The Evolution of Backflow Test Kits

by Michael A. Lueck
Mid-West Instruments, Sterling Heights, Michigan

Backflow test kits have been around for about 30 years. Before we think about how test kits will change in the future it is interesting to look at where they have been.

Prior to 1970, backflow prevention assemblies were tested with devices that probably didn't qualify as "test kits" by today's standards. One such device was a mercury manometer. This device required a 30-inch mercury manometer to achieve the 15 PSID range required for testing backflow prevention assemblies. It also required mercury "catch pots" to protect the water supply from the mercury in the manometer. A second device consisted of two pressure gauges and some valves mounted on a plywood board. A third device, which is still in use today, is the old reliable sight tube.

The differential pressure gauge (DP) test kit was developed around 1970. This test kit consisted of a 0-15 PSID differential pressure gauge plumbed with either three (3) or five (5) valves, three (3) hoses, a carrying case, test procedures and adapter fittings to attach to 1/8" NPT through ¾" NPT test cocks. This style test kit replaced the mercury manometer. Over the years minor changes were made to these test kits. The changes included filters in hoses, laminated test procedures, soft seated needle valves, line pressure gauges, and 2-valve versions. Today they are available in plastic, brass or aluminum materials, and with 3", 4.5" or 6" dials. Today dial type test kits are available in at least 10 name brands with differential gauges from five (5) different manufacturers.

The duplex style test kit was created a few years after the differential pressure gauge test kit to test double check valve assemblies. A duplex gauge has two (2) independent bourdon tubes, movements and pointers housed in a single case with a single dial. The duplex gauge was plumbed with valves; hoses and a carrying case much like the DP test kit. The duplex test kit led a controversial life. The main complaints were, "the test procedure is confusing and complicated", "why do I have to have two (2) test kits", and "back pressure helps the check valves close during testing". The duplex test kit era ended in 1994 when direction of flow testing of double check valve (DCV) assemblies with DP test kits became more recognized nationwide.

The uncertainty of test kit readings has three components: the accuracy of the pressure-sensing element, the range of the instrument, and the readability or resolution of the indicator.

Digital test kits arrived on the scene in the mid 1980's. This style test kit consists of two (2) pressure transducers and circuitry to display a differential pressure. Today they are available in 2-valve and 3-valve versions. Some models have built-in printers.

In the late 1980's a few areas around the country started requiring that testers must have their test kits checked for accuracy. Today this practice is commonplace. In many areas testers must demonstrate that they have had their test kit certified as accurate by a third party in order to maintain their tester certification.

Where do backflow test kits go from here? One certain change will be performance standards for backflow test kits. Two organizations are currently working on these very performance standards. Two different standards should be ready for publication within the next year or two. An important dilemma facing both standards committees is what to do with test kits that are currently in the field. It will require an industry wide consensus to properly resolve this issue.

What about the test kits? Will they or should they undergo any major changes? Perhaps we should first look at the proposed changes to backflow prevention assemblies.

One of the "buzzwords" regarding backflow prevention assemblies is "headloss" or pressure drop. Customers are demanding lower "headloss" backflow preventers. As a result manufacturers and laboratories are addressing these demands.

 Reprinted with permission from the Oct - Dec - 2000 issue of Plumbing Standards Magazine

One change that is being considered is the elimination of the "3 PSI buffer" requirement on the reduced pressure principle (RP) assembly. It has been proposed that the "3 PSI buffer" be replaced by a 5 PSID minimum for the first check valve on the RP assembly.

A new line of backflow prevention assemblies is being proposed for fire sprinkler systems. A proposed change to the DCV assemblies is dropping the check valve closing pressures from the current 1 PSID to ½ PSID. Changes to the RP assembly include dropping the current relief valve opening pressure from the current 2 PSID to 1 PSID, dropping the second check valve closing pressure from 1 PSID to ½ PSID, and replacing the "3 PSI buffer" with a first check valve differential as low as 4 PSID.

If the above mentioned changes take place perhaps the test kits should undergo some changes. The problem with the current 0-15 PSID test kits is that they will not be ideally suited for reading pressure drops of ½ PSID. The challenge will be making a test kit that is practical and cost effective while measuring these lower pressure drops.

The uncertainty of test kit readings has three components: the accuracy of the pressure-sensing element, the range of the instrument, and the readability or resolution of the indicator. The uncertainty in a test kit's reading is generally the accuracy (in percent) of the gauge times the full-scale range divided by one hundred (100). The readability of the indicator is often over looked. If a dial has too few graduations or graduations too close together it may be hard to read accurately. If a digital display has too few digits it will be impossible to read accurately. If a digital display has too many digits it may be hard and annoying to read accurately if the last digit is constantly changing.

Let's look at dial type test kits first. The most economical way to reduce the uncertainty of a dial type gauge and improve readability at lower pressures is to reduce the range. Table 1 illustrates the effect of lowering the range of a gauge.

Standard industry practice for pressure gauges recommend that gauges be ranged so that the most critical readings occur at or near mid-scale. If 1 PSID and 2 PSID are the most critical pass/fail pressures for backflow preventers and the pressure drop for a #1 check on an RP assembly becomes 5 PSID minimum, a change to a 0-5 PSID test kit should be considered. The benefits to this change would include reduced uncertainty in the test kit readings, better readability at 1 and 2 PSID, readability at ½ PSID, ability to resolve 0.05 PSID, and would have little or no cost effect over the price of current 0-15 PSID test kits. Test reports, however, would have to change. RP #1 check valves would have to be recorded as "Pass" or "5+ PSID" for pressure drops greater than 5.0 PSID. This change in reporting will have no bearing on how well the RP assembly is protecting against backflow.

Table 1

RANGE	ACCURACY	UNCERTAINTY
0-15 PSID	± 2 %	± 0.3 psid
0-5 PSID	± 2 %	± 0.1 psid
0-2 PSID	± 2 %	± 0.04 psid

If a 0-5 PSID test kit will not work for all devices perhaps a new test kit should be created specifically designed for direction of flow testing. A 1-valve, 1-hose test kit could be developed for this specific purpose using a 0-2 PSID DP gauge. This new style test kit would have several advantages including a much lower uncertainty in the test kit readings (± 0.04 PSID or better), improved readability at 0.5 and 1.0 PSID, and the ability to resolve 0.025 PSID. Having only one hose and one valve this test kit would be easier to hold at the proper level, which is critical with single hose testing due to the weight of water. This test kit would also be less expensive than current test kits because it would have fewer parts. The only disadvantage is that two test kits would be required.

Let's look at the digital test kits. Current digital test kits use two (2) pressure transducers capable of withstanding 200 PSIG. As with dial type gauges the accuracy of these transducers is based on the full-scale range of the transducers. A ± 0.25% transducer with a 200 PSIG range has an uncertainty of ± 0.5 PSIG. This error alone exceeds today's requirements. However, with microprocessor technology the pressure difference between the two (2) transducers is converted to a digital display and the uncertainty is reduced to ± 0.15 PSID. The current digital test kits are able to resolve 0.1 PSID because only the 1/10th digit is displayed. A digital test kit with the 1/100th digit displayed (0.00 instead of 0.0) should be considered if backflow prevention assemblies are created that have pass/fail pressure drops below 1 PSID. This change would improve the resolution of the digital test kit to 0.01 PSID. This type of change may require more accurate or higher resolution electrical components. More accurate sensors or revised linearization and compensation techniques may be required to reduce the uncertainty of the digital test kit.

New technology could change digital test kits in the future. A DP transducer could replace the current two (2) transducers in the current test kits. This new type DP transducer will have to fill three requirements. First it must be able to have water on both high and low sides of the transducer. Second it must be able to handle over-range pressures similar to the dial type DP gauges. Third it will have to fulfill the first two requirements at a much more economical price than currently available to be realistically considered for backflow test kits.

How and when should test kits change? Test kits, backflow prevention assemblies, test procedures, and regulations are related to each other. Any changes in future test kits should reflect and coordinate with changes to backflow prevention assemblies, test procedures, and regulations.

*****

Michael A. Lueck may be reached at telephone 1-810-254-6500 or by e-mail at mlueck@midwestinstrument.com.

 Reprinted with permission from the Oct - Dec - 2000 issue of Plumbing Standards Magazine