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Measurement of Gas by Turbine Meters

Transmission Measurement Committee Report No. 7



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FOREWORD

Report No. 7, Measurement of Gas by Turbine Meters was developed by a Transmission Measurement Committee task group, chaired by Daniel G. Harris, Columbia Gas Transmission Corp. Suggested revisions are invited and should be submitted to the Director, Engineering Services, American Gas Association, 1515 Wilson Boulevard, Arlington, VA 22209.

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SUBJECT-RECOMMENDATIONS COVERING THE USE OF AXIAL-FLOW TURBINE METERS IN THE MEASUREMENT OF GAS

This report of the Measurement Committees of the American Gas Association is submitted as an approach to the Measurement of Gas through Turbine Meters. It is published as a recommended practice and is not issued as a standard.

SECTION 0. INTRODUCTION

- 0.1** - In February 1976 the A.G.A. Transmission Measurement Committee established a Turbine Meter Task Group with the duties as outlined:
 - 0.1.1** - To recommend the correct methods of installing turbine meters for measuring gas.
 - 0.1.2** - To recommend the necessary corrective factors and operative requirements in the use of turbine meters.
 - 0.1.3** - To secure, if possible, the assignment of members from the International Organization for Standardization Technical Committee ISO/TC30 "Measurement of Fluid Flow in Closed Conduits," and the ASME Standards Committee on "Measurement of Fluid Flow in Closed Conduits" to the Turbine Meter Task Group to assist in this work and to coordinate any foregoing Committee-sponsored standards on turbine meters to prevent major differences in published material.
- 0.2** - This Turbine Meter Task Group held its first meeting in May 1976 and discussed the various aspects of the work assigned to it. In subsequent meetings, drafts of the document were completed, and the final draft was approved by the A.G.A. Transmission and Distribution Measurement Committees in February 1980. The American Gas Association published the first printing of Report No. 7 in late 1980. The first revision was printed in late 1984.
- 0.3** - The material presented in this report was developed based on numerous tests conducted by the engineering and research staffs of the various manufacturers, gas distribution, transmission, and production companies. Accepted knowledge and the latest techniques were employed to determine the performance and installation requirements for turbine meters.

SECTION 1. SCOPE

- 1.1** - This report and its recommendations relate and are limited to the axial-flow gas turbine meter in which the entire gas stream flows through the turbine meter body and impinges on the turbine meter rotor.
- 1.2** - This report covers the measurement of gas by turbine meters as related to the installation, operation, calibration practices and calculation methods for determining volumetric and mass flow. This report does not cover the equipment used in the determination of the pressures, temperatures, densities and other variables that must be known for the accurate determination of measured gas quantities. Reference to other publications is made in the discussion of this equipment.

SECTION 2. CONSTRUCTION

2.1 - General

- 2.1.1** - The turbine meter consists of three basic components:

- 2.1.1.1** - The body

- 2.1.1.2** - The measuring mechanism

2.1.1.3 - The output device

- 2.1.2 - Schematics of axial-flow gas turbine meters are shown in Figures I and I-A. Gas entering the meter increases in velocity through the annular passage formed by the nose cone and the interior wall of the body. The movement of gas over the angled rotor blades imparts a force to the rotor, causing it to revolve. The ideal rotational speed is directly proportional to the flow rate. The actual rotational speed is a function of the passageway size and shape, and the rotor design. It is also dependent upon the load that is imposed due to internal mechanical friction, fluid drag, external loading, and the gas density.

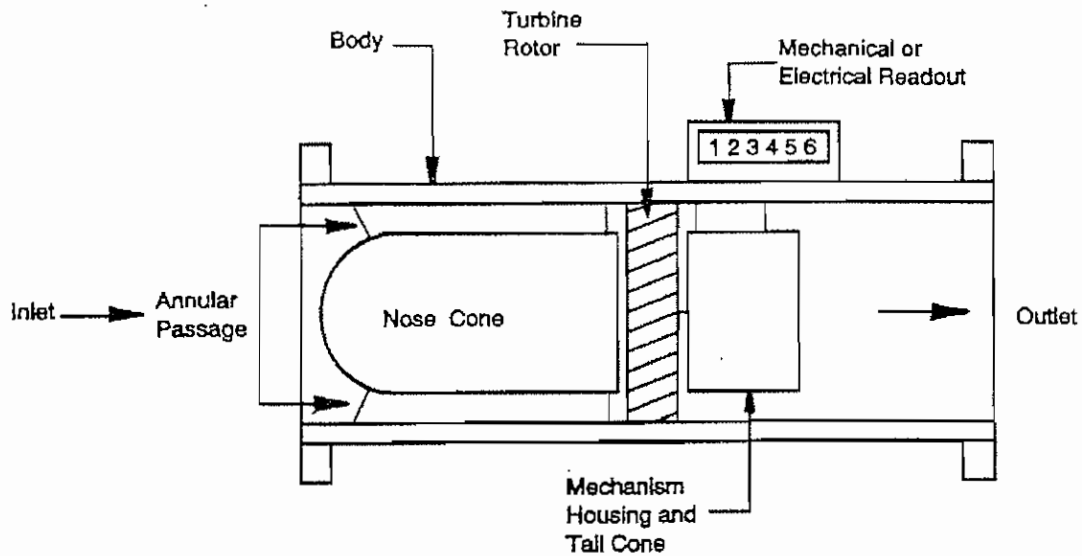


FIGURE 1

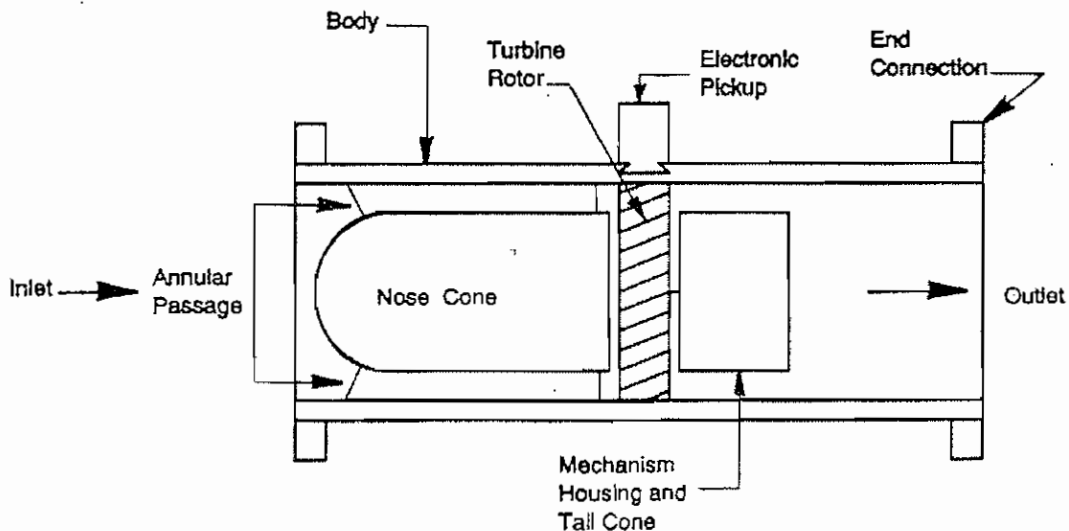


FIGURE 1A

2

2.2 - Body

- 2.2.1 - The body and all other parts comprising the pressure containing structures should be designed and constructed of material suitable for the service conditions for which the meter is rated.
- 2.2.2 - The body end connections should be designed in accordance with the appropriate flange and threaded connection standards.
- 2.2.3 - The body should be identified to show the following:
 - 2.2.3.1 - Manufacturer's name.
 - 2.2.3.2 - Maximum capacity in actual volume units-actual cubic feet per hour.
 - 2.2.3.3 - Maximum allowable operating pressure, psig.
 - 2.2.3.4 - Serial number.
 - 2.2.3.5 - Inlet, stamped on the appropriate end connection, or an arrow indicating the direction of flow.

2.3 – Measuring Mechanism

- 2.3.1 - The measuring mechanism consists of the turbine rotor, rotor shafting, bearings, flow passage area and the necessary support housing structure.
- 2.3.2 - There are two general mechanism configurations categorized by the way they are installed in the meter body:
 - 2.3.2.1 - The top or side entry type-the measuring mechanism is removable, as a unit, through a top or side flange without disturbing the end connections.
 - 2.3.2.2 - The end entry type-the measuring mechanism is removable, either as a unit or as separate pieces, through the end connections.
- 2.3.3 - The measuring mechanism should be permanently identified if it is removable as a unit with the following information:
 - 2.3.3.1 - Serial Number.
 - 2.3.3.2 - Direction of flow if module mounting is reversible.

2.4 - Output Device

- 2.4.1 - Turbine meters are available with mechanical drive and/or electrical pulse outputs.
- 2.4.2 - For meters with mechanical drive outputs, the output consists of shafting, gearing and other drive components needed to transmit the indicated rotor revolutions outside the body for uncorrected volume registration. Meters should be marked near the output drive to indicate the direction of rotation and the uncorrected volume per revolution. The intermediate gear assembly should be marked with the basic gear ratio, excluding the change gears. Change gears should be stamped with the size and the number of teeth.

- 2.4.3 - For meters with electrical pulse outputs, the output includes the pulse detector system and all electrical connections necessary to transmit the indicated rotor revolutions outside the body for uncorrected volume. Electrical pulse output and electronic devices shall be designed, and certified for the applicable electrical area classification which the device is installed.

SECTION 3. INSTALLATION

3.1 - General

- 3.1.1 - The turbine meter is a fluid velocity-measuring device. The piping configuration immediately upstream of the meter should be such that the flow profile entering the meter has an axisymmetric distribution and is without jetting or swirl. Since the turbine meter construction is designed to direct the flow to the annular passage upstream of the rotor, it effectively tends to average the velocity profile of most normal flow conditions, thus minimizing the influence of minor flow distortions on meter performance.
- 3.1.2 - A flow conditioner, located in the upstream meter piping in accordance with piping configurations of Section 3.2, is recommended as it will eliminate most normal flow swirl conditions. Flow swirl conditions may be caused by pipe fittings, valves or regulators preceding the meter inlet piping. An integral flow conditioner installed in the entrance of the meter and part of the meter design will further eliminate remaining minor swirl conditions and reduce the necessary upstream pipe length in the case of strong jetting. However, regardless of location some flow conditioners will not eliminate the effect of strong jetting.

Section 3.3, Straightening Vanes, provides construction specifications for the traditional tube bundle type flow conditioner. This design has demonstrated its effectiveness in the reduction of swirl flow conditions. Flow conditioners of other designs may be used provided the turbine meter's performance is acceptable and when mutually agreed upon by the parties involved.

- 3.1.3 - The installation of a throttling device such as a regulator or partially closed valve is not recommended in close proximity to the meter. Where such installations are necessary, the throttling device should be placed an additional eight nominal pipe diameters upstream or an additional two nominal pipe diameters downstream in the in-line recommended installation in Figure 2. In installation configurations illustrated in Figures 3, 4, and 5, the throttling device should be placed eight additional nominal pipe diameters ahead of the inlet vertical riser or an additional two nominal pipe diameters downstream of the outlet vertical riser. Placement of such a device in closer proximity to the meter may result in a higher uncertainty and/or reduced bearing life.

3.2 - Installation Configurations (Minimum Lengths)

3.2.1 - Recommended Installation for In-Line Meters

- 3.2.1.1- The recommended installation requires a length of ten nominal pipe diameters upstream with the straightening vane outlet located at five nominal pipe diameters from meter inlet as shown in Figure 2. A minimum length of five nominal pipe diameters is recommended downstream of the meter. Both inlet and outlet pipe should be of the same nominal size as the meter. There shall be no pipe connections within the upstream or downstream piping other than pressure taps, temperature wells and/or flow conditioners, either flanged or in line.

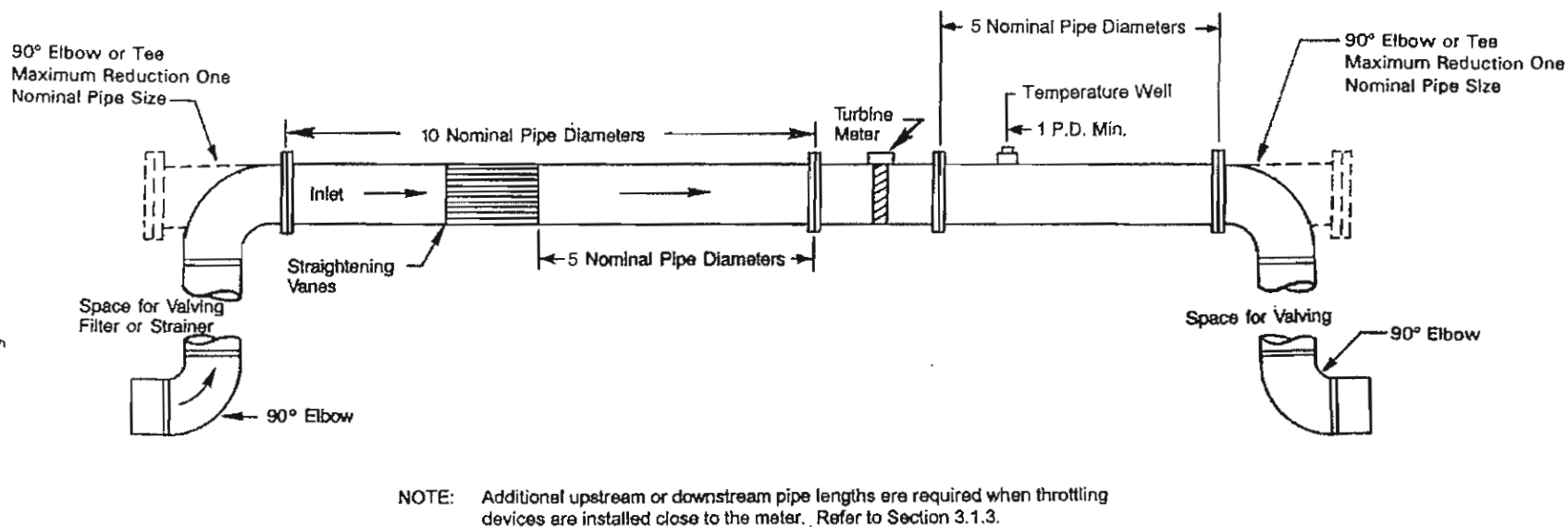


FIGURE 2 - RECOMMENDED INSTALLATION OF AN IN-LINE GAS TURBINE METER (MINIMUM LENGTHS)