -Table 53A | 15 | C | X | | | | | | | | |
| ASTM D1250-80 -Table 53B | 15 | C | | X | | | | | | | |
| ASTM D1250-80 -Table 53D | 15 | C | | | | X | | | | | |
| ASTM D1250-80 -Table 59A | 20 | C | X | | | | | | | | |
| ASTM D1250-80 -Table 59B | 20 | C | | X | | | | | | | |
| ASTM D1250-80 -Table 59D | 20 | C | | | | X | | | | | |
| ASTM D1250-80 -Table 5A | 60 | F | X | | | | | | | | |
| ASTM D1250-80 -Table 5B | 60 | F | | X | | | | | | | |
| ASTM D1250-80 -Table 5D | 60 | F | | | | X | | | | | |
| GPA TP-25 Table 23E | 60 | F | | | | | | | | | X |
| GPA TP-27 Table 23E | 60 | F | | | | | | | | | X |
| GPA TP-27 Table 53E | 15 | C | | | | | | | | | X |
| GPA TP-27 Table 59E | 20 | C | | | | | | | | | X |
| M B & Redwood DCF | 15 | C | | | | | | | | | X |
| Chemical 1 | 15 | -1 | | | | | | X | | | |
| Palm Oil | 15 | -1 | | | | | X | | | | |
| RDC = 1 / VCF | 0 | C | X | X | X | X | X | X | X | X | X |
| T.P.D.Table | 15 | C | X | X | X | X | X | X | X | X | X |
| ASTM D1250-04 -Table 23A | 60 | F | X | | | | | | | | |
| ASTM D1250-04 -Table 23B | 60 | F | | X | | | | | | | |
| ASTM D1250-04 -Table 23D | 60 | F | | | | X | | | | | |
| ASTM D1250-04 -Table 53A | 15 | C | X | | | | | | | | |
| ASTM D1250-04 -Table 53B | 15 | C | | X | | | | | | | |
| ASTM D1250-04 -Table 53D | 15 | C | | | | X | | | | | |
| ASTM D1250-04 -Table 59A | 20 | C | X | | | | | | | | |
| ASTM D1250-04 -Table 59B | 20 | C | | X | | | | | | | |
| ASTM D1250-04 -Table 59D | 20 | C | | | | X | | | | | |
| ASTM D1250-04 -Table 5A | 60 | F | X | | | | | | | | |
| ASTM D1250-04 -Table 5B | 60 | F | | X | | | | | | | |
| ASTM D1250-04 -Table 5D | 60 | F | | | | X | | | | | |

8.14 Annex A.7

GBT Calculation VCF Table

| Table Name | Reference Temperature | Reference Temperature Unit | Generalized Crudes | Generalized Refined Products | Generalized Lubricants |
|--------------------------------|-----------------------|----------------------------|--------------------|------------------------------|------------------------|
| IP PMP No. 3 (1988) -Table 60A | 20 | C | X | | |
| IP PMP No. 3 (1988) -Table 60B | 20 | C | | X | |
| IP PMP No. 3 (1988) -Table 60D | 20 | C | | | X |
| ASTM D1250-04 -Table 60A | 20 | C | X | | |
| ASTM D1250-04 -Table 60B | 20 | C | | X | |
| ASTM D1250-04 -Table 60D | 20 | C | | | X |

8.15 Annex A.8

GBT Calculation RDC Tables

| Table Name | Reference Temperature | Reference Temperature Unit | Generalized Crudes | Generalized Refined Products | Generalized Lubricants |
|--------------------------|-----------------------|----------------------------|--------------------|------------------------------|------------------------|
| ASTM D1250-80 -Table 59A | 20 | C | X | | |
| ASTM D1250-80 -Table 59B | 20 | C | | X | |
| ASTM D1250-80 -Table 59D | 20 | C | | | X |
| T.P.D.Table | 15 | C | X | X | X |
| ASTM D1250-04 -Table 23A | 60 | F | X | | |
| ASTM D1250-04 -Table 23B | 60 | F | | X | |
| ASTM D1250-04 -Table 23D | 60 | F | | | X |
| ASTM D1250-04 -Table 59A | 20 | C | X | | |
| ASTM D1250-04 -Table 59B | 20 | C | | X | |
| ASTM D1250-04 -Table 59D | 20 | C | | | X |

8.16 Documentation

| Document | Instrument | Description |
|----------------|------------------|---|
| TI00419G/00/EN | Tankvision | Inventory Management System with completely integrated software for operation via standard web browser |
| TI01252G/00/EN | Micropilot NMR81 | Micropilot NMR8 Series intelligent tank gauges are designed for high accuracy liquid level measurement in storage and process applications. They fulfill the exacting demands of tank inventory management, inventory control, custody transfer, loss control, total cost saving, and safe operation. |
| TI01253G/00/EN | Micropilot NMR84 | |
| TI01248G/00/EN | Proservo NMS80 | Proservo NMS8x Series intelligent tank gauges are designed for high accuracy liquid level measurement in storage and process applications. They fulfill the exacting demands of tank inventory management, inventory control, custody transfer, loss control, total cost saving, and safe operation. |
| TI01249G/00/EN | Proservo NMS81 | |
| TI01250G/00/EN | Proservo NMS83 | |

| Document | Instrument | Description |
|----------------|-------------------------------------|---|
| TI01251G/00/EN | Tankside Monitor NRF81 | Tankside Monitor NRF81 is a robust gateway for collecting and integrating tank gauging data in storage and process applications. It fulfills the exacting demands of tank inventory management, inventory control, custody transfer, loss control, total cost saving, and safe operation. |
| TI00452G/08/EN | Proservo NMS5 | Intelligent tank gauge with high accuracy performance Liquid level, I/F, Density & Density Profile |
| TI00402F/00/EN | Tank Side Monitor NRF590 | Field device for tank sensor operation and monitoring and for integration into inventory control system |
| TI00344F/00/EN | Micropilot S FMR531 | Continuous level transmitter for continuous and non-contact precision level measurement. For custody transfer and inventory control applications with NMI- and PTB-approvals |
| TI01122F/00/EN | Micropilot S FMR532 | |
| TI00344F/00/EN | Micropilot S FMR533 | |
| TI01123F/00/EN | Micropilot S FMR540 | Continuous level transmitter for continuous and non-contact precision level measurement. For custody transfer and inventory control applications with NMI and PTB approvals |
| TI00042G/08/EN | Prothermo NMT539 | Intrinsically safe multi-signal converter with precision average temperature and water bottom sensor for inventory control and custody transfer applications |
| TI00049G/08/EN | Prothermo NMT532 | Intrinsically safe multi-signal converter with precision average temperature sensor for inventory control |
| TI00345F/00/EN | Micropilot M FMR23x, FMR24x | Continuous and non-contact level measurement. Cost-effective 4 to 20 mA 2-wire technology. Suitable for hazardous locations. |
| TI00358F/00/EN | Levelflex M FMP40 | Continuous Level Transmitter for: - Level Measurement in Bulk Solids and Liquids - Interface Measurement in Liquids |
| TI01001F/00/EN | Levelflex FMP51, FMP52, FMP54 | Level and interface measurement in liquids |
| TI00436P/00/EN | Cerabar M PMC51, PMP51, PMP55 | Pressure transmitter with ceramic and metal sensors; With analog electronics or communication via HART, PROFIBUS PA or FOUNDATION Fieldbus |
| TI00383P/00/EN | Cerabar S PMC71, PMP71, PMP75 | Pressure transmitter with ceramic and metal sensors Overload-resistant and function-monitored; Communication via HART, PROFIBUS PA or FOUNDATION Fieldbus |
| TI00434P/00/EN | Deltabar M PMD55 | Differential pressure transmitter with metal sensor Communication via HART, PROFIBUS PA or FOUNDATION Fieldbus |
| TI00382P/00/EN | Deltabar S PMD70/75, FMD76/77/78 | Differential pressure transmitter with ceramic and silicon sensors; Overload-resistant and function monitored; Communication via HART, PROFIBUS PA or FOUNDATION Fieldbus |
| TI00401F/00/EN | Liquicap M FMI51, FMI52 | For continuous measurement in liquids |

| Document | Instrument | Description |
|----------------|------------|---|
| BA00340G/00/EN | Tankvision | Tank Scanner NXA820, Data Concentrator NXA821, Host Link NXA822 |
| BA00339G/00/EN | Tankvision | Tank Scanner NXA820, Data Concentrator NXA821, Host Link NXA822 |
| BA00424G/00/EN | Tankvision | Tank Scanner NXA820, Data Concentrator NXA821, Host Link NXA822 |
| BA01137G/00/EN | Tankvision | Tankvision NXA820 OPC Server |

Index

A

| | |
|--|----|
| Alcohol calculations | 61 |
| API (American Petroleum Institute) | 29 |
| API Flow Charts | 28 |
| Application | 9 |
| Application areas | 9 |

C

| | |
|---|----|
| Calculated Gauge Volume | 43 |
| Calculations | 28 |
| Calculations for liquefied gases | 53 |
| Communication variants | 19 |
| Components | 10 |
| Connection to Tankvision Professional | 24 |
| Connections to gauges and host systems | 19 |
| Correction factors for CTSh | 75 |
| Correction for the thermal Expansion of the tank shell - CTSh | 45 |
| CTSh | 56 |

D

| | |
|----------------------------------|----|
| Data Concentrator NXA821 | 12 |
| Density Calculation - RDC | 64 |
| Density calculations | 39 |
| Density handling in NXA820 | 40 |
| Designated use | 7 |
| Document | 4 |
| Documentation | 79 |

E

| | |
|---------------------------------|----|
| Example CTSh calculations | 76 |
| Examples | 25 |
| Explosion picture | 16 |

F

| | |
|---|--------|
| Field devices | 20 |
| Field instruments and slave devices | 19 |
| Floating roof adjustment - FRA | 45, 64 |
| Floating Roof Correction - FRC | 31 |
| Free Water Volume - FWV | 30, 44 |

G

| | |
|---------------------------------------|--------|
| GB (Chinese national standards) | 29 |
| GBT calculation flow chart | 42 |
| Gross Observed Volume - GOV | 33, 45 |
| Gross Standard Volume - GSV | 37 |

H

| | |
|---|----|
| Host Link NXA822 | 14 |
| Host Systems communication | 24 |
| HTG Calculation according to GOST R 8.595-2004. ... | 50 |
| Hybrid Tank Measurement Systems | 49 |
| Hydrometer Correction - Hyc | 39 |
| Hydrostatic Deformation Correction Volume - HyDC Vol. . | 44 |
| Hydrostatic Tank Gauging | 48 |

I

| | |
|--|----|
| Insulation factors for various tank geometries | 74 |
| Inventory control | 9 |
| IT security | 8 |

J

| | |
|-----------------------------------|----|
| JIS calculation flow charts | 63 |
|-----------------------------------|----|

M

| | |
|--|----|
| Mass Measurement | 48 |
| Mass/Net Weight in Vacuum | 40 |
| MBR method | 53 |
| Measurement of ambient temperature | 61 |
| Modbus slave via Host Link NXA822 | 24 |

N

| | |
|--|--------|
| Net Standard Volume - NSV | 38, 46 |
| Net Standard Weight - NSW / Product Mass | 47 |
| Net Weight in Air - NWA | 41, 47 |

O

| | |
|---------------------|----|
| OIML R22 | 61 |
| OPC DA server | 24 |

P

| | |
|--------------------------|----|
| PC recommendations | 18 |
|--------------------------|----|

S

| | |
|---|--------|
| Screen examples in Browser | 26 |
| Sediment & Water - S&W | 38, 46 |
| Static Pressure Correction Volume - VSP | 43 |
| Sump/Heel/Pipe volume | 33 |
| Sump/pipe volume | 45 |
| Symbols | 4 |
| System architecture | 25 |

T

| | |
|------------------------------------|--------|
| Tank Scanner NXA820 | 11 |
| Tank Shell Correction - CTSh | 31, 67 |
| Tankvision Alarm Agent | 17 |
| Tankvision OPC Server | 16 |
| Tankvision Printer Agent | 16 |
| Total Mass | 53 |
| Total Observed Volume - TOV | 30, 44 |
| Trademarks | 6 |

V

| | |
|--------------------------------------|------------|
| Volume Correction Factor - VCF | 34, 46, 64 |
|--------------------------------------|------------|



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