METER SELECTION FOR VARIOUS LOAD REQUIREMENTS

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INTRODUCTION

Gas meters have become known as the "CASH REGISTER" of the natural gas industry. With today's competitive energy markets and the environment of FERC Order 636, natural gas measurement has become an increasingly important issue. It is therefore the duty of measurement departments to select equipment and design installations that are both efficient and economical.

HISTORY OF GAS MEASUREMENT

The Diaphragm Meter, as we know it today, was first developed in 1847. Rotary measurement was introduced in 1923. Development of the Turbine Meter began after World War II and was introduced in 1963.

POSITIVE DISPLACEMENT METERS

Positive Displacement (diaphragm and rotary) Meters, measure gas quantities by the successive filling and emptying of chambers of known quantity. This can be compared to a cook adding quantities of ingredients to a recipe with a measuring cup. This motion is transferred, by a mechanical linkage, to an "index" or read-out device which is graduated in the appropriate units (usually cubic feet).

Diaphragm Meters accomplish this with a set of bellows which are filled and then emptied through a set of sliding valves. As one compartment of the bellows fills, the other is emptying. (See Figure 1)

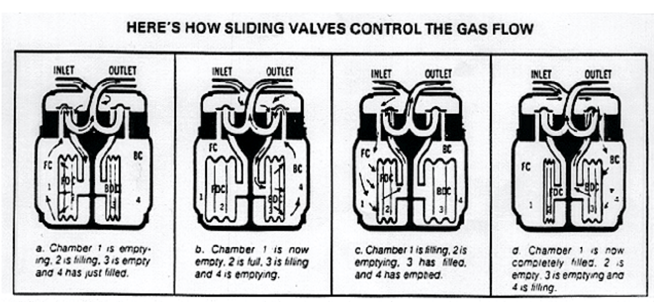

FIGURE 1. Operation of Positive Meters

Diaphragm Meters are available with capacities ranging from domestic loads (175 cubic feet per hour) to commercial and industrial loads (10,000 cubic feet per hour) per hour, at base conditions.

Because of their construction, these meters are limited to working pressures of 100# or less. Some models though are available with 500# cases.

Rotary Meters have a set of rotating vanes or impellers that counter rotate inside a chamber. Each rotation of the vanes carry a known quantity of gas though the meter. (See Figure 2)

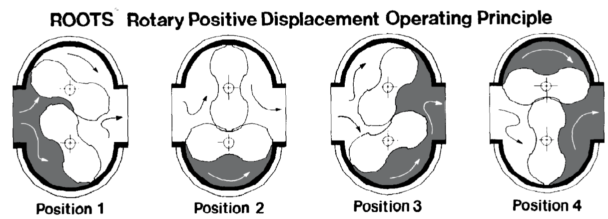

FIGURE 2. Operation of Rotary Meters

Capacities of rotary meters range from 800 to 102,000 cubic feet per hour, at base conditions.

These meters typically have working pressures of 175#, with some sizes ranging to 400#, 600#, 900# and 1440#.

INFERENTIAL METERS

Inferential Meters measure gas volumes based on physical properties of the gas being measured. Turbine and Orifice Meters are two types of inferential measurement.

Similar to a child's pinwheel, *Turbine Meters* use gas velocity to spin a turbine wheel. This spinning motion is linked to an index by means of a gear train. The higher the rate of flow, the faster the spin, therefore registering higher volume on the index over a given period of time. Figure 3 shows the construction of a typical Turbine Meter.

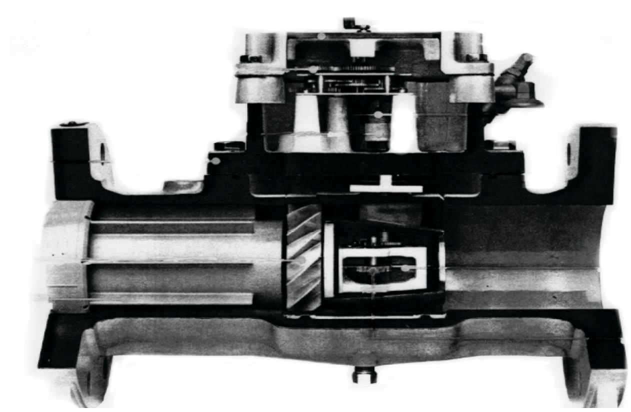

FIGURE 3. Construction of a Turbine Meter

Turbine Meters have the advantage of high capacity, for a given size but limited low flow characteristics.

Orifice Meters consist of “PRIMARY” devices (orifices) and “SECONDARY” devices (chart recorders or flow computers). Measurement is achieved by recording pressure and the differential created by the flow across the orifice. Calculations are then made using various parameters (such as meter tube size, orifice diameter, etc.) to determine gas volumes. Rules governing orifice measurement can be found in the A.G.A. Report No. 3.

DESIGN PARAMETERS

Several parameters have to be considered when selecting measurement equipment for a particular load. These would include: load characteristics, equipment pressure requirements, system capabilities, site restrictions, etc.

The Louisiana Division of ENTEX uses the form shown in Figure 4 to provide this information to the various departments involved in meter selection.

This form must be submitted when application for service is made for connected loads of 1500 cfh or more or for pressure requirements above 4 oz.

The form is completed by Marketing personnel and sent to the Engineering Department for a determination of system capabilities.

Engineering “plugs” the proposed load into its *pressure studies* and determines if the system can support the load.

Once it is determined that the system can handle the load (or what improvements or changes have to be made) the form is sent to the Measurement Department for meter selection.

Measurement studies the load and decides on the meter size based on the type of load.

The Division Chief Engineer makes the final approval and the form is then sent to the field for installation.

SIZING FOR VARIOUS TYPES OF LOADS

Various types of loads require different sizing criteria. For example; consider the load in Figure 4. It consists of several types of gas burning equipment and may be sized, based on a “DIVERSITY FACTOR.” Experience shows that this type of load may be sized using a factor of 60% to 75% of total connected load.

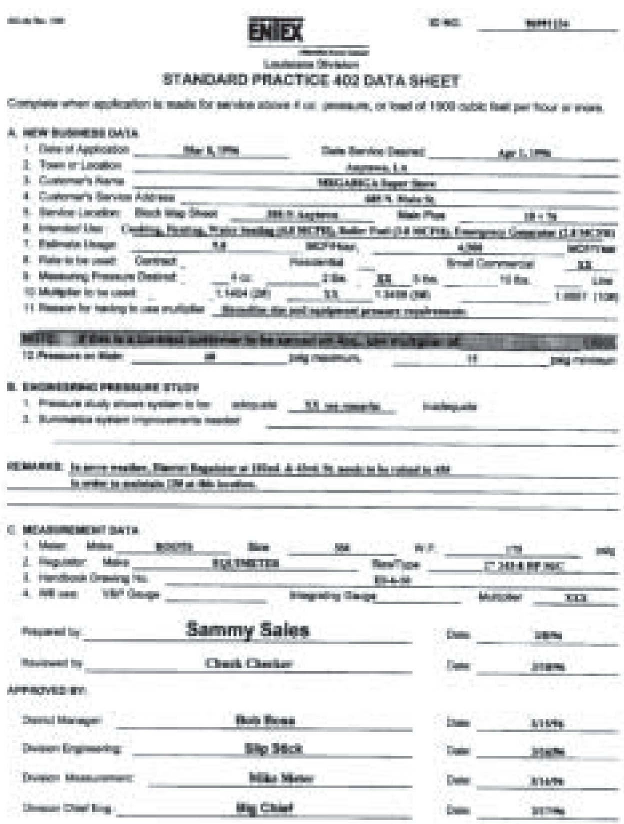
ENTEX
Louisiana Division
STANDARD PRACTICE 402 DATA SHEET
Prepared by: Sammy Sales
Reviewed by: Chuck Checker
APPROVED BY:
District Manager: Bob Boss
Division Engineering: Slip Stick
Division Measurement: Mike Meter
Division Chief Eng.: Big Chief

FIGURE 4.


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STANDARD PRACTICE 402 DATA SHEET
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FIGURE 5.

As a contrast, the load shown in Figure 5 is a DEMAND type load and has to be sized for full capacity of the connected equipment.

If a load is in question, sometimes it is practicable to research actual usage of similar operations in other areas. This technique is possible, for example, in the case of the new "Super Stores" where the connected load may exceed the actual usage.

METER CAPACITIES

Once a load for a customer has been determined, it is time to select the equipment. Meter capacity tables are necessary for this procedure.

Manufacturers rate the capacities of their meters at a "BASE" pressure and at pressures up to the working pressure of the meter. Figure 6 is a typical meter capacity table.

GAUGE PRESSURE	MTR. SIZE / DIFF.	750	1600	1000	3000	5000	10000
4 OZ.	2" W.C.	1600	1600	2200	3000	5000	10000
	MAX. ALLOW.	1600	1600	2200	3000	5000	10000
5#	2" W.C.	1840	1840	2530	3450	5750	11500
	MAX. ALLOW.	2070	2070	2840	3880	3450	12900
10#	2" W.C.	2080	2080	2860	3900	6500	13000
	MAX. ALLOW.	2480	2480	3420	4660	7760	15550
15#	2" W.C.	2320	2320	3190	4350	7250	14500
	MAX. ALLOW.	2840	2840	3960	5400	9000	18000
25#	2" W.C.		2640	3630	4950	8250	16500
	MAX. ALLOW.		3750	4900	6700	11100	22300
50#	2" W.C.		3360		6300	10500	21000
	MAX. ALLOW.		5000		9370	15600	31200
100#	2" W.C.		4480		8400	14000	28000
	MAX. ALLOW.		7170		13400	22400	44800

FIGURE 6.

SPECIAL CONSIDERATIONS

When selecting meters for various applications, special considerations need to be taken into account. For instance: Rotary and Turbine Meters should be used only where gas is relatively free of foreign materials (such as dust) that may cause undue wear on close tolerance parts. Strainers or filters should be used is such applications.

In situations where the minimum flow is only a small percentage of the maximum flow, (such as a pilot load on a large boiler) low flow measurement must be taken into account. This can be accomplished by using a combination of large and small capacity meters in conjunction with regulators, set at different pressures and an orifice plate (choke). Figure 7 illustrates the layout.

The regulator upstream of the small meter is set at 10#, for instance. The regulator upstream of the large meter is then set at 5#.

Under low flow conditions, the regulator upstream of the larger meter (T-60) is "locked-up" because of the higher pressure of the regulator ahead of the smaller meter (3M). This allows flow through the small meter and prevents flow through the large meter. As the flow increases, the choke downstream of the small meter reaches critical

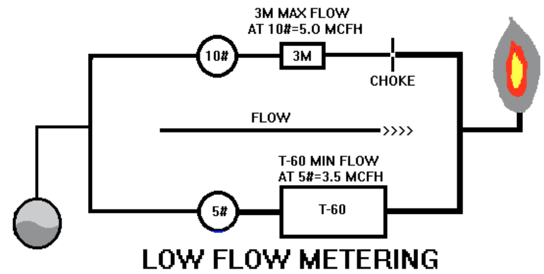

FIGURE 7.

flow causing the pressure downstream to fall to the set pressure of the regulator upstream of the large meter thus allowing flow through both meters.

In locations where seasonal loads vary, parallel meters could be the used. During the "off season" one of the meters can be shut-in. This would allow the single meter to operate towards the upper limit of its range rather than both meters operating in the lower ends of their capacities.

With measurement personnel now using "Transfer Provers," accessibility to field test meters is an issue. Normally the provers are installed in a vehicle or trailer necessitating ample "maneuvering space" near the meter installation. All too often location becomes a problem. In situations such as this, meters should be selected that are small, compact and easily removed from the line. This allows the technicians to bring the meter to the prover for test.

MEASUREMENT AT ELEVATED PRESSURES

When it is necessary to measure natural gas at pressures other than "base pressure," the Measurement Supervisor has several options. These would include: pressure compensating indexes, fixed factor measurement, mechanical or electronic integrators and flow computers.

Basic economics will dictate the best choice for selecting from these options. Pressure compensating indexes or fixed factors should be used only on smaller loads (such as steam cleaners or small boilers) where a regulator, of adequate capacity, is installed upstream of the meter. This will assure a constant pressure for measurement. Mechanical or electronic integrators can be used on larger commercial loads. These instruments will compensate for any fluctuating pressure (or temperature) on the meter. Full blown flow computers should be used on large industrial loads, where there may be multiple meter runs. These devices will store information, such as pressure, temperature, uncorrected and corrected volumes, etc. for retrieval by laptop or "on-line."

CONCLUSION

Because meter sizing is not an "exact science", prior experience and common sense should be used when selecting measurement equipment for various load requirements. Load profiles and operating characteristics should be carefully studied and equipment selected accordingly. Using over sized meters will result in poor measurement during periods of low flow; under sizing will cause undue wear on meters and possibility customer equipment problems.

Even though the $\pm{}^{1}/_{4}\%$ accuracy Measurement Personnel strive for, is not always possible, it is possible to select measurement equipment that is economical, efficient and safe.

Mike Haydell