SPARTAN CONTROLS

SpartanPRO™ NOC

Instruction Manual

SPARTAN CONTROLS LTD.

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1 Overview

1.1 Revision History

Revision 1.0 October 2024 by JRC – First Release

1.2 How to Use this Manual

Read this manual in its entirety to aid in setup, configuration, navigation and troubleshooting. This manual provides a basic overview of the Net Oil Calculator, and briefly describes how to install and configure the SpartanPRO™ NOC program for an Emerson FB3000 using FBxConnect Configuration Interface Software.

1.3 Getting Help

If you have any questions, please don't hesitate to contact us at:

SPARTAN CONTROLS HEAD OFFICE
305 - 27 Street SE, Calgary, Alberta, Canada T2A 7V2
Phone: 403-207-0700
M-F 8am-5pm: 1-877-278-6404
After Hours: 1-877-278-6404

1.4 Warranty

Please find Spartan Controls current terms and conditions here:
https://www.spartancontrols.com/terms/

1.5 Application Overview

The SpartanPRO™ NOC application is a Net Oil Calculator that uses inputs from various end devices to calculate the water cut present in an emulsion stream. It is intended for use in parallel with Vinson's ProductionManager™ Equipment (PMEQ) and ProductionManager™ Well Test (PMWT) applications. This application has been developed for Emerson's FB3000 flow computer.

2 Introduction

For quick installation and configuration go to Sections 3.2 and 3.3.

The Net Oil Calculator (NOC) uses a MicroMotion mass flow meter as a flow sensor to calculate the net water present in an emulsion stream (as a percentage). Water cut determination can be made by comparing the measured emulsion density to the reference densities of free oil and water. The system can also accept an input from a water cut analyzer.

The Net Oil Calculator calculates the volume correction factor using the temperature effect on the densities of oil and water, as well as the pressure effect on the density of oil, if pressure compensation is enabled. Using the water cut and volume correction factors, the emulsion flow is factored to determine the net oil and water at standard conditions. This program provides up to two net oil calculations.

The SpartanPRO™ NOC application utilizes Vinson ProductionManager™ applications (Equipment: PMEQ and Well Test: PMWT) to provide a set of complimentary user interfaces. The operator can start and stop tests, monitor production numbers, and enter other key parameters through the Vinson applications using FBxConnect software. Refer to Vinson's documentation for further information on equipment setup and well testing.

2.1 Technical Overview

There has been one program version used for the SpartanPRO™ NOC software. All future supported software versions will be listed below.

# of NOCs or LACT	Latest Version	# of Liquid Runs	# of Gas Compositions	Gas Composition Type	# of History Points
1 or 2	Contact Spartan Controls	24	24	Per Well	FB3000 History: Transactional History for well testing (256 records/PMWT) Standard periodic history for LACT (default 730 days, user defined)

Note: FB3000 Firmware revision required is 2.17 or greater. Field Tools version 3.17 or greater.

The SpartanPRO™ NOC system has two operating modes available. The modes are PMWT (ProductionManager™ Well Test) or LACT (continuous mode). In PMWT mode, the system will allow daily production to be tested for oil, water and gas production. The system has a database for each well containing oil density, water density and well identifiers. The well test mode prorates measurement to a 24 hour period. If the test is stopped prior or extended beyond 24 hours, the production data will be prorated to a 24 hour test. In LACT mode, the system will run the well test continuously. Daily production numbers will be recorded based on the contract hour configured in the FB3000.

Both PMWT and LACT modes allow measurement of either a 2 phase or a 3 phase separator. The liquid emulsion measurement is made by Micro Motion Coriolis meter. If a 3 phase separator is used, a turbine meter may be used for the water measurement. The gas measurement is made using a differential pressure or linear meter (software configurable).

The system can provide water cut measurement by several methods. The most common method is using a MicroMotion Coriolis meter density measurement for the inferred water cut. Alternately, a Drexelbrook BS&W monitor can be added in the range of 0-5% (±0.5% deadband) and an alternate technology such as a Phase Dynamics Microwave analyzer can be added for a high water cut range (0% to ~60%).

Low Range	High Range	Cut Method
0%	5%*	Drexelbrook
0%	100%	Net Oil Calculator
0%	~60%**	Phase Dynamics

*±0.5% Deadband

**Depends on emulsion Phase

2.2 Software Interface

The software used for configuration of the FB3000 is the Emerson FBxConnect program included within Field Tools. The instructions provided in this manual are directed specifically for the use of the FBxConnect program. There are additional utility programs available for use with the SpartanPRO™ NOC user program, the FBxVue and FBxDesigner software. This additional software also allows the user

to make most configuration changes to the user program as done with FBxConnect. It is recommended to use the FBxConnect for all set up and configuration, then use the FBxVue or FBxDesigner program utilities to assist in diagnostics when required.

Emerson FBxConnect software is used to download the user program into an FB3000. By default, an application file (.zap) that includes the SpartanPRO™ NOC will be downloaded into any slot on the FB3000 according to site conditions. Alternatively, a solution (.zsl) file that includes all three applications can be used. However, in this case, application slot 1 will be designated for the SpartanPRO™ NOC application, slot 2 the Vinson PMEQ application, and slot 3 the Vinson PMWT application. Refer to Vinson documentation for licensing/activation of the PMEQ/PMWT applications.

The programs are as follows:

User Program	**Application Slot (Recommended)**	**Description**
SpartanPRO™ NOC	1	Net Oil Calculator
PMEQ v5	2	Equipment Manager
PMWT v5	3	Well Tester

3 Installation

3.1 Installation Procedure

The following outlines the recommended steps to download the SpartanPRO™ NOC Application file (.zap) or solution file (.zsl).

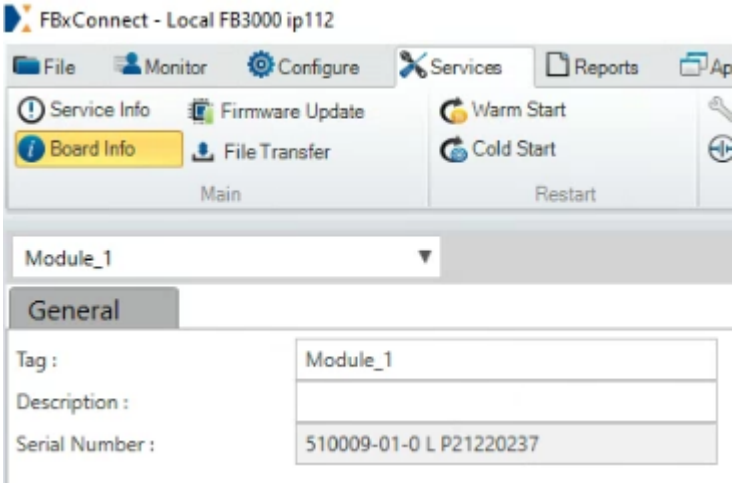
Step	Description
1	**If this is a new FB3000 with no previous history to collect, you may skip to step 2.** **Backup History / Alarms / Events** Select the Reports tab on the FBxConnect main screen. Under the History section, generate a set of the History, Events and Alarms reports. Define the relevant collection period, time, sorting and file format. Select Generate.
2	**Perform a Factory Default Cold Start** Select the Services tab on the FBxConnect main screen. Under the Restart section, select Cold Start. Select 'Database is re-initialized with factory defaults and any other relevant options to clear during the cold start as needed, select OK.
3	**Pick 1 or 2, not both.** **1 Application (.zap) Download** An application download will only bring the SpartanPRO™ NOC application into the FB3000. Select the Applications tab on the FBxConnect main screen. Under the Main section, select Management. Select an empty slot to load the application into and select Import Application. Browse to the location of and select the SpartanPRO NOC zap file. **2 Solution (.zsl) Download** A solution download will bring all three applications into the FB3000. Select the File tab on the FBxConnect main screen. Under the Solution section, select Download Solution. Browse to the location of and select the SpartanPRO NOC.zsl file. Select Download.

3.2 Licensing

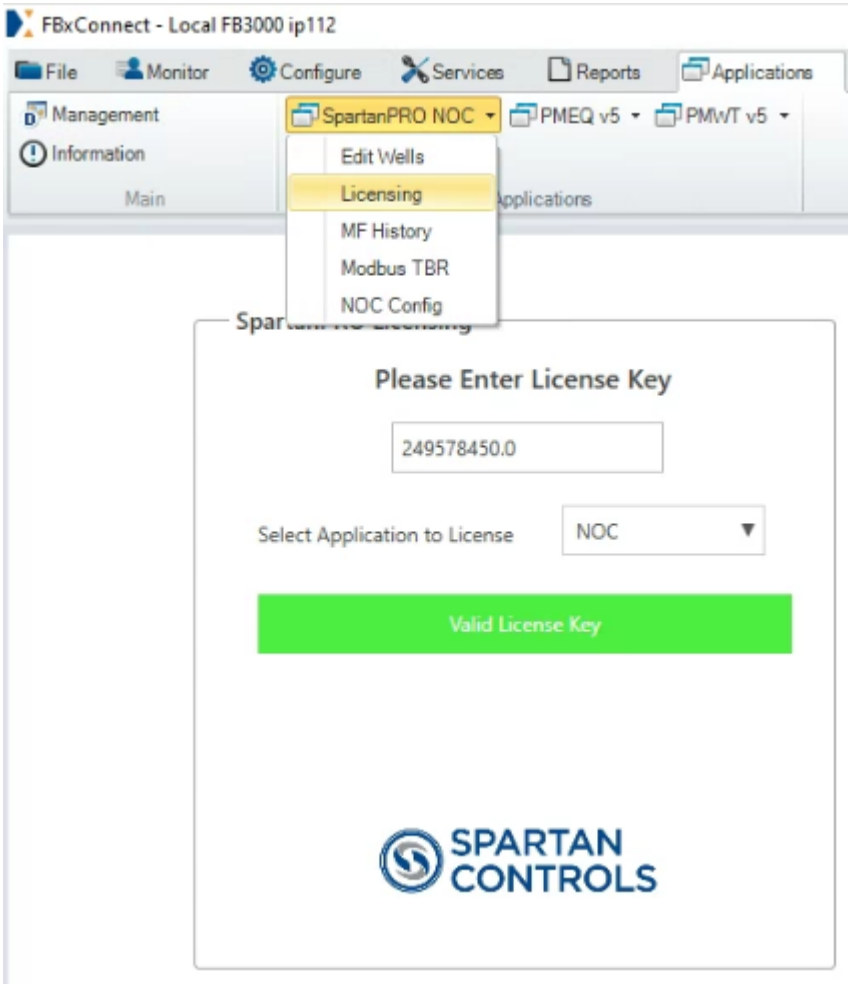
Once installed the SpartanPRO™ NOC application will require a license to operate. If the application was loaded prior to the FB3000 shipping from Spartan Controls, it will be licensed already.

If the application is installed in the field, a call to contact Spartan Controls will be required for the license key. You will require:

1. Purchase order used to purchase SpartanPRO™ NOC
2. FB3000 Serial number located in Field Tools FBxConnect, Services, Board Info



Spartan Controls will return a “License Key” which is entered into the Licensing page of the application.



3.3 Commissioning

The SpartanPRO™ NOC application should be configured and commissioned by a Spartan Service Technician unless the user is familiar with the application and this manual. It is strongly recommended that a Spartan Service technician be involved in the first implementation of this product.

4 NOC Configuration

4.1 Configuration Options to Note

- The Net Oil Calculations are performed using well specific constants for oil and water density and shrinkage factors.
- Modbus is used to transmit density, emulsion flowrate and temperature. Accumulation is performed over the duration of the test for oil, water, and gas flow AGA calculation.
- A pressure input is optionally provided for pressure compensation of oil density. If pressure input is not chosen, a fixed pressure must be used in API liquids correction application. An estimate of the vessel pressure will suffice.
- Water cut can be directly monitored, with up to two monitoring ranges defined: a low range equipped with either an S&W or % analog monitor, and a high range that can be supplied by Phase Dynamics from a Modbus connection.

4.2 NOC Configuration Info

The NOC program uses 5 sets of user defined points.

The User Defined Points are summarized in the following table:

UDP Title	**Purpose**
NOC	Modbus, configuration, calculation registers
NOC_Well	Well database registers
NOC MF Hst	Meter factor history registers
NOC RZR	Phase Razor registers
NOC PRO	NOC licencing registers

4.3 FB3000 NOC Base Configuration

The following are the typical configuration settings for the FB3000 when in use with the SpartanPRO™ NOC application. Note the settings may vary dependent on application.

Parameter	Description
MicroMotion Configuration	Metric Units: Volume = m^3/min Mass = kg/min, Temperature = Deg C, Density = g/cm^3 Communications: Address 1, 19.2K baud, 1SB, 8DB, No parity
I/O Setup	3 AI, or 1 4088 MVS per NOC separator for gas flow 1 AI for low range water cut (Drexelbrook)
Program Setup for MicroMotion	Set Modbus address = 1 Enter well database – as per site information provided
FB3000 Units	Units – Set all to Metric Re Station Contract Hour – Site Specific
NOC Comms	19.2k Baud Rate, 8 Data Bits, No Parity, 1 Stop Bit Port Owner = Modbus Master
Modbus Access Configure / Communications / NOC Comms	Using the COM Port config tool (NOC Config screen), the FB3000 port number and Modbus register start value can be defined by the user. **Note:** the desired FB3000 port must be configured as a Modbus Master.

4.4 Standard Configuration (MicroMotion)

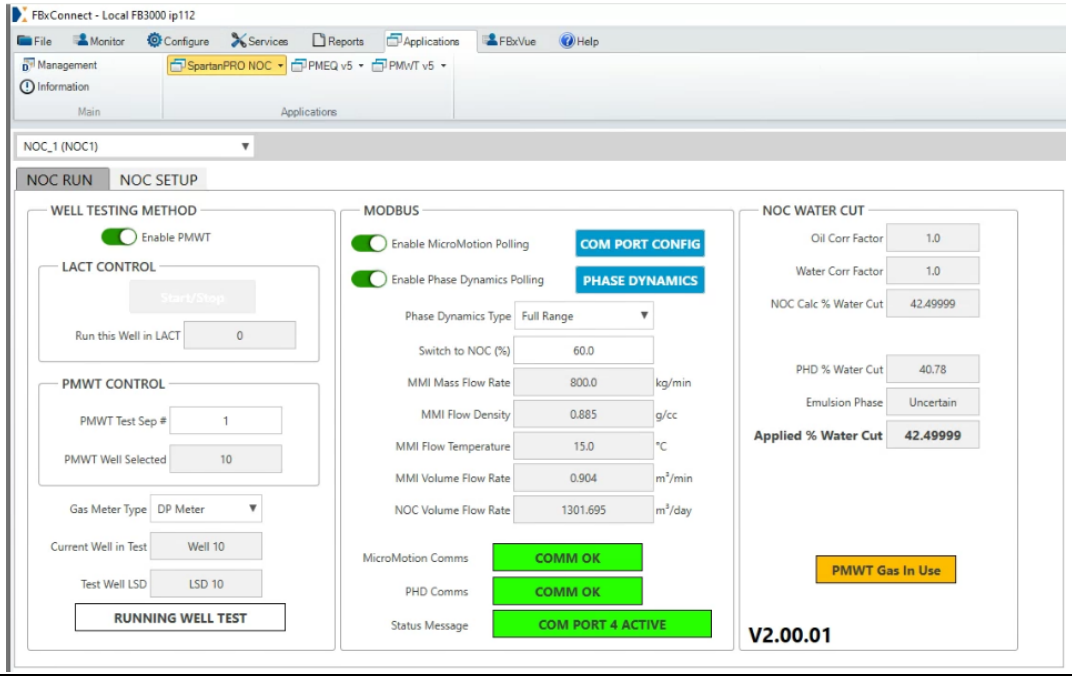
SpartanPRO™ NOC is designed for use with a MicroMotion Coriolis meter communicating over Modbus RS485. The following is a list of the basic parameters when using a MicroMotion Coriolis meter.

Parameter	Description
Volume Units	m^3 / min
Mass Units	kg / min
Density Units	g / cm^3
Temperature Units	°C
Modbus Address	1 (NOC 1) / 2 (NOC 2)
Communications	19.2k Baud Rate, 8 Data Bits, No Parity, 1 Stop Bit

5 Screens

5.1 NOC 1 and NOC 2 Screens

In the Applications tab select **SpartanPRO™ NOC** / **NOC Config.** The NOC 1 screen is now available with a NOC SETUP tab. NOC 2 is available from the pulldown list on the top left.



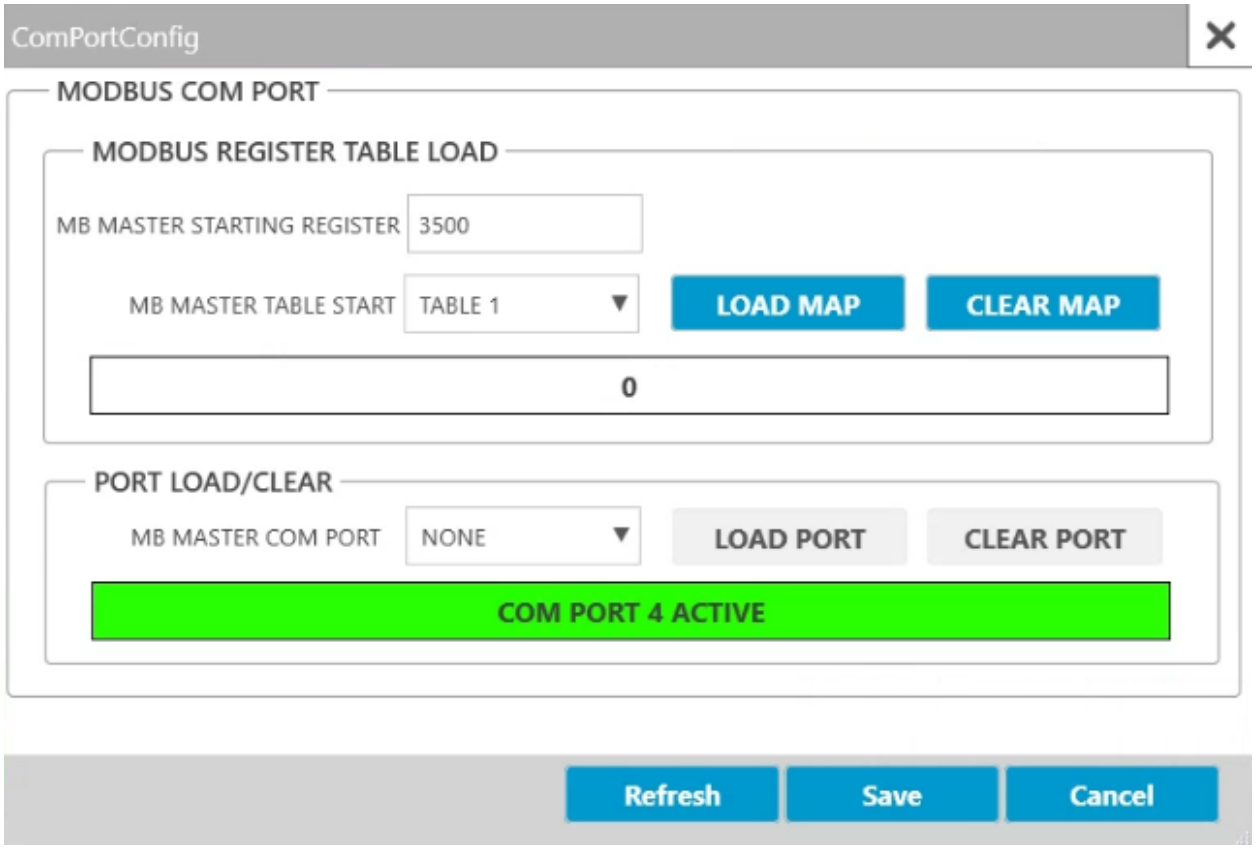
5.1.1 NOC RUN

SCREEN SECTION (Box)	Parameter Description
WELL TESTING METHOD **Enable PMWT Toggle (1 = Toggle)**	Toggle this on to enable **PMWT Mode**. Toggle this off to enable **LACT Mode**. NOC 1 and NOC 2 are independent.
LACT CONTROL	This text box displays the current well data to be used in LACT mode. It also provides a Start/Stop button to start LACT mode.
PMWT CONTROL	This text box displays the current well on test and which PMWT test separator is being used. Zero (0) as test separator means that well testing mode is not running. **Gas Meter Type:** defines type of gas meter (DP or Linear). **Current Well in Test**: This read only field displays the well number currently being tested or of the well last tested. Refer to the Vinson applications for additional information. **Test Well LSD:** This read only field displays the Legal Site Descriptor of the well currently in test.

MODBUS	**Enable MicroMotion** Polling toggle **COM PORT CONFIG**: See section 5.1.2 **Enable Phase Dynamics**: See section 5.1.3 **Phase Dynamics:** button to configure specific parameters of the Phase Dynamics. See Section 5.1.3 **Phase Dynamics Type:** Selection of Phase or Razor devices. See section 5.1.3 **Switch to NOC (%):** Value of Water cut to switch to NOC from Phase Dynamics. NOTE: Emulsion Phase needs to be "Oil" for water cut to be selected from Phase. **Parameters Greyed Out:** Modbus parameters from MicroMotion. See section 5.1.4 **Status values of Communications:** Micromotion coms, PHD coms, Port active
NOC WATER CUT	All read only parameters indicating water cut measurement and/or calculations. **Applied % Water Cut:** Value to be applied to liquid flow calculation as water cut. **V2.xx.xx:** Displays the current NOC application version on the FB3000.

5.1.2 MODBUS COM PORT

Allows the user to define a desired COM port for MicroMotion/Phase Dynamics communications and adjust Modbus mapping requirements.

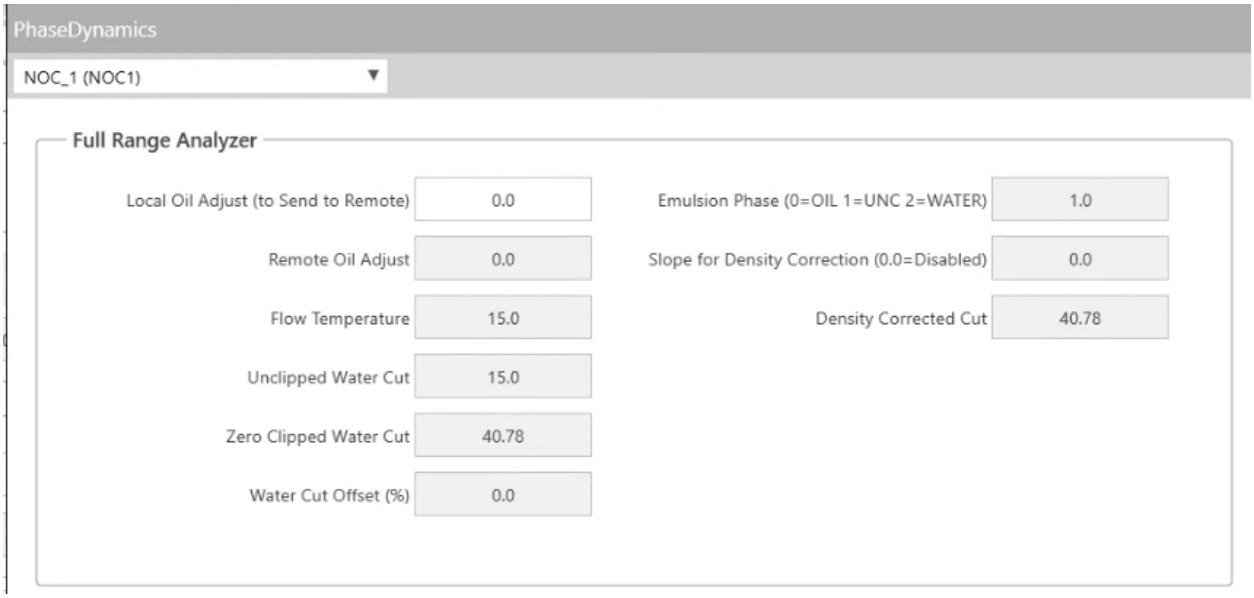


5.1.3 Phase Dynamics

Phase Dynamics Type:

- Unselected – No PHD selected. (Recommended to turn off Modbus Coms)
- Full Range – Select this for the Phase “Classic” models.
- Razor – Select this for the new Razor insertion models.

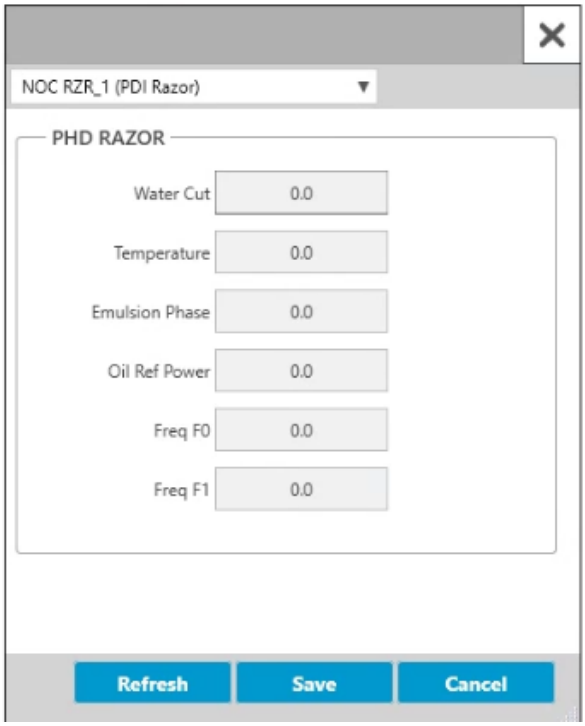
If Selected = “Full Range”



Parameter	Description
Local Oil Adjust (to send to Remote)	Allows the user to adjust oil locally. Saving this value will adjust the remote oil if phase dynamics is enabled.
Remote Oil Adjust	This read only parameter displays the oil adjustment setting from the Phase Dynamics.
Flow Temperature	This read only parameter displays the current flow temperature used in phase dynamics if enabled.

Unclipped Water Cut	This read only parameter displays the current unclipped water cut from phase dynamics if enabled.
Zero Clipped Water Cut	This read only parameter displays the current zero clipped water cut from phase dynamics if enabled.
Water Cut Offset %	Allows the user to enter a water cut offset for phase dynamics if enabled. This offset is applied to the unclipped water cut.
Emulsion Phase	Allows the user to specify the emulsion phase of the mixture if phase dynamics is enabled and the high PHD range is selected. This parameter is typically set to 0 for continuous oil.
Slope for Density Correction	Allows the user to specify a slope to be used in the NOC calculation to correct the water cut. The slope must be less than zero for density correction to occur. **Note: -0.0286 is a good number to start with when density compensation is required**
Density Corrected Water Cut	This read only parameter displays the density corrected water cut.

If Selected = “Razor”



Parameter	Description
Water Cut	Read Only parameter of measured water cut.
Temperature	Read Only parameter of measured temperature.
Emulsion Phase	Read Only parameter of emulsion phase.
Oil Ref Power	Read Only parameter of measured Oil Reference Power (used for diagnostics).
Freq F0	Read Only parameter of measured frequency (used for diagnostics).
Freq F1	Read Only parameter of measured frequency (used for diagnostics).

5.1.4 MODBUS Parameters

Read only parameters

Parameter	Description
Mass Flow Rate	This read only parameter displays the instantaneous mass flow rate from the MicroMotion if Modbus polling is enabled.
Flow Density	This read only parameter displays the instantaneous flow density from the MicroMotion if Modbus polling is enabled.
Flow Temperature	This read only parameter displays the instantaneous flow temperature from the MicroMotion if Modbus polling is enabled.
Volume Flow Rate	This read only parameter displays the instantaneous volumetric flow rate from the MicroMotion if Modbus polling is enabled.
Flow Rate	These read only parameters display the instantaneous volumetric flow rate and the prorated (PMWT only) flow rate for a 24 hour period.

5.2 NOC SETUP

SCREEN SECTION (Box)	Parameter Description
TEMPERATURE	**Flow Temperature Source:** Allows the user to configure the flow temperature source to be either the MicroMotion or an analog input. **Raw Temperature:** This read only parameter displays the raw temperature from the source. **+/- Temperature Adjust:** Allows the user to apply a temperature adjustment to the raw temperature (if required). **Applied Temperature:** This read only parameter displays the temperature used in NOC calculations. Applied Temperature = Raw Temperature +/- Temperature Adjust.
Flow Pressure Source Toggle	Allows the user to select if flow pressure is used in NOC calculation. Flow pressure compensation is optional. **Note: a value is required for Liquid Meter calc to operate (simulate in necessary)** **Flow Pressure Source:** This read only parameter displays the analog input currently configured to read flow pressure if enabled. **AI Pressure EU Reading:** This read only parameter displays the current pressure reading from the pressure source if enabled.
Pressure From Source	This read only parameter displays the current pressure reading from the pressure source if enabled.

Water Cut **AI Water Cut Source Toggle**	Allows the user to select if the water cut source from an analog input is used. **AI Reading Type:** Defines AI EUs as Dielectric or %Water Cut **AI Cut Source:** Defines AI to be used as water cut source **AI Cut EU Reading:** This read only parameter displays the selected Engineering Unit (EU) value of the water cut input. **Switch to NOC/PHD (%):** Point to switch out of AI cut source, default 5.0, deadband is 0.5%. **Well Water Density @ 15°C:** Read only value of well data **Well Oil Density @ 15°C:** Read only value of well data
AI/BSW CALC INFO	All read only values for AI water cut either dielectric or % water cut. Only to be modified by qualified Spartan Controls technician. See section 5.1.5.

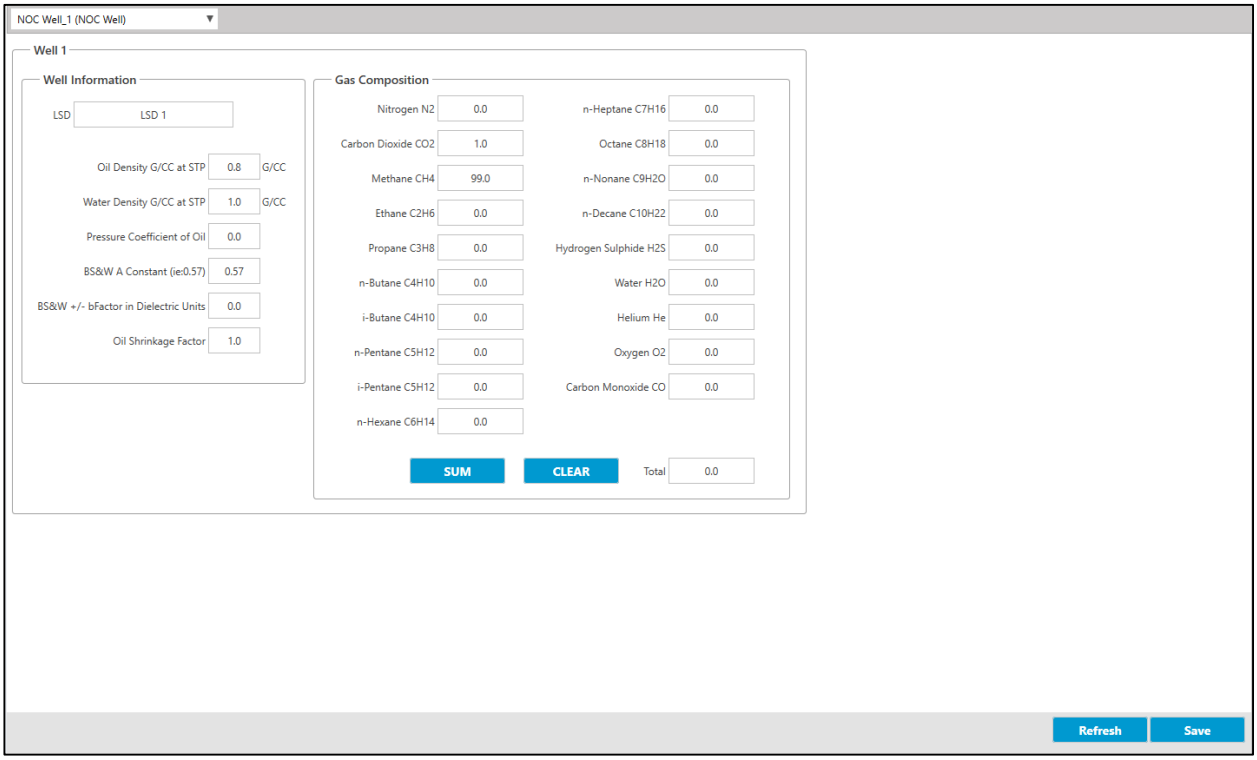
5.2.1 AI/BSW CALC INFO

Parameter	Description
BSW Well bTrim	This read only parameter displays the ±bTrim value in dielectric units if an analog input is selected as the water cut source. This value is set in the Edit Wells screen.
BSW k_mix + Well bTrim	This read only parameter displays the sum of the k mix and bTrim values in dielectric units if an analog input is selected as the water cut source.

BSW Dielectric K of Oil	This read only parameter displays the dielectric of oil at operating temperature if an analog input is selected as the water cut source.
BSW Dielectric K of Water	This read only parameter displays the dielectric of water at operating temperature if an analog input is selected as the water cut source.
Oil Density at Flow Temperature	This read only parameter displays the oil density at flowing temperature. This value is found by taking the well oil density at 15ºC and correcting to the current flow temperature.
Oil Correction Factor (CTL)	This read only parameter displays the density ratio of oil. coFac = density of oil at operating temperature / density of oil at 15ºC and operating pressure (if enabled).
Water Density at Flow Temperature	This read only parameter displays the water density at flowing temperature. This value is found by taking the well water density at 15ºC and correcting to the current flow temperature.
Water Correction Factor (WCF)	This read only parameter displays the density ratio of water. cwFac = density of water at operating temperature / density of water at 15ºC.
BSW Water Cut %	This read only parameter displays the instantaneous water cut percentage at operating temperature if an analog input is selected as the water cut source.

5.3 Well Configuration Screen

In the Applications tab select **SpartanPRO™ NOC** / **Edit Wells**. The well configuration has 24 wells and must be complete for the well testing to function properly. Enter the gas composition for each well, the sum of all components must be 100%. Default values are set for the five parameters on the left of the screen, however, they are not process-backed. Confirm site specific values for these parameters during initial setup.

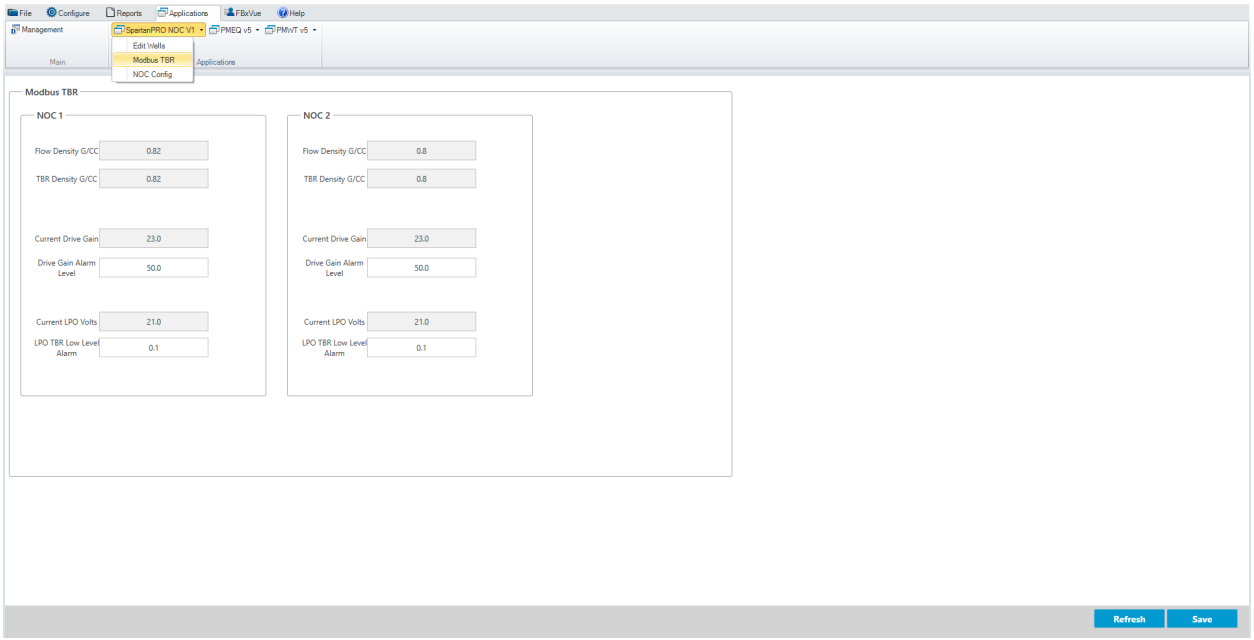


Parameter	Description
LSD	A 20 character identifier which can be used as a Legal Site Description or another description of the well. This identifier is displayed on the NOC Config screen when this well is in test.
Oil Density G/CM^3 at STP	Allows the user to specify the oil density at 15ºC to be used in the NOC calculation. Default value is 0.8 g/cm^3.

Water Density G/CM^3 at STP	Allows the user to specify the water density at 15ºC to be used in the NOC calculation. Default value is 1.0 g/cm^3.
Pressure Coefficient of Oil	The pressure coefficient of oil used in the pressure compensation of the oil density. Units: E-7 g/cm^3/kPA. Pressure Coefficient of Oil = (standard density – operating density) / (standard pressure – operating pressure) Note: Typically, in test separator applications, the pressure coefficient is set to 0 because the difference in standard density and operating density is minimal and pressure compensation on density does not have to be performed. Default value is 0.0.
BS&W A Constant	The BS&W A constant. This value is 0.57 by default and should not ever be changed unless advised by Spartan Controls. A change will impact the accuracy of the BS&W monitor if in use.
BS&W +/- bFactor in Dielectric Units	The BS&W B constant which is the change in % water per unit change in dielectric of the mixture. This entry is essentially an offset for the BS&W monitor. Default value is 0.0.
Oil Shrinkage Factor	The shrinkage factor of oil. API 20.1 is calculation required by emulsion meter in order for this factor to be enabled.

5.4 Modbus TBR Screen

In the Applications tab select **SpartanPRO™ NOC** / **Modbus TBR**. NOC 1 and NOC 2 can be configured independently. This configuration must be complete for the well testing to function properly. These settings are used if a TBR event occurs (entrained gas is carried through the meter).

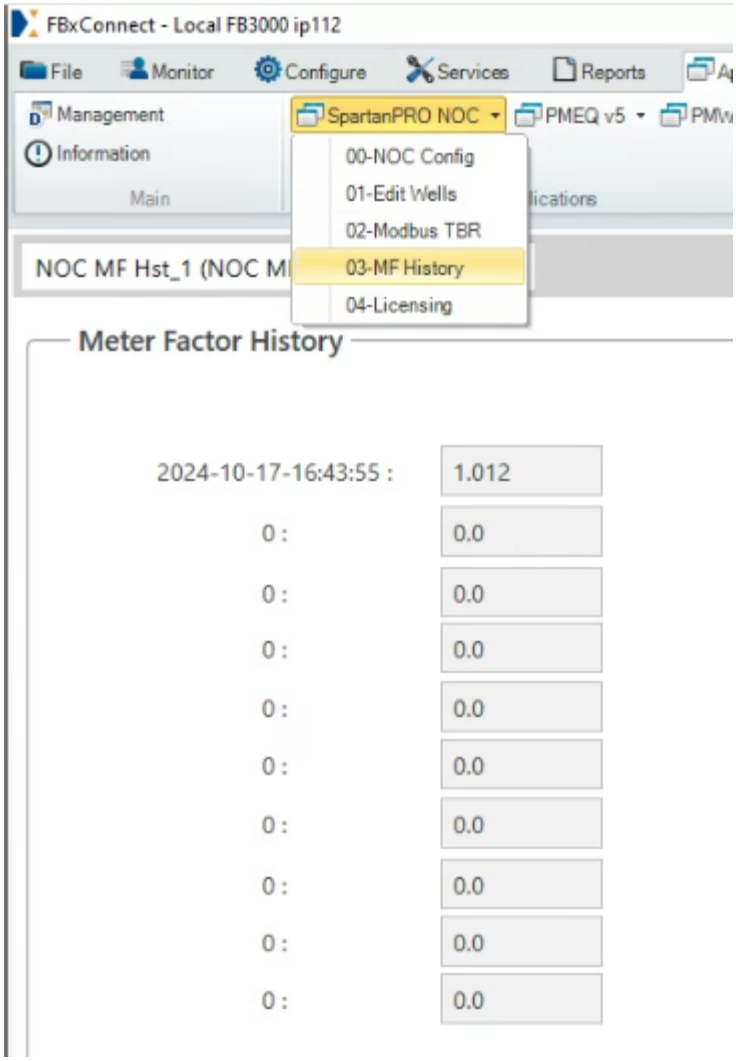


Parameter	Description
Flow Density G/CM^3	This read only parameter displays the instantaneous flow density from the MicroMotion if Modbus polling is enabled.
TBR Density G/CM^3	This read only parameter displays the density to be used in the NOC calculation.
Current Drive Gain	This read only parameter displays the current drive gain.

Drive Gain TBR Alarm Level	Setting used to define a high alarm limit of the coriolis meter drive gain. If the drive gain TBR alarm level is exceeded an alarm will be generated and displayed on the screen and recorded in the FB3000 alarm log. If this alarm occurs regularly then process operational changes may be required to minimize the amount of gas breakout accruing in the coriolis meter. Additional features on the Micro Motion transmitter may be employed like Advanced Phase Measurement.
Current LPO Volts	This read only parameter displays the current LPO volts.
LPO TBR Low Level Alarm	Also an indicator of the presence of entrained gas. Alarm is generated if the LPO is below this level.

5.5 MF History

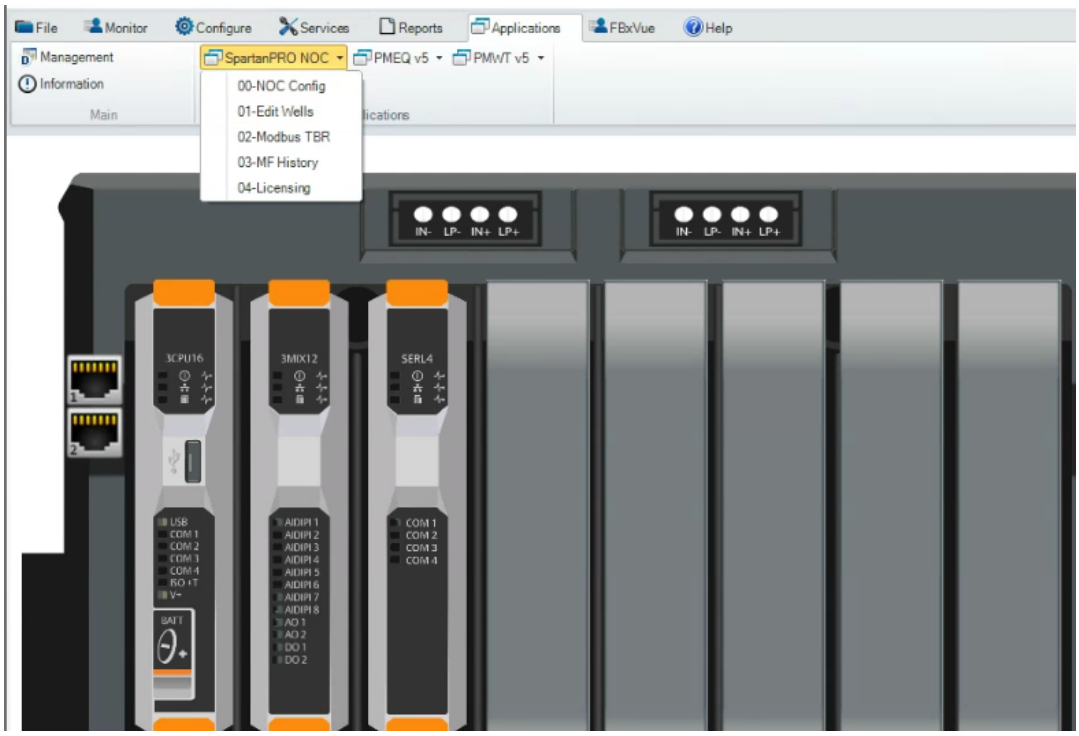
When MF is entered into the emulsion flow meter calculation in the FB3000, this application records the last 10 of them for easy reference. The FB3000 Audit logs will also record this parameter change. Use caution to only apply a single meter factor to either the flow computer (FB3000) or the MicroMotion coriolis transmitter.



6 Operation

6.1 Accessing the Operation Screens

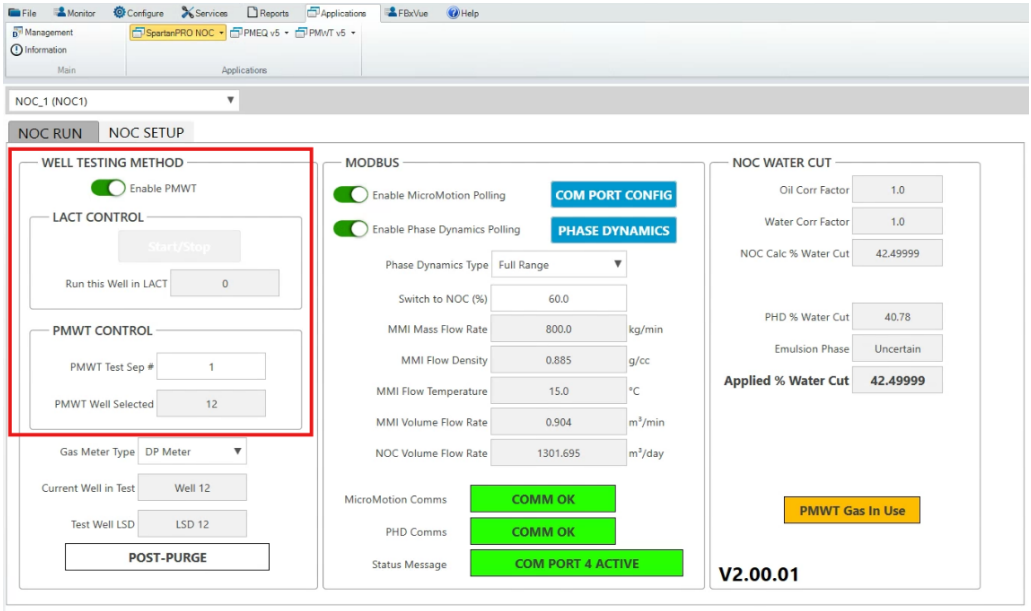
All screens can be accessed directly through FBxConnect under the SpartanPRO™ NOC application.



6.2 Starting and Stopping a Test

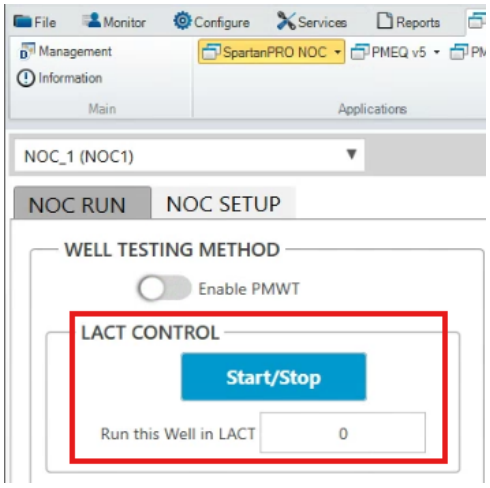
Tests are controlled through a combination of Spartan and Vinson applications. A test can be started in LACT mode on NOC 1 and NOC 2 directly from the NOC Config screen. PMWT tests can also be enabled from these screens. PMWT tests can be setup and controlled through the Vinson (PMEQ and PMWT) applications, see Vinson for additional information and documentation regarding test setup. Test separators 1 and 2 are available for use in the NOC application and can accommodate up to 12 wells each. Only one of either LACT or PMWT testing modes may be running on each NOC at one time. The test status will display as ‘Running Continuous’ if in LACT mode, ‘Pre-Purge’ / ‘Running Well Test’ / ‘Post-Purge’ if in PMWT mode or ‘Stopped’ if NOC is not running. The

screen will display the current well in test as well as the well's LSD for both modes of operation.



When PMWT is enabled, the screen will display the current separator and well being tested, as well as a status message for the test. The selection of the well in test must be done through the PMWT application. To enable or disable PMWT, use the toggle button in the top left of the screen.

If PMWT is disabled, the user will have the option to start and stop LACT testing. To start or stop a test in LACT mode, press the START/STOP button and ensure the test status is 'Running Continuous'.



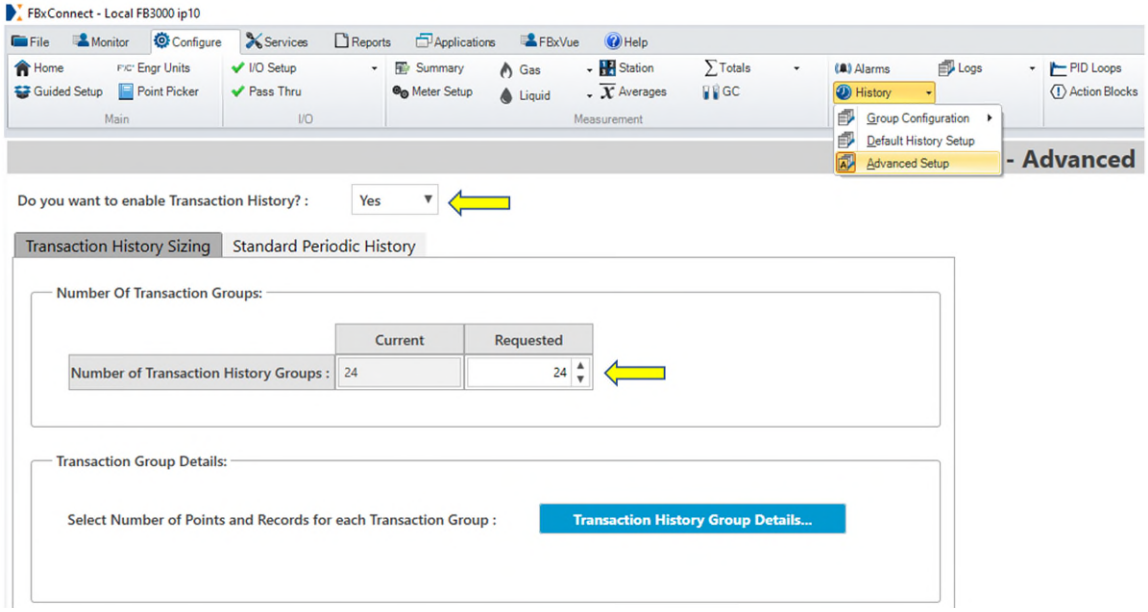
6.3 Setting Up Historical Data

6.3.1 Well Test Mode (with PMWT)

Transactional History must be setup for each Well being tested. This is completed with the following steps:

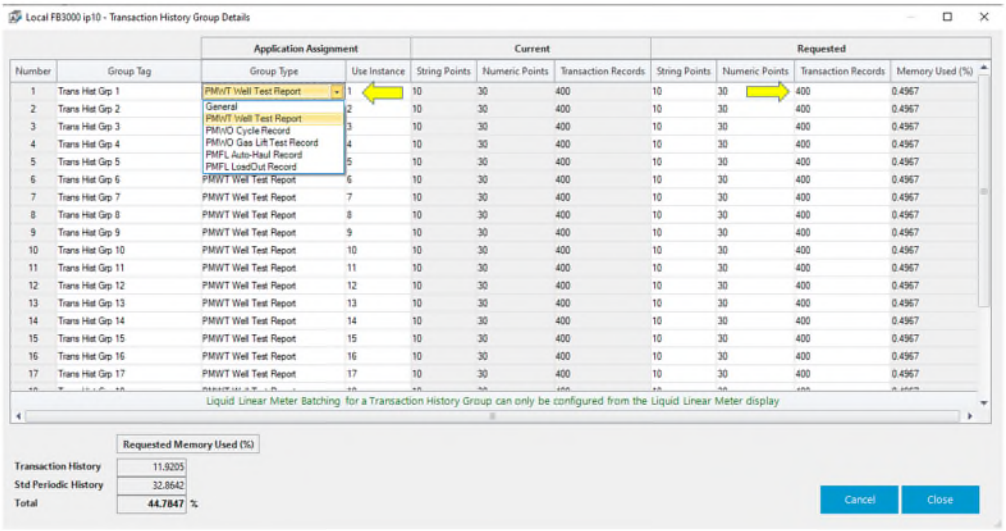
Step 1

- Select <History> <Advanced Setup>
- Enable Transaction History
- Set number of wells (max 24 for PMWT) that will need transactional history
- Click <Save>
- Select <Transaction History Group Details>



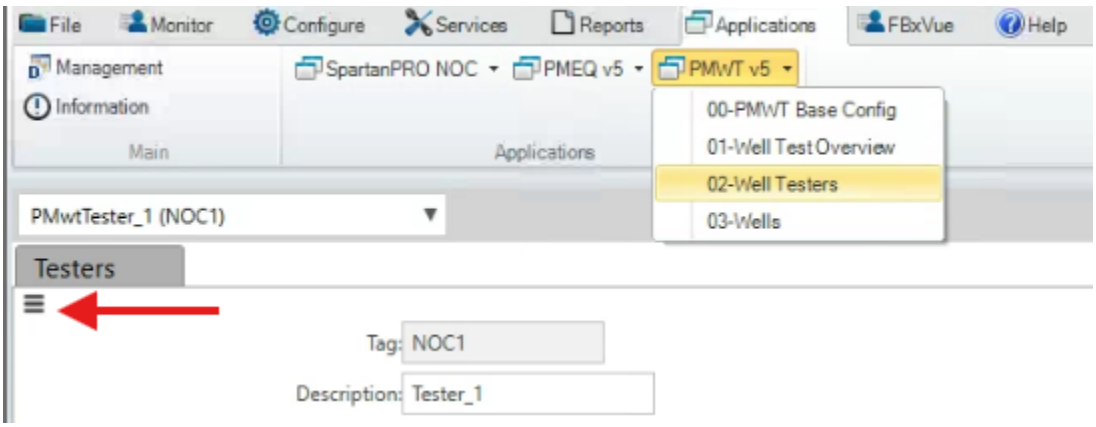
Step 2

- Select <Group Type> pull down box, select <PMWT Well Test Report>
- Select <Use Instance> to equal Trans Hist Grp #
- Change Requested <Transaction Records> if desired
- Click <Save>



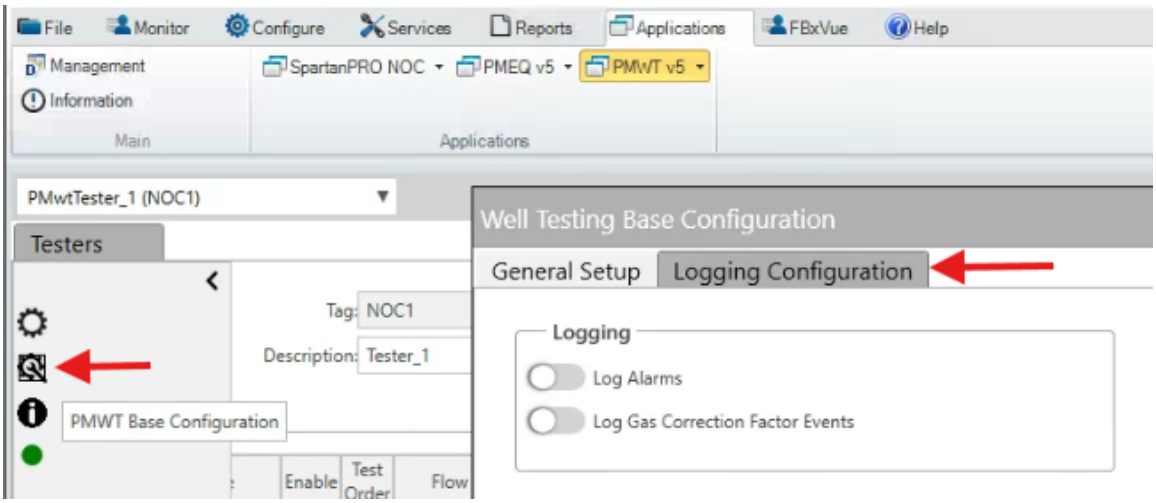
Step 3

- Under Applications, select <PMWT v5> <Well Testers>
- Select <Hamburger> <PMWT Well Testers>

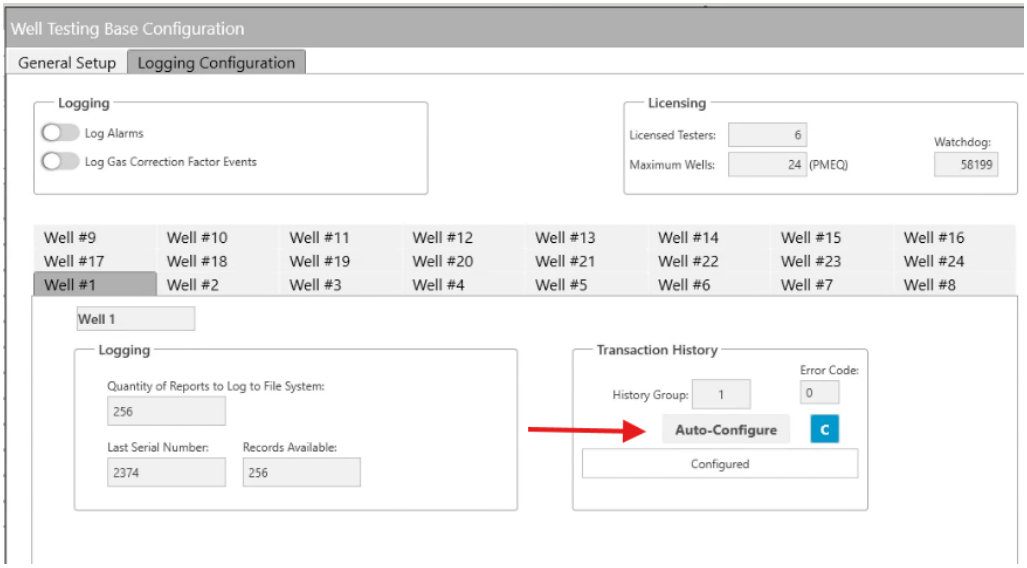


Step 4

- Select < Gear with wrench >Tab “Logging Configuration”

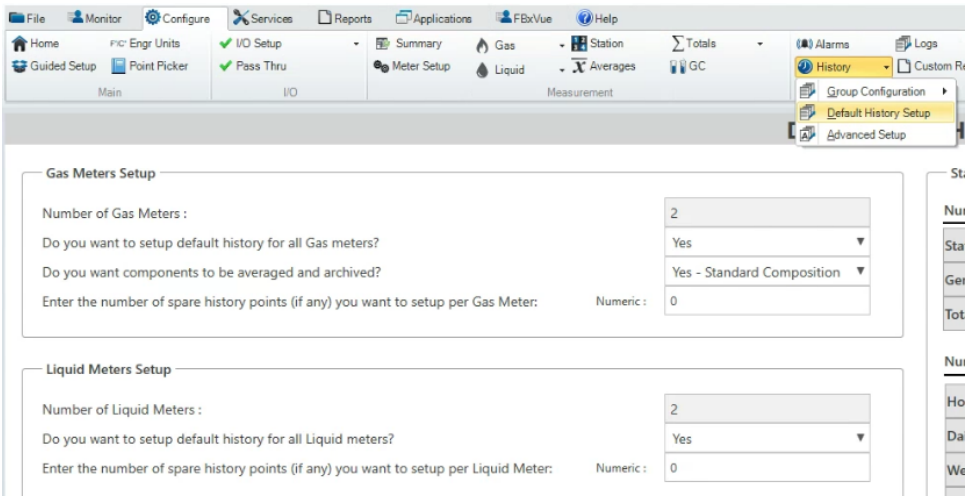


- Select <Auto-Configure> for Transaction History on each well that is used

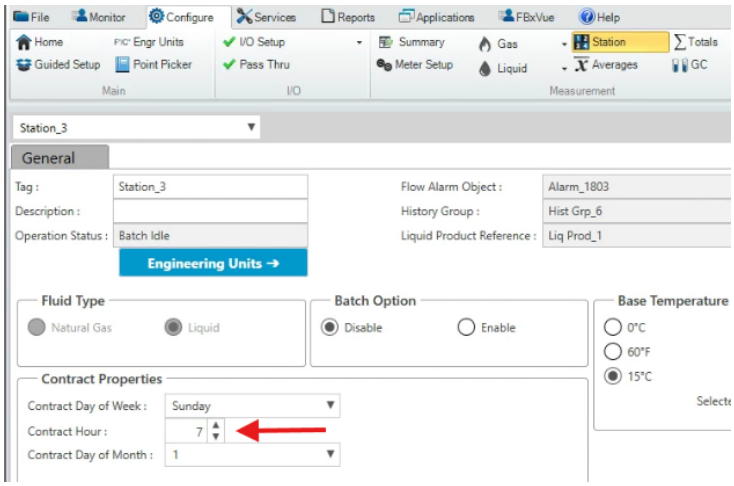


6.3.2 LACT Mode (without PMWT)

It is recommended to setup periodic history as a “Default History Setup”.



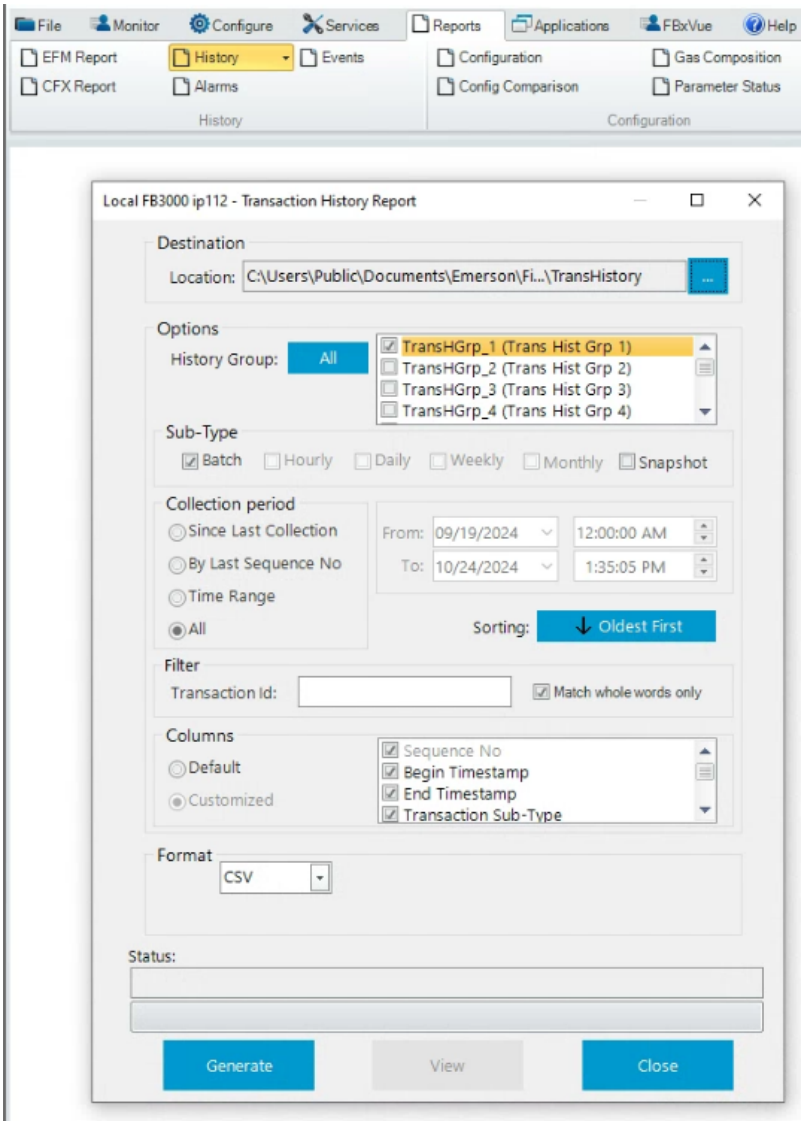
Ensure to set the specific contract hour required in the appropriate Station.



6.4 Reports – Transactional (Well Testing)

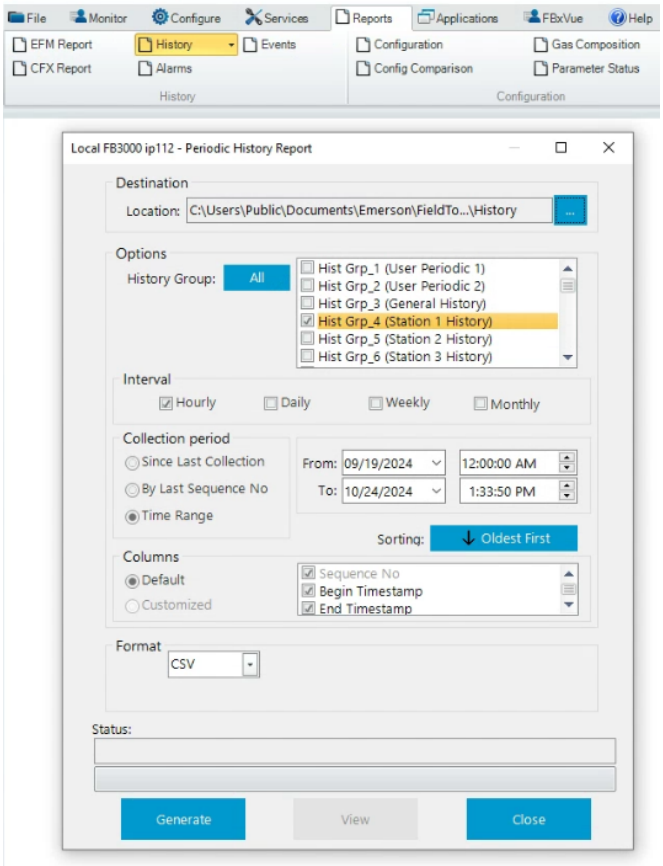
A CSV report can be downloaded from the FB3000 that contains 400 transactions per well/transaction record. This will include:

- Site Identifier (typically LSD)
- Test Date with start and end times
- Test Duration (hours)
- 24 Hour Equivalent oil, water and gas volumes
- Test oil, water and gas volumes



6.5 Reports – Periodic (LACT)

A CSV report can be downloaded from the FB3000 that contains the flowing volumes for Oil, Water and gas for the 24 hour period defined by the Station contract hour.



6.6 Alarms/Events

The system maintains an event record for any configuration changes that occur. This report can be accessed through **Reports / Events**. The system also maintains an alarm record for any alarm codes that occur. This report can be accessed through **Reports / Alarms**. The FB3000 also includes other reports for users, available under the reports tab.

Appendix A: Standards

The NOC calculations are based on the following specifications and standards:

- Algorithm of Net Oil Computation using MicroMotion Flow Meter and FB3000
- Manual of Petroleum Measurement Standards, Chapter 11.1 – Volume Correction Factors, API Standard 2450, 2004 Edition.

Appendix B: Liquid Meter Configuration Guide

FUTURE RELEASE

Appendix C: Directive 17 Compliance

The following is a summary of the Directive 17 compliance requirements and confirmation on what Spartan believes provides system compliance.

Application: Well Production Testing

Requirement	Compliance	Reference
Single point oil production uncertainty requirement: 2%	MicroMotion volume accuracy: 0.1%. Typical water cut accuracy for 2 phase separator applications: 1%.	Section 1 of Directive 17
Single point gas production uncertainty requirement: 3%	Rosemount 4088B accuracy: 0.1% of span for 1:1 to 10:1 turn down.	Section 1 of Directive 17
Calibration and proving requirement: Annually	MicroMotion requires proving annually unless Meter Verification (MV) is in use. With MV, proving is not required provided MV testing confirms meter performance is good.	Section 2 of Directive 17 See Exceptions Note 1 for information on meter verification
Calibration of density for water cut calculation requirement: Annually	The MicroMotion density can be calibrated against a known density of liquid if required.	Section 2.11 of Directive 17

Accounting for shrinkage	The NOC software has an individual shrinkage factor for each well in the database.	Section 2.7.1 of Directive 17 Section 6.3.2.3 of Directive 17
Calculation requirement for volume	The FB3000 NOC program complies to 2 decimal places.	Section 6.3.2 of Directive 17
Calculation requirement for daily volume	The system provides daily volumes and non-resettable running totalizers.	Section 6.3.2.4 of Directive 17
Temperature correction requirement	The system provides real time CTL using an electronic flow measurement system.	Section 6.3.2.1 of Directive 17
Pressure correction requirement (not required for test production measurement)	The system provides real time CPL using an electronic flow measurement system.	Section 6.3.2.2 of Directive 17
Water cut calculation requirement The percentage of water in the gross volume is determined by measuring the percentage of sediment (% S&W) of a representative sample or by continuous on-line measurement.	The FB3000 NOC program computes water cut using an inferred density calculation in the range of 0% to 100% water cut. (U.S. patent # 4,689,989 and # 4,773,257) The system optionally computes water cut in the low range (0% to 5%) based on a density corrected water cut probe. (U.S. patent # 5,325,066 and Canadian patent # 2,074,017)	Section 6.3.2.4 of Directive 17
Calculation performance evaluation	The API liquids correction is contained within the firmware of the FB3000. This calculation should be verified to PC based reference software recognized by the regulator.	Section 6.8 of Directive 17
Electronic Flow Measurement for Oil Systems Hardware and software requirements: The memory on board the EFM must allow for at least 32 days of storage of the required flow data before being overwritten or erased.	FB3000 NOC has 24 wells and maintains 256 (PMWT) or a user-configurable amount (with Transactional History) of well test records. History records are dependent on user set up.	Section 6.8 of Directive 17

Electronic Flow Measurement for Oil Systems Hardware and software requirements: The EFM must be equipped with its own on-board battery to protect the memory in the event of a power failure.	FB3000 NOC has on board battery back up.	Section 6.8 of Directive 17
Electronic Flow Measurement for Oil Systems Hardware and software requirements: The system must have various levels of system security, with the highest level of access to the program restricted to authorized people.	The FB3000 permits device-based security. You can define and store custom log-on identifiers (IDs). In order for the unit to communicate, the log-on ID supplied to FBxConnect software must match one of the IDs stored in the FB3000. This security feature is enabled by default.	Section 6.8 of Directive 17
Electronic Flow Measurement for Oil Systems Hardware and software requirements: The communication system must use a data integrity error checking routine to ensure that the data transmitted is correct.	FB3000 NOC communications protocol is DNP3 which has integrated error checking.	Section 6.8 of Directive 17
Electronic Flow Measurement for Oil Systems Hardware and software requirements: The EFM must be set to alarm on high and low differential pressure, if applicable, over the range of any end devices, low power and communication failures.	FB3000 NOC can be configured to provide alarms for any device failure, under/over range condition, low power or communications failure. Alarm related conditions are also automatically logged to an event log in the FB3000.	Section 6.8 of Directive 17

Electronic Flow Measurement for Oil Systems Hardware and software requirements: Any changes made to the data or any manually entered values that affect the flow calculation must be flagged so it is clear that these are estimated, not actual, readings. This flagging must carry through to values calculated from the data.	FB3000 NOC does not allow flow data records to be edited. Any changes to the system configuration are logged in the event log for tracking purposes.	Section 6.8 of Directive 17
Electronic Flow Measurement for Oil Systems Hardware and software requirements: When any parameter that affects the flow calculation is changed, such as meter factor, fluid densities, or transmitter range, a signoff procedure or an event log must be set up to ensure that the change is made in the EFM system. All data and reports must be retained for a minimum of 12 months.	The FB3000 firmware has a database for events, alarms, and history that stores the last 8000 events, the last 8000 alarms, and six months of hourly records as per API Chapter 21.1 and 21.2. Additional off-RTU storage may be required.	Section 6.8 of Directive 17

The Daily Report The daily report must include: • Meter identification • Daily accumulated flow with indicating flags for estimated flow made by the system or manual inputs and alarms that have occurred for over ranging of end devices • Hours on production or hours of flow (specify) • Flow data audit trail – include at least one of the following: - Instantaneous values for flow rate, operating pressure (if applicable), and temperature taken at the same time each day - Average daily values for volumes, operating pressure (if applicable), and temperature, or hourly accumulated flow rate and average hourly values for operating pressure (if applicable) and temperature	FB3000 NOC daily records are available and are compliant.	Section 6.8 of Directive 17
The monthly report is for the entire system, providing data for each measurement point. It is to contain the following at each measurement point as applicable: • Monthly cumulative flow • Flags indicating any change made to flow volumes • Total hours on production or hours of flow (specify)	FB3000 NOC has all the listed information available through non-resettable totalizers, event logs and well test history.	Section 6.8 of Directive 17

The Meter Report The meter report details the configuration of each meter and the flow calculation information. These values are used as part of the audit trail to confirm that the flow calculation is functioning correctly. The meter report must include the following as applicable and be produced upon request: • Instantaneous flow data - Instantaneous flow rate - Instantaneous operating pressure - Instantaneous flowing temperature - CTL - CPL • Current configuration information: - Meter identification - Date and time - Atmospheric pressure - Pressure base - Temperature base - Calibrated operating pressure range - Calibrated temperature range - Meter factor and/or k-factor - Shrinkage factor	FB3000 NOC allows all instantaneous data for the meter report to be accessed through Modbus or DNP3 registers.	Section 6.8 of Directive 17

NOTES: