



*Technology Training that Works*

---

# Introduction to the Selection, Installation, Commissioning and Maintenance of Fiscal Flow and Metering Equipment

---

## Contents

<b>1</b>	<b>Introduction to Fiscal Metering</b>	<b>1</b>
1.1	Introduction	1
1.2	Custody transfer metering	4
1.3	Flow metering and custody transfer measurement	9
1.4	Fundamentals of gas and liquid measurement	13
<b>2</b>	<b>Field Instruments</b>	<b>23</b>
2.1	Introduction	23
2.2	Field instrument technologies	23
2.3	Fiscal quality measurement	28
2.4	Fiscal-allocation measurement	30
2.5	Fiscal well test measurement	31
2.6	Multiphase measurement	32
2.7	Appropriate meter selection	39
2.8	Factors affecting performance	41
2.9	Operation of meters	43
2.10	Re-verification of meters	43
2.11	Calibration	44
2.12	Calibration methods	47
2.13	Measurement standards	53
2.14	Primary, secondary, tertiary measurement equipment	55
2.15	Sampling	61
2.16	Gas sampling	67
<b>3</b>	<b>Operating Procedures</b>	<b>75</b>
3.1	Introduction	75
3.2	Operating principles	75
3.3	Flow conditions	76
3.4	Flow conditioners	77
3.5	Flowmeter combinations	84
3.6	Start-up	85
3.7	Fault conditions and mis-measurements	86
3.8	Flow computers	88
3.9	Control charts	93
3.10	Conclusion	101



*Technology Training that Works*

<b>4</b>	<b>Basic Properties of Fluids</b>	<b>103</b>
4.1	Introduction	103
4.2	Basic fluid properties	104
4.3	Non-Newtonian fluids	105
4.4	Velocity profiles	108
4.5	Reynolds number	113
4.6	Flow measurement	114
4.7	Mass flow rate	116
4.8	Multi-phase flows	116
<b>5</b>	<b>Flowmeters</b>	<b>119</b>
5.1	Introduction	119
5.2	Positive displacement meters	120
5.3	Inferential meters	125
5.4	Oscillatory flowmeters	130
5.5	Differential pressure meters	143
5.6	Variable area meters	159
5.7	Electromagnetic flowmeters	164
5.8	Ultrasonic flowmeters	179
5.9	Mass flow measurement	188
5.10	Open channel flow measurement	201
<b>6</b>	<b>Installation and Maintenance</b>	<b>215</b>
6.1	Introduction	215
6.2	Installation considerations (MPFM)	216
6.3	Installation and site integration	216
6.4	Commissioning	218
6.5	Troubleshooting	220
6.6	Troubleshooting of turbine meters	224
6.7	Troubleshooting of oscillatory flowmeters	224
6.8	Troubleshooting of positive displacement meters	226
6.9	Troubleshooting of differential pressure meters	227
6.10	Troubleshooting of electromagnetic flowmeters	227
6.11	Troubleshooting of mass flow measurements	228
6.12	Troubleshooting of open channel flow measurement	230
6.13	Troubleshooting of variable area meters	230
6.14	Installation and operational errors	231
6.15	Oil and gas personnel measurement training	235
<b>7</b>	<b>Documentation</b>	<b>243</b>
7.1	Introduction	243
7.2	Documentation control	244
7.3	Documentation control in general	246
7.4	Documentation procedure	248
	<b>Appendix A - Practical Exercises</b>	<b>251</b>
	<b>Appendix B - Practical Exercises - Answers</b>	<b>257</b>