



GAS MEASUREMENT MANUAL

(REVISED)

GENERAL

PART NO. ONE

A. G. A. GAS MEASUREMENT MANUAL (REVISED)

PART ONE GENERAL

SECTION 1.1—HISTORY OF GAS MEASUREMENT
SECTION 1.2—FUNDAMENTAL GAS LAWS
SECTION 1.3—METERING OF GAS AND PRINCIPLES OF MEASUREMENT
SECTION 1.4—GLOSSARY

**Prepared by the Distribution Measurement
and Transmission Measurement Committees
of the Operating Section**

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Arlington, Virginia 22209

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Other Manual Parts Published:

Part 2, Displacement Measurement (Catalog No. XZ0277)

Part 6, Auxiliary Devices (XQ0779)

Part 7, Measurement Calculations and Data Gathering (XQ0379)

Part 12, Meter Proving (XQ0278)

Part 13, Distribution Metering Data (XQ0278)

Printed in U.S.A.

2M5.82-9.00-526

PREFACE

The original A.G.A. Gas Measurement Manual was conceived in 1956 by the A.G.A. Gas Measurement Committee. After seven years of work, it was published in 1965.

The publication proved to be very popular; however, it was soon realized that the original manual should be revised. Work on the revision has been going on for several years.

In 1974, the A.G.A. Managing Committee made a change in the standing committees of the A.G.A. Operating Section. The A.G.A. Gas Measurement Committee was designated as the Transmission Measurement Committee and the Distribution Metering Committee was designated as the Distribution Measurement Committee. The Managing Committee also decided at this time that the revision to the A.G.A. Gas Measurement Manual would be a joint project of the two committees.

The revised A.G.A. Gas Measurement Manual has been broadened in scope and many additional subjects have been included. Subjects covered in the previous manual have been updated and expanded.

Due to the increasing costs of publications and the rapid increase in the rate-of-change in technology, it was decided that the revised A.G.A. Gas Measurement Manual would be published in a different format. The revised manual is being published as separate parts. Each part will be bound in a soft cover and be three-hole punched for insertion in a loose-leaf binder. Each part contains one or more sections. The various sections that make up the 14 parts of the manual are arranged to have related subject matter included within the same part. This approach recognizes that some parts of the manual will need more frequent revision than others. Additional parts or subsequent revisions can be handled more readily than the original hard copy publication.

This revised A.G.A. Gas Measurement Manual represents many hours of work by both present and past members of the Transmission Measurement Committee and the Distribution Measurement Committee. Their contributions, as well as the contributions of the various manufacturers of measurement equipment who supply information and photographs, should make the A.G.A. Gas Measurement Manual a valuable information source for the Gas Industry personnel concerned with gas measurement.



TABLE OF CONTENTS

SECTION 1.1—HISTORY OF GAS MEASUREMENT

	Page
Introduction	1.1.1
Early History	1.1.1
Displacement Meters	1.1.1
Velocity Type Meters	1.1.5
Turbine Meters	1.1.10
Consumerism	1.1.10
International Aspects	1.1.10
References	1.1.12

SECTION 1.2—FUNDAMENTAL GAS LAWS

	Page
Introduction	1.2.1
Terms and Definitions	1.2.1
Abbreviations and Symbols	1.2.1
Pressure and Head	1.2.1
Temperature	1.2.6
Volume	1.2.6
Specific Weight, Density, and Specific Gravity	1.2.7
Gas Laws and Equations for Gases	1.2.7
Boyle's Law	1.2.7
Charles' Law	1.2.7
Boyle's and Charles' Laws	1.2.9
Avogadro's Law	1.2.9
Kinetic Theory	1.2.9
The Molar Volume	1.2.10
Equation for an Ideal Gas	1.2.10
Departures from Ideal Gas Law	1.2.11
Gas Mixtures	1.2.16
Theorem of Corresponding States	1.2.24
Appendix A: Mass, Force, Weight, and Acceleration	1.2.28
Mass	1.2.28
Force	1.2.28
Weight	1.2.28
Acceleration	1.2.28
Newton's Second Law of Motion	1.2.29
Dimensions of Units	1.2.31
Appendix B: Relation Between Pressure and Head	1.2.32
Specific Weights of Manometer Fluids	1.2.32
Appendix C: Manometry	1.2.35
Types of Manometers	1.2.35
Manometer Uses	1.2.37
Manometer Errors	1.2.37
Corrections to Manometer Readings	1.2.37
Appendix D: Typical Applications	1.2.42
Example 1.2.1: Pressure	1.2.42
Example 1.2.2: Pressure	1.2.42
Example 1.2.3: Pressure	1.2.43

Example 1.2.4: Pressure.....	1.2.43
Example 1.2.5: Temperature.....	1.2.44
Example 1.2.6: Temperature.....	1.2.44
Example 1.2.7: Boyle's Law.....	1.2.44
Example 1.2.8: Charles' Law.....	1.2.45
Example 1.2.9: Charles' Law.....	1.2.45
Example 1.2.10: Combined Boyle's and Charles' Laws.....	1.2.45
Example 1.2.11: Ideal Gas Law.....	1.2.46
Example 1.2.12: Ideal Gas Law.....	1.2.47
Example 1.2.13: Specific Gravity of Atmospheric Air.....	1.2.47
Example 1.2.14: Specific Weight of Atmospheric Air.....	1.2.48
Example 1.2.15: Specific Gravity and Heating Value of a Gas Mixture.....	1.2.49
Example 1.2.16: Gas-Water Vapor Mixture.....	1.2.51
Example 1.2.17: Gas-Water Vapor Mixture.....	1.2.51
Example 1.2.18: Manometry.....	1.2.52
Example 1.2.19: Manometry.....	1.2.53
Example 1.2.20: Manometry.....	1.2.55
Example 1.2.21: Manometry.....	1.2.56
Example 1.2.22: Manometry.....	1.2.57
Example 1.2.23: Manometry.....	1.2.59
Example 1.2.24: Manometry.....	1.2.61
Example 1.2.25: Manometry.....	1.2.63
Appendix E: Abbreviations and Symbols.....	1.2.67
Appendix F: Summary of Equations.....	1.2.70
Bibliography.....	1.2.75

SECTION 1.3—METERING OF GAS AND PRINCIPLES OF MEASUREMENT

	Page
Metering of Gas	
Definition.....	1.3.1
Metering Applications.....	1.3.1
Sources of Technical Practices.....	1.3.1
Units of Gas Measurement.....	1.3.2
Temperature and Pressure Bases.....	1.3.2
Practical Methods.....	1.3.2
Gas Contract Measurement Clauses.....	1.3.5
Principles of Measurement	
Volumetric Measurement Principles.....	1.3.6
Displacement Metering.....	1.3.7
Velocity Meters.....	1.3.13
Inferential Meters.....	1.3.14
Other Metering Principles.....	1.3.15
Other Units of Measurement	
Measurement Trends.....	1.3.16
Bibliography.....	1.3.18

SECTION 1.4—GLOSSARY

	Page
	1.4

LIST OF FIGURES

Figure	Page
1.1.1 Large Water-Sealed Rotating-Drum Station Meters	1.1.2
1.1.2 Several Early Designs of Gas Meters	1.1.3
1.1.3 A Cut-Away View of a Steel Cased 12×36 Rotary Meter	1.1.4
1.1.4 The Oliphant Pitot Tube	1.1.5
1.1.5 A Bomb-Case Differential Pressure Recorder	1.1.7
1.1.6 An Early Design of a Differential Pressure Recorder	1.1.8
1.1.7 A Relatively Large Volume Turbine Meter	1.1.11
1.2.1 Diagram showing relationship between absolute and gage pressure	1.2.2
1.2.2 Temperature scales	1.2.5
1.2.3 Pressure-volume relationship according to Boyle's law, temperature constant	1.2.8
1.2.4 Temperature-volume relationship according to Charles' law, pressure constant	1.2.8
1.2.5 Temperature-pressure relationship according to Charles' law, volume constant	1.2.9
1.2.6 Supercompressibility ratios "s" for methane	1.2.14
1.2.7 Supercompressibility factor "F _{pv} " relation to pressure for a 0.60 specific gravity hydrocarbon gas at several temperatures	1.2.15
1.2.8 Water vapor content of gas versus dew-point temperature	1.2.19
1.2.9 End or side view of the p-T-v surface describing liquid, gas, and liquid-gas equilibrium scales	1.2.25
1.2.10 Factors for converting in H ₂ O and in Hg to psi at International mean acceleration of gravity	1.2.33
1.2.11 U-Tube Manometer: Zero or equal pressure on both legs	1.2.35
1.2.12 U-Tube Manometer: Pressure applied to left leg	1.2.35
1.2.13 Well-Type Manometer: Zero pressure	1.2.36
1.2.14 Well-Type Manometer: Pressure applied	1.2.36
1.2.15 Inclined Manometer	1.2.36
1.3.1 Showing how, in a closed container (fixed mass and volume), gage pressure varies to offset changes in atmospheric pressure	1.3.3
1.3.2 Two double-acting cylinders and reciprocating piston representation of a two-diaphragm displacement meter	1.3.8
1.3.3 Modern Displacement Gas Meter	1.3.10
1.3.4 Cutaway View of a Rotary Positive Displacement Meter showing important features	1.3.12
1.3.5 Cross Section of a Gas Turbine Meter	1.3.13
1.3.6 Flow pattern through an orifice and the static pressure gradient	1.3.14

TABLES

Table	Page
1.2.1 Measurement Equivalents—English to Metric Units	1.2.3
1.2.2 Pressure Equivalents	1.2.4
1.2.3 Physical Constants for Various Gases	1.2.12
1.2.4 Physical Constants for Gas Compounds	1.2.13
1.2.5 Saturation Vapor Pressure of Water—psia	1.2.18
1.2.6 Mass-Force-Acceleration Units and Relationships	1.2.30
1.2.7 Dimensional Formulas	1.2.31
1.3.1 Base Pressure Conversion Factors for Volumetric Gas Measurement	1.3.4
1.3.2 Energy Conversion	1.3.17
1.3.3 Energy per Unit-Volume Conversion	1.3.17
1.3.4 Power Conversion	1.3.18

SECTION 1.1 HISTORY OF GAS MEASUREMENT

INTRODUCTION

One of the greatest challenges to man has been, and continues to be, the concept of measurement. Many of the measurement principles, which we are presently using and still trying to refine, were introduced thousands of years ago. The Egyptians used weirs in 2200 B.C. to measure the flow of water. Archeologists have found both the Egyptians and Romans were familiar with orifice regulation; during Caesar's time, orifices were used to regulate the flow of water to households. However, in all probability, the first quantity to be measured was the phenomenon of time. It was in the measurement of time that we witness the first use of a crude displacement-restriction type of meter—the hourglass—which was used approximately 600 to 700 B.C. Somewhat later, liquids were sold by various standard vessel measures. In the third century B.C., Archimedes discovered that any shaped object would displace its own volume of water when submerged, a principle we still use with our gas meter provers.

This section briefly outlines the main historical developments in the volumetric measurement of fuel gases for production, transmission, distribution, and utilization, primarily in the United States.

EARLY HISTORY

Little is known about the very early history of the volumetric measurement of gases of any kind up to the beginning of the Industrial Revolution and the first use of coal gas about 200 years ago. Early Greeks may have had some very limited concepts of the nature of gases and their volumetric measurement. Later alchemists probably made crude estimates or measurements of gas volumes in their experiments. Renaissance scholars studied and observed physical principles and phenomena of gases and probably made a number of simple volumetric measurements as the basic "gas laws" were formulated and later verified in this period. Early practical experimenters with coal gas between 1700 and 1800 in England and France probably made some volumetric measurements with very simple water-sealed gasometers similar in principle to present-day bell provers. Cruder, but similar, smaller devices may have been used by earlier scholars and alchemists. These devices used the simple displacement principle.

The first really practical or commercial known development of volumetric gas measurement began in London in 1808 and in Baltimore in 1817 when coal gas production and distribution first began for street and building illumination. Simple gasometers were used for measuring and storing production gas, but no measurements were made of the gas used by each consumer. Initially, the common method was to charge for the privilege of using the gas in unlimited quantities for a fixed weekly or monthly charge. Then, for a number of years this was estimated or calculated in proportion to the number and size of each consumer's "lights."

Such estimates of gas use for billing charges were soon found to be neither equitable nor satisfactory to supplier or consumer. The need for volumetric measurement of each consumer's use in appropriate periods prompted the invention and use of suitable displacement-type meters with an index. Since then the invention and use of other types and sizes of meters has evolved to meet different and changing needs for volumetric measurement of fuel gases. Concepts, methods, and performance have generally kept pace with measurement equipment and needs.

DISPLACEMENT METERS

The first practical gas displacement meter was invented in England by Samuel Clegg in 1815. It was essentially the present wet-type meter with an enclosed water-sealed revolving drum connected to a registering index. The design was further improved by John Malam in 1817 and Samuel Crosley in 1820. After several further improvements by these and other Englishmen, Charles Hinman, of Boston, in 1896 built a much improved drum with increased capacity and reduced water resistance to rotation. Subsequent improvements have been mainly in fabrication, in use of non-corrosive metals, and in light mineral oil instead of water for sealing. Fig. 1.1.1 shows two large station wet meters similar to meters used at one time by almost every gas-manufacturing plant to measure the volume of gas made and sent out. The use of wet meters is limited today to volumetric gas measurement at relatively low flow rates and low pressures in laboratories and in water-flow calorimeters.

The first use of gas meters in the United States to charge customers occurred in New York City in 1825. A franchise had been granted to the New York Gas-Light Company and a line was installed on Broadway to distribute gas to several dwellings and stores. Later, gas street lights were added and thus the origin of the expression "The Great White Way." The meters utilized were the wet drum meter manufactured in England and customers were charged one dollar per hundred cubic feet, plus a rental charge for the meter.

A gas company in Baltimore soon followed in the use of gas meters. Samuel Hill, of Baltimore, built the first wet drum meter manufactured in the United States in 1832. Also in 1832 in Baltimore, John Rogers made a similar meter under the supervision of John Slaney, Sr., a former employee of Clegg & Crosley, London's leading meter maker. These men are generally considered the "Fathers of the United States Meter Industry." The Gas-Light Company of Baltimore had originally charged its customers based on the size of the gas burners, the height of the flame, and the assumption that the burners would be shut off at 10:00 p.m. Needless to say, this method was not too practical and the directors of the company soon decided the only way to make money was to adopt the use of meters. In 1833, meters manufactured in England were installed and then a contract was given to Rogers and Slaney for meters manufactured in this country.

The general inconvenience, relatively high cost and necessary operating precautions in using wet drum meters for gas measurement to consumers resulted in the invention of the dry meter. In 1833 an American, James Bogardus, used a rectangular tin case to house diaphragms and sliding valves rather than the water and drum arrangement of the wet meter. He probably would have been credited with the invention of the dry meter, except that his device was unreliable—the valves had too much friction. Another American, William Richards, working in England with Mr. Croll, in 1844 invented a dry displacement meter having two moving diaphragms, two slide valves and a dial index. The meter was accurate, regular in action and remarkably simple in construction. It was further improved several years later by Thomas Glover of London. Although Glover did not invent this type meter, this meter became known as the Glover two-diaphragm, slide valve, type meter. Samuel Down of New York displayed a further improved dry meter in 1853 at the New York World's Fair.

The remainder of the nineteenth century saw numerous attempts to invent a better dry meter. This resulted in countless new designs and patented features primarily attempting to improve the diaphragm valves and connecting linkage. While this resulted in meters of every shape and size, the end result was to further establish the soundness of the Glover-type dry meter in its simplest form. Fig. 1.1.2 shows some examples of early-design gas meters.

Fig. 1.1.1—Large Water-Sealed Rotating-Drum Station Meters

