A REVIEW OF THE REVISIONS TO API 14.3 / AGA 3 – PART 2

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Introduction

In April of 2003, revisions to the specification and installation requirements for orifice meters was published by the American Gas Association in the form of the AGA Report No. 3 – Part 2, Fourth Edition. The revisions or changes in the following categories are significant when compared to the 1991 Third Edition publication of AGA Report No. 3 and will be discussed in greater detail throughout this paper:

- Flow Conditioners
- Required Meter Tube Lengths
- Meter Tube Surface Roughness
- Orifice Plates
- Thermometer Well Location
- Pulsation Environment

Flow Conditioners

Flow conditioners are divided into two categories:
flow straighteners and isolating flow conditioners. Flow straighteners are defined as "Devices that remove or have limited ability to accurately replicate the orifice plate coefficient of discharge database values". Isolating flow conditioners are defined as "Devices that effectively remove the swirl component from the flowing stream while redistributing the stream to produce flow conditions that accurately replicate the orifice plate coefficient of discharge database values".

The 1998 Uniform Concentric 19-Tube bundle is considered a flow straightener and the physical specifications are considerably different from the requirements listed in the 1991 publication for straightening vanes. The individual tubes must be of uniform smoothness, outer diameter and wall thickness. Commercially available seamless carbon steel tubing is readily available and most commonly used. The individual wall thickness of the tubes shall be less than or equal to 2.5% of the published internal diameter. For example: The individual wall tube thickness for a 3" schedule 40 meter tube (3.068") must be .025 X 3.068 or 0.0767" or less. The individual tubes must be chamfered on both ends not less than 50% of the wall thickness by 45 degrees. The tubes must be arranged in a cylindrical pattern and the individual tube outer walls must come in direct contact with each other. The outside diameter of the tube bundle must be a minimum of 95% of the published internal diameter of the meter tube and can obviously be no greater than the published internal diameter. In order to ensure that the bundle outer tube walls come in direct contact with each other and achieve an outside diameter greater than or equal to 95% of the published inside diameter of the meter tube, the correct O.D. tubing must be used as illustrated in the table below for schedule 40 piping.

Meter Tube ID "	Vane Tube O.D. "	Minimum Vane Bundle O.D. "
3.068	19/32	2.9146
4.026	13/16	3.8247
6.065	1- 3/16	5.7618
7.981	1- 5/8	7.5820
10.020	2	9.5190

The required length of the tube bundles must be as follows:

- 3 X NPS for 2"
- 2.5 X NPS for 3" & 4"
- 2 X NPS for 6" and above

Flow conditioners not meeting the requirements of the 1998 Uniform Concentric Tube Bundle are considered as Other Flow Conditioners. While the 2000 publication does not recommend any particular type of flow conditioner, specific criterion for evaluation of installation and/or flow conditioner testing is provided. These tests define the meter tube lengths and flow conditioner locations for acceptable performance. Significant research and numerous flow studies have been conducted since 1991 to test various flow conditioner designs with repeatable and acceptable results.

Required Meter Tube Lengths

A beta ratio of.75 should be used as the design criteria for new orifice meter installations. The 2000 publication provides required minimum installation lengths for meter tubes with no flow conditioners in Table 2-7 and minimum installation lengths for meter tubes with the 1998 Concentric 19-Tube Flow Straighteners in Tables 2-8a and 2-8b. Two configurations to be noted for tubes without flow conditioners in Table 2-7 are:

- Two 90° elbows in perpendicular planes where $S<5D_i$
- Any other configuration (catch all category)

For the two 90° elbows in perpendicular planes, the recommendation is 95 published inside diameters beginning at beta ratios of .50 through .75. For configurations not specifically addressed in Table 2-7, 145 published inside diameters are recommended for beta ratios of .40 through .75.

For tubes with The Uniform Concentric 1998 19-Tube Bundle, there are multiple configurations that are not allowed at the higher beta ratios. This means that it is not possible to find an acceptable location for the 1998 Concentric 19-Tube Bundle downstream of the fitting for all values of upstream length. A few examples follow:

- Single 90° tee used as an elbow but not as a header element for beta ratios of .67 and higher.

- Partially closed valves (at least 50% open) for beta ratios of .60 and higher.

Required minimum lengths for other types of flow conditioners are not specified although flow testing in situ and at flow-testing laboratories is addressed. Many companies have now changed their engineering standards to accommodate other types of one and two piece flow conditioners such as those produced by Gallagher, Canadian Pipeline Accessories and Daniel.

Meter Tube Surface Roughness

In the 1991 and 2000 publications, sections 2.5.1.1 through 2.5.1.1.3 address the inside surface of meter tubes. There are several changes for tubes greater than 12 inches in diameter and a minimum surface roughness is specified for the first time. To illustrate the changes more clearly, the 1991 requirements are listed followed by the 2000 requirements.

<u>1991</u>

- 300 micro inches for beta ratios less than 0.6

- 250 micro inches for beta ratios greater than or equal to 0.6

<u>2000</u>

For meter runs with nominal diameters of 12 inches or smaller:

- 300 micro inches for diameter ratios equal to or less than 0.6

- 250 micro inches for diameter ratios greater than or equal to .60

- The minimum roughness shall not be less than 34 micro inches for all diameter ratios

- For meter runs with nominal diameters larger than 12 inches:

- 600 micro inches for diameter ratios equal to or less than 0.6

- 500 micro inches for diameter ratios greater than or equal to 0.6

- The minimum roughness shall no be less than 34 micro inches for all diameter ratios.

Orifice Plates

There are revisions to 8 inch and 24 inch plates in the 2000 publication as well as maximum allowable differential pressures for all meter tube diameters. Changes in recommended thickness for 8 inch and 24 inch orifice plates are as follows:

Recommended Orifice Plate Thickness

1991	8”	.125”
2000		.250”
1991	24”	.375”
2000		.500”

The maximum recommended differential pressure was 200” W.C. for all tube diameters and plate bores in the 1991 publication. The exception was the 8 inch plate with a .125” thickness which was limited at 150” W.C. to prevent plate deflection. In the 2000 publication, maximum recommended differential pressures are listed in Table 2-3. These differential pressures apply to stainless steel orifice plates at a maximum operating temperature of 150°F. For all orifice flange fittings or unions, the maximum differential pressure is listed at 1000 inches of water column. For other orifice fittings (single and dual chamber) differential pressure maximums vary from a minimum of 180” to a maximum of 1000”.

Thermometer Well Location

The required lengths downstream of the orifice plate related to thermometer well location remain unchanged from the 1991 to the 2000 publication. In the 1991 publication, the thermometer well could be located between 12 –36” upstream of the straightening vane. In the latest revision, the thermometer well may be located no closer than 36” upstream of the flow conditioner inlet

Pulsation Environment

Pulsation is addressed in section 2.6.4 of the 2000 publication. The allowable pulsation environment is stated as follows:

$\Delta P_{rms} / \Delta P_{avg} \leq 0.10$

or:

“Accurate measurement of flow with an orifice meter operating under pulsating flow conditions can be ensured only when the root mean square of the fluctuating differential pressure amplitude normalized over differential pressure time mean does not exceed 10%.”

This applies to single frequency pulsations caused by reciprocating compressors or releif/blowdown valves and to broadband flow pulsation or noise caused by throttling valves. There is currently no reliable means to adjust for indicated pulsation and it is stated that attempting to do so may actually introduce more error. Every effort should be made to eliminate the source of the pulsation which can usually be accomplished through proper design of the facility.