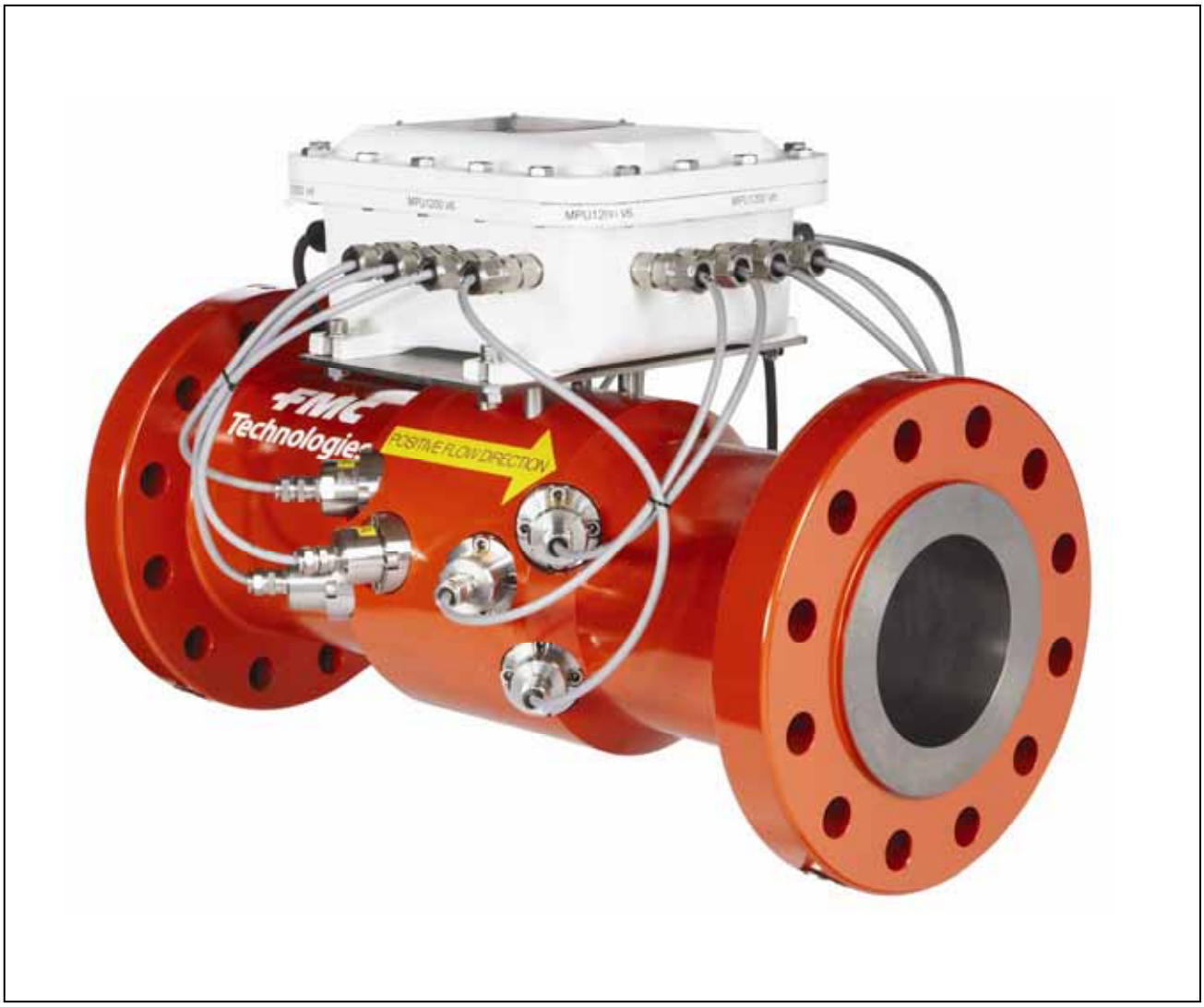

FMC Technologies
POSITIVE FLOW DIRECTION

History

Revision	Date	Editor	ECN	Status	Description
Rev. 00	14.03.2003	xxx	50000018509	released	Take over from KOS SAP System
Rev. 00A	**April 2008**	NB	20207	released	New Logo

Important

All information and technical specifications in this documentation have been carefully checked and compiled by the author. However, we cannot completely exclude the possibility of errors. **Smith Meter GmbH** is always grateful to be informed of any errors.

ATTACHMENT LIST

Attachment	Description
1	Course Description – Operator Training
2	Course Description – Maintenance Training
3	Agenda – Operator Training
4	Agenda – Maintenance Training – 2 Days
5	Agenda – Maintenance Training – 3 Days
6	Table of Contents for Training Manual
7	Front Page for Training Manual
8	Back Page for Training Manual
9	Training Certificate
10	Instructor Guidelines

2. ATTACHMENT 1

COURSE DESCRIPTION – OPERATOR TRAINING

COURSE DESCRIPTION

Course:

MPU – OPERATOR TRAINING

Purpose: Qualify the participants to operate the MPU ultrasonic gas flow meter, evaluate measurement data and understand meter alarms and error messages.

Duration: 1 day

Participants: Maximum 6

Target: Control room and metering station operators

Background: General instrumentation and basic flow metering knowledge

Contents:

General subjects:

- General ultrasonic measurement techniques
- Ultrasonic flow measurement, single-path, multi-path
- Installation effects

MPU specific subjects:

- Basic components and functions
- Calibration
- Testing
- Configuration
- Flow calculation
- Alarm and error detection

ATTACHMENT 2

COURSE DESCRIPTION – MAINTENANCE TRAINING

COURSE DESCRIPTION

Course:

MPU – MAINTENANCE TRAINING

Purpose: Qualify the participants to perform basic troubleshooting on the MPU ultrasonic gas flow meter, replace transducers and main components, maintain the equipment.

Duration: 2-3 days

Participants: Maximum 6

Target: Metering station operators and technicians

Background: General instrumentation and basic flow metering knowledge

Contents:

General subjects:

- General ultrasonic measurement techniques
- Ultrasonic flow measurement, single-path, multi-path
- Installation effects

MPU Ultrasonic Gas Flow Meter:

- Basic components and functions
- Calibration
- Testing
- Configuration
- Flow calculation
- Alarm and error detection
-

MPU - Signals, electronics and troubleshooting:

- Detailed functional description of ultrasonic signal generation and processing
- Testpoints and troubleshooting
- Troubleshooting tools and software
- Hands-on troubleshooting exercises

MPU - Transducer replacement:

- Meter mechanical construction
- Replacement of ultrasonic transducer
- Re-configuring the meter after transducer replacement
- Hands-on transducer replacement exercise

MPU - Parameter settings:

- Up- and downloading of parameters
- Configuration report generation

ATTACHMENT 3

AGENDA – OPERATOR TRAINING – 1 DAY

AGENDA

Session	Subject	Duration
1	**Opening**	15 minutes
2	**Introduction to Ultrasonic Flow Measurement** - introduction to ultrasonic flow measurement principles	45 minutes
3	**MPU Features** - flow meter design, operation and special features	45 minutes
	WinScreen - presentation of the MPU User Interface software	20 minutes
4	**MPU Testing and Configuration** - description of in-house testing and configuration as well as external flow calibration	30 minutes
	Lunch	
5	**MPU Electronics and Signal Processing** - detailed description of electronics and ultrasonic signal processing	30 minutes
6	**MPU Alarms and Error Handling** - description of self-diagnostics features, alarm functions and automatic correction mechanisms	45 minutes
7	**MPU Commissioning and Start-up** - description of on-site meter set-up and requirements	20 minutes
8	**MPU Maintenance** - description of periodic maintenance, troubleshooting and parts replacement	30 minutes
9	**MPU Verification of Measurements** - verification of parameters and flow measurements	30 minutes
10	**Review – Questions – Additional subjects**	20 minutes

ATTACHMENT 4

AGENDA - MAINTENANCE TRAINING – 2 DAYS

AGENDA - DAY 1

Session	Subject	Duration	Location
1	**Opening**	15 minutes	Classroom
2	**Introduction to Ultrasonic Flow Measurement** - introduction to ultrasonic flow measurement principles	45 minutes	Classroom
3	**MPU Features** - flow meter design, operation and special features	45 minutes	Classroom
4	**WinScreen** - presentation of the MPU User Interface software	20 minutes	Classroom
5	**Testing and Configuration** - description of in-house testing and configuration as well as external flow calibration	30 minutes	Classroom
	Lunch		
6	**WinScreen hands-on introduction to the MPU user interface software** - start-up and communication - measurement data, menus and options	45 minutes	Workshop (Hands-on practice)
7	**Transducer Inspection & Replacement** - dismounting and mounting of transducers - configuration after transducer replacement	45 minutes	Workshop (Hands-on practice)
8	**Backup & Printing Configuration Data** - use of PC tools for storing meter configuration data on file - generating meter configuration report	45 minutes	Workshop (Hands-on practice)

AGENDA - DAY 2

Session	Subject	Duration	Location
1	**Electronics and Signal Processing** - detailed description of electronics and ultrasonic signal processing	30 minutes	Classroom
2	**Alarms and Error Handling** - description of self-diagnostics features, alarm functions and automatic correction mechanisms	45 minutes	Classroom
3	**Commissioning and Start-up** - description of on-site meter set-up and requirements	20 minutes	Classroom
4	**Maintenance** - description of periodic maintenance, troubleshooting and parts replacement	30 minutes	Classroom
5	**Verification of Measurements** - verification of parameters and flow measurements	20 minutes	Classroom
	Lunch		
6	**Troubleshooting** - alarm indications - location of fault (electronics/transducers) - using WinScreen Diagnostics tools	1 hour	Workshop (Hands-on practice)
7	**Replacement of Electronics** - removing / installing electronics boards - configuration of new electronics boards	1 hour	Workshop (Hands-on practice)
8	**Verification of Measurements** - verifying Velocity-of-Sound measurement - verifying parameters and calculations	30 minutes	Workshop (Hands-on practice)
9	**Review – Questions – Additional subjects**	20 minutes	Classroom

ATTACHMENT 5

AGENDA - MAINTENANCE TRAINING – 3 DAYS

AGENDA - DAY 1

Session	Subject	Duration	Location
1	**Opening**	15 minutes	Classroom
2	**Introduction to Ultrasonic Flow Measurement** - introduction to ultrasonic flow measurement principles	45 minutes	Classroom
3	**MPU Features** - flow meter design, operation and special features	45 minutes	Classroom
	Lunch		
4	**WinScreen** - presentation of the MPU User Interface software	45 minutes	Classroom
5	**WinScreen hands-on introduction to the MPU user interface software** - start-up and communication - measurement data, menus and options	45 minutes	Workshop (Hands-on practice)
6	**Transducer Inspection & Replacement** - dismounting and mounting of transducers - configuration after transducer replacement	45 minutes	Workshop (Hands-on practice)

AGENDA - DAY 2

Session	Subject	Duration	Location
1	**Testing and Configuration** - description of in-house testing and configuration as well as external flow calibration	30 minutes	Classroom
2	**Electronics and Signal Processing** - detailed description of electronics and ultrasonic signal processing	30 minutes	Classroom
3	**Alarms and Error Handling** - description of self-diagnostics features, alarm functions and automatic correction mechanisms	45 minutes	Classroom
4	**Maintenance** - description of periodic maintenance, troubleshooting and parts replacement ***Lunch***	30 minutes	Classroom
5	**Troubleshooting** - alarm indications - location of fault (electronics/transducers) - using WinScreen Diagnostics tools	1 hour	Workshop (Hands-on practice)
6	**Replacement of Electronics** - removing / installing electronics boards - configuration of new electronics boards	1 hour	Workshop (Hands-on practice)
7	**Backup & Printing Configuration Data** - use of PC tools for storing meter configuration data on file - generating meter configuration report	45 minutes	Workshop (Hands-on practice)

AGENDA - DAY 3

Session	Subject	Duration	Location
1	**Commissioning and Start-up** - description of on-site meter set-up and requirements	15 minutes	Classroom
2	**Verification of Measurements** - verification of parameters and flow measurements	45 minutes	Classroom
3	**Verification of Measurements** - verifying Velocity-of-Sound measurement - verifying parameters and calculations	1 hour	Workshop (Hands-on practice)
	Lunch		
4	**Review – Questions – Additional subjects**	45 minutes	Classroom

ATTACHMENT 6

TABLE OF CONTENTS FOR TRAINING MANUAL

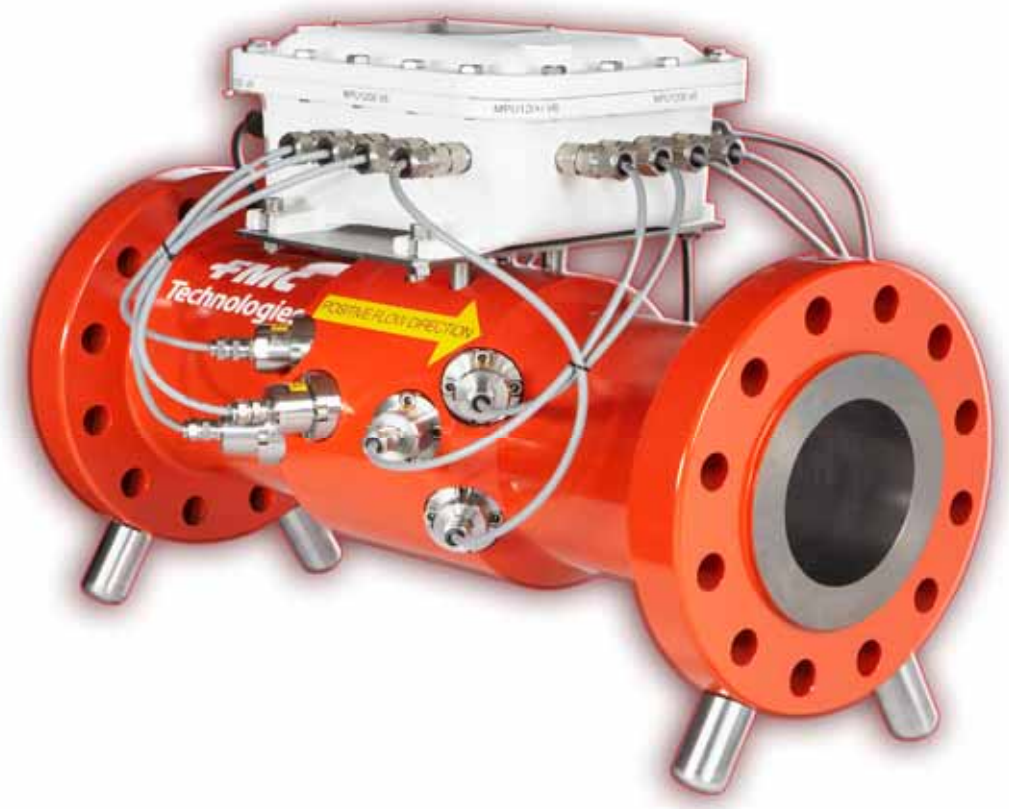
CONTENTS

ATTACHMENT 7

FRONT PAGE FOR TRAINING MANUAL

MPU

Ultrasonic Gas Flow Meter



MPU Series B

Multipath Ultrasonic Gas Flow Meter

ATTACHMENT 8

BACK PAGE FOR TRAINING MANUAL

ATTACHMENT 9

TRAINING CERTIFICATE

FMC Technologies

TRAINING CERTIFICATE

PARTICIPANT

HAS COMPLETED THE FOLLOWING TRAINING COURSE

MPU

ULTRASONIC GAS FLOW METER

Series B

PLACE AND DATE

INSTRUCTOR

ATTACHMENT 10

INSTRUCTOR GUIDELINES

INSTRUCTOR GUIDELINES FOR MPU TRAINING

COURSE PREPARATIONS

General

A PC projector must be available for classroom lections for displaying MS-Powerpoint slides. The slides are listed with file names and must be copied from the network server.

Operator Training

For 1-day operator training, demos can be run with WinScreen simulations or by running static transit times on MPU electronics rack.

Maintenance Training

For maintenance training and FMC internal training, it is required to have a complete flow meter with Ethernet connection available for demos, troubleshooting and hands-on practice.

Have handtools available for troubleshooting and for transducer and electronics replacement:

Multi-meter (Fluke)
8 mm hexagonal key for end covers
10 mm pipe socket for electronics removal
adjustable spanner for glands
screwdrivers (flat, Phillips)

FMC Internal Training

Same as for maintenance training, plus equipment for dimensional measurements, zero-flow testing and communications testing:

micrometer
blind flanges, pressure and temperature sensors
pressurized Nitrogen
RS-485 converter

DETAILED TRAINING MANUAL CONTENTS – CUSTOMER TRAINING

Chapter	Topic	Format	Print Format	File
1	Agenda	Document	1-sided	Attachment in this document.
2	Training Course Description	Document	1-sided	Attachment in this document.
3	General Information	Brochure(s)	2-sided	Technical Description.pdf (FMC Bulletin SSKS001) Sales_flier.pdf (FMC Bulletin SFKS001)
4	Introduction to Ultrasonic Flow Measurement	Slides	Handout (2 slides)	(1) MPU Introduction.ppt
5	MPU Features	Slides	Handout (2 slides)	(2) MPU Features.ppt
6	WinScreen	Slides	Handout (2 slides)	(3) MPU WinScreen.ppt
7	Testing and Configuration	Slides	Handout (2 slides)	(4) MPU Testing and Configuration.ppt
8	Electronics & Signal Processing		Handout (Notes)	(5) MPU Electronics and Signal Processing.ppt
9	Alarms & Error Handling	Slides	Handout (Notes)	(6) MPU Alarms and Error Handling.ppt
10	Commissioning & Start-up	Slides	Handout (2 slides)	(7) MPU Commissioning and Start-up.ppt
11	Maintenance	Slides	Handout (2 slides)	(8) MPU Maintenance.ppt
12	Verification	Slides	Handout (2 slides)	(9) MPU Verification.ppt
13	MPU User Manual	Document	2-sided	USM-0000020565
14	MPU Transducer Replacement Procedure	Document	2-sided	PRD-0000022520
15	MPU Verifications of Measurements and Calibrations	Document	2-sided	PRD-0000022559
16				
17				
18				
19				
20				

COURSE EXECUTION

Item	Subject	Presentation / Hands-on	Location	Items to be covered	Slides and Documents	Duration
1	Opening	Presentation	Classroom	• Welcome • Instructor presentation • Training goals/course description • Agenda	• Course Description (Document) • Agenda (Document)	15 minutes

2	General Ultrasonic Technology	Presentation	Classroom	• Measurement principles
				  • Reflection, doppler, transit time, velocity formula v=k*(t2-t1), Q=v*A
				• Applications
				  • Flow
				  • single path (flare, checkmeter, hot-tap)
				  • multipath (custody transfer, fuel / power plants)
				• Advantages and Disadvantages of ultrasonic flow meters
				  • + advantages
				  • High Turndown
				  • Short upstream length
				  • -> Reduced weight and cost
				  • Bi-directional (for underground gas storage)
				  • Non-intrusive (no pressure drop)
				  • - disadvantages
				  • Hi-tech (need for training and knowledge for service and repair)
				• Installation effects
				  • Upstream pipe (swirl, crossflow, profiles, step, surface roughness)
				  • Flow conditioners
				  • Pulsation (pressure, velocity)
				  • Effects of temperature and pressure
				  • Noise
				• Output signals (pulse, serial, Ethernet, analog)
					1. (1) MPU Introduction.ppt	45 minutes

Item	Subject	Presentation / Hands-on	Location	Items to be covered	Slides and Documents	Duration

3	MPU Overview	Presentation	Classroom	• Technical specifications
				• Mechanical construction
				  • 6 paths, direct signals
				• Formulas
				  • Velocity, VOS, Path weighting, Flowrate
				• Swirl / crossflow compensation
				• Transducers
				  • Specs (Frequency, press/temp spec., construction)
				  • Parameters (Transd. Delay, delta-T)
				• Travel time measurement
				  • Subtraction of transducer delays
				• Pressure and temperature compensation
				  • Inner diameter, transducer delay, frequency
				• Flow calibration factors and correction
				• Output data and User interface
				  • Network terminal for data entry and alarm log
				  • Ouput options (pulse, RS-xxx, LAN, analog)
				• Diagnostics and alarms
				  • Covered in detail in later session
				• Retractable transducers
				  • Vented line (ease of replacement)
				  • pressurized line (Replacement tool)
					• (2) MPU Features.ppt	45 minutes

4	WinScreen	Presentation	Classroom	• Presentation of WinScreen
				  • Slide show
				  • Run WinScreen in simulation mode or hook up to MPU electronics rack
					• (3) MPU WinScreen.ppt
					• USM-0000020565
						20 minutes

Item	Subject	Presentation / Hands-on	Location	Items to be covered	Slides and Documents	Duration

5	MPU Testing and Configuration	Presentation	Classroom	• Transducers testing
				  • Pairing, hardening, calibration
				• Dimensional measurements
				• Software loading
				• Parameter configuration
				  • Transducer delays
				  • Path lengths
				  • Path angles
				  • Inner diameter (bore)
				  • Wall thickness
				  • Expansion coefficients
				  • Flow calibration factors
				• Static meter test
				  • Dry calibration check
				  • Functionality test (pulse, serial, network, analog communication)
				• Flow calibration
				  • Installation (upstream pipe and flow conditioner)
				  • Process conditions (similar to site)
				  • Determining A and B values
				• *Show Telnet pictures on PC if available*
				• Configuration for transducer replacement
				  • Transducer delays
				  • Path lengths
					• (4) MPU Testing and Configuration.ppt
					• Example of parameter report
					• Live WinScreen pictures on PC
						30 minutes

6	WinScreen	Hands-on	Workshop	• Connection to meter • Simulation • Access pictures and menus	• USM-0000020565	45 minutes
7	Transducer Inspection and Replacement	Hands-on	Workshop	• Dismount transducer • Mount transducer	• PRD-0000022520	45 minutes

Item	Subject	Presentation / Hands-on	Location	Items to be covered	Slides and Documents	Duration
8	Backup and Printing Configuration Data	Hands-on	Workshop	• Backup using WinScreen • Report gerenation using WinScreen	• USM-0000020565	45 minutes

9	MPU Electronics and Signal Processing	Presentation	Classroom	• Electronics
				  • Purpose of electronics boards (CPU, SPC, MUX, VADM, pulse and serial modules)
				• Signal processing
				  • Burst routing
				  • Signal recognition and correlation
					• (5) MPU Electronics and Signal Processing.ppt	30 minutes

10	MPU Alarms and Error Handling	Presentation	Classroom	• Self diagnostics features
				  • Active alarm log
				  • Display live Telnet picture on PC if available
				  • Alarm Status Word
				  • Bit coded, 0=OK
				  • Valid Measurement Relay
				• Transducer failure alarm
				  • Triggered if
				  • Burst % outside alarm limits
				  • Gain outside alarm limits
				Automatic corrections
				Triggered if
				Flow velocity deviation
				VOS deviation
				Velocity profile outside limits
				Additional alarms:
				Electronics failure
				Calculation error
				Flow corrections
				Accuracy with failed transducer pair(s)
				Diagnostics tools based on Ethernet communication:
				WinScreen: Trendlog, Analyzer/Diagnostics
					• (6) MPU Alarms and Error Handling.ppt (Slides)	45 minutes

Item	Subject	Presentation / Hands-on	Location	Items to be covered	Slides and Documents	Duration

11	MPU Commissioning and Start-up	Presentation	Classroom	• Communications testing
				• Signal checking – signal recognition
				• Set alarm limits for self-diagnostics
				  • Gain
				  • Burst %
				  (VOS deviation to be set at factory)
				  (Profiles are automatic)
					(7) MPU Commissioning and Start-up.ppt (Slides)	20 minutes

12	MPU Maintenance	Presentation	Classroom	• Periodic Maintenance
				  • Mechanical inspections
				  • O-ring replacements
				  • Flow calibration?
				  • Transducer re-calibration?
				• Troubleshooting
				  • Alarm status word
				  • Active alarm log (Ethernet)
				  • WinScreen (Ethernet)
				  • Swap transducer cables
				Parts replacement
				  O-rings
				  Transducers
				  Always in pair
				  De-pressurized (4 screws)
				  Pressurized (Retraction tool)
				  Electronics
				Flame paths (Transducer, End Cover, Enclosure) - ATEX
				Spare Part List
					(8) MPU Maintenance.ppt (Slides)
					USM-0000020565 (Document)
						30 minutes

Item	Subject	Presentation / Hands-on	Location	Items to be covered	Slides and Documents	Duration

13	Verification of Measurements	Presentation	Classroom	• VOS calculation with PC software
				• VOS calculation with WinScreen (AGA-10)
				• Simulation Mode
				  • Entering manual transit time values
				  • Calibration Check Certificate
					(9) MPU Verification.ppt
					PRD-0000022559
						20 minutes

14	Trouble-shooting	Hands-on	Workshop	• Simulate alarms on MPU
				  • Check alarm list
				  • Cross-connection of transducer cables to locate transducer or electronics failue
				  • WinScreen Diagnostics
					USM-0000020565	1 hour

15	Replacement of Electronics	Hands-on	Workshop	• Electronics board swapping
				• Configuration of electronics
				  • UAFE (no configuration)
				  • UDSP (Address, SW, Parameters)
					USM-0000020565	1 hour

16	Verification of Measurements	Hands-on	Workshop	• VOS calculation on PC software • VOS calculation with WinScreen (AGA-10) • Enter simulation data based on Calibration Check Certificate	PRD-0000022559	30 minutes

The specifications contained herein are subject to change without notice and any user of said specifications should verify from the manufacturer that the specifications are currently in effect. Otherwise, the manufacturer assumes no responsibility for the use of specifications which may have been changed and are no longer in effect.

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