CROSS CONNECTIONS

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1.0 SCOPE

This data sheet discusses the interconnection of public or private potable water sources with fire protection systems. Backflow prevention assemblies of the reduced pressure principle and double check valve assembly types are covered.

Details pertaining to other types of valves, meters, fire department pumper connections, hydrants, and fire service mains are covered in Data Sheet 3-10, *Installation and Maintenance of Private Fire Service Mains and Their Appurtenances.*

1.1 Changes

September 2000. This revision of the document has been reorganized to provide a consistent format.

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 Protection

2.1.1 General

2.1.1.1 Safeguard the public water supply, taking all precautions necessary to prevent any unfavorable experience due to the use of a cross connection. Comply with all regulations of the public health or water authorities having jurisdiction. Often installation of backflow prevention assemblies may be avoided.

For example, an antifreeze system may be replaced with a dry system or dry pendent sprinklers if authorities recommend a backflow prevention device because of the antifreeze system.

2.1.1.2 Install Factory Mutual Research Approved (See Appendix A for definition) backflow prevention assemblies when such assemblies are required on fire protection supply lines by state or local authorities. Tables 1, 2 and 3 list Approved reduced pressure principle, double check and double check-detector check valve assemblies.

2.1.1.3 Verify before installation that water pressure will be adequate for fire protection after deducting friction loss for the specific backflow prevention device to be installed. (See Table 1.)

2.1.1.4 If backflow prevention assemblies are required, they should be :

a) located *downstream* of booster pumps when permissible by the authority having jurisdiction;

b) installed *after* all mains have been flushed of foreign material;

c) provided with indicating-type control valve (i.e., OS&Y or gate valve with indicator post);

d) located only in areas with adequate provisions for drainage and protection from freeze-ups; and

e) installed such that there is ample space to assure accessibility for inspection, testing, and maintenance. (Most codes specify that devices should be installed about waist-high).

2.1.1.5 Reduced pressure and double check valve assemblies should be tested as required by regulations of public health or water authorities having jurisdiction. Generally, testing by a certified tester is required at least once a year. Many authorities also require the building owner to maintain inspection/repair records for each backflow prevention device.

2.1.1.6 Reduced pressure and double check valve assemblies should be internally inspected and cleaned at least once every five years. More frequent internal inspections may be necessary at locations with highly mineralized or corrosive water or where required by health or water authorities. Consult manufacturer’s instructions for details on maintenance and cleaning procedures.

Table 1. Approved Backflow Prevention Assemblies

Type	*Manufacturer*	*Model*	*Size, in. (mm)*	*Flow Rate, gal/min (cu dm/min)*	*Friction Loss psi (kPa)**
Reduced Pressure Principle	Ames Co., Inc.	4000 RP	4 (102)	500 (1895) 750 (2840) 850 (3220)	13.4 (92.5) 13.5 (93.0) 15.7 (108.0)
			6 (152)	1000 (3785) 1500 (5680) 1650 (6245)	12.8 (88.0) 11.5 (79.0) 10.9 (75.0)
			8 (203)	2000 (7570) 2500 (9465) 3000 (11 355)	19.5 (135.5) 21.2 (146.0) 22.9 (160.0)
			10 (254)	4000 (15 140) 4900 (18 550) 5500 (20 820)	30.0 (207.0) 34.2 (236.0) 37.0 (255.0)
	CMB Industries Febco Div.	825 825D 825YD	3 (76)	300 (1135) 400 (1515) 500 (1895)	14.6 (101.0) 18.3 (126.0) 23.1 (159.5)
			4 (102)	500 (1895) 750 (2840) 1000 (3785)	11.6 (80.0) 15.3 (105.5) 20.8 (143.5)
			6 (152)	1000 (3785) 1500 (5680) 1750 (6625)	12.8 (88.5) 16.3 (112.5) 18.1 (125.0)

Table 1 (Cont'd.)

Type	*Manufacturer*	*Model*	*Size, in. (mm)*	*Flow Rate, gal/min (cu dm/min)*	*Friction Loss psi (kPa)**
Reduced Pressure Principle	CMB Industries Febco Div.	825, 825D, 825YD	8 (203)	1500 (5680) 2000 (7570) 2500 (9465)	10.6 (73.0) 11.8 (81.5) 14.0 (96.5)
			10 (254)	3000 (11 355) 4000 (15 140) 5000 (18 925)	14.7 (101.5) 17.6 (121.5) 20.8 (143.5)
	Conbraco Ind. Inc.	40-209-02 40-209-03	2-½ (64)	50 (190) 150 (570) 275 (1040)	13.6 (95) 14.3 (100) 16.2 (110)
		40-200-02 40-200-03	3 (76)	100 (380) 300 (1135) 500 (1895)	13.4 (95) 14.5 (100) 23.1 (160)
		40-20A-02 40-200A-03	4 (102)	500 (1895) 750 (2840) 1000 (3785)	12.0 (85) 16.0 (110) 22.2 (130)
		40-20C-02 40-20C-03	6 (152)	1000 (3785) 1500 (5680) 1900 (7190)	11.9 (80) 17.4 (120) 25.2 (175)
	Hersey Products Inc. Sub Grinnell Corp.	6CM	2-½ (64)	200 (755) 250 (945) 300 (1135)	13.8 (95) 15.1 (105) 17.3 (120)

*1 kPa = 0.01 bar

Table 1 (cont'd.)

Type	*Manufacturer*	*Model*	*Size, in. (mm)*	*Flow Rate, gal/min (cu dm/min)*	*Friction Loss psi (kPa)**
Reduced Pressure Principle	Hersey Products Inc. Sub Grinnell Corp.	6CM	3 (76)	300 (1135) 400 (1515) 450 (1705)	14.6 (100) 16.5 (115) 17.7 (120)
			4 (102)	500 (1895) 750 (2840) 800 (3030)	13.6 (95) 15.6 (110) 18.2 (125)
			6 (152)	1000 (3785) 1500 (5680) 1750 (6625)	12.9 (90) 17.8 (125) 20.3 (140)
			8 (203)	1500 (5680) 2000 (7570) 2500 (9465)	13.9 (95) 15.8 (110) 18.4 (125)
			10 (254)	3000 (11 355) 4000 (15 140) 5000 (18 925)	14.2 (100) 18.1 (125) 19.6 (135)
	Mueller Co.	H-9506	4 (102)	500 (1895) 750 (2840) 1000 (3785)	11.9 (82.0) 13.1 (90.5) 25.3 (174.5)
			6 (152)	1000 (3785) 1250 (4730) 1450 (5490)	11.6 (80.0) 13.6 (94.0) 15.5 (107.0)

*1 kPa = 0.01 bar

Table 1 (cont'd)

Type	*Manufacturer*	*Model*	*Size, in. (mm)*	*Flow Rate, gal/min (cu dm/min)*	*Friction Loss psi (kPa)**
Reduced Pressure Principle	Mueller Co.	H-9506	8 (203)	1500 (5680) 2000 (7570) 2500 (9465)	10.6 (73.0) 12.2 (84.0) 15.1 (104.0)
			10 (254)	4345 (16 445) 4900 (18 550) 5990 (22 675)	20.10 (140) 25.01 (170) 38.29 (265)
	Watts Regulator Co.	909	3 (76)	300 (1135) 400 (1515) 500 (1895)	14.2 (98.0) 16.9 (116.5) 21.7 (149.5)
			4 (102)	500 (1895) 750 (2840) 1000 (3785)	13.0 (89.5) 16.7 (115.0) 22.8 (157.0)
			6 (152)	1000 (3785) 1500 (5680) 1750 (6625)	12.8 (88.5) 17.5 (120.0) 21.0 (145.0)
			8 (203)	1500 (5680) 2000 (7570) 2500 (9465)	11.8 (81.5) 13.1 (90.5) 15.0 (103.5)
			10 (254)	3000 (11 355) 4000 (15 140) 4500 (17 035)	11.9 (82.0) 3.8 (95.0) 15.4 (106.0)

*1 kPa = 0.01 bar

Table 2. Approved Backflow Prevention Assemblies

Type	*Manufacturer*	*Model*	*Size, in. (mm)*	*Flow Rate, gal/min (cu dm/min)*	*Friction Loss psi (kPa)**
Double Check	Ames Co., Inc.	2000 DC 2000 DCA	4 (102)	300 (1135) 500 (1895) 750 (2840)	7.9 (54) 8.2 (56) 11.5 (79)
			6 (152)	1000 (3785) 1300 (4920) 1500 (5680)	9.1 (63) 9.8 (68) 10.2 (70)
			8 (203)	2500 (9455) 3000 (11 355) 3100 (11 735)	10.7 (74) 15.5 (107) 16.1 (111)
		2000 DC	10 (254)	4000 (15 140) 4900 (18 550) 5500 (20 820)	25.5 (176) 36.0 (248) 44.0 (303)
	CMB Industries Febco Div.	805Y, 805YD	3 (76)	300 (1135) 400 (1515) 500 (1895)	7.5 (51.5) 11.7 (81.0) 17.8 (122.5)
			4 (102)	500 (1895) 750 (2840) 1000 (3785)	5.7 (39.5) 10.6 (73.0) 18.5 (130.0)
			6 (152)	1000 (3785) 1500 (5680) 1750 (6625)	6.0 (41.5) 9.7 (67.0) 12.0 (83.0)

*1 kPa = 0.01 bar

Table 2 (Cont'd.)

Type	*Manufacturer*	*Model*	*Size, in. (mm)*	*Flow Rate, gal/min (cu dm/min)*	*Friction Loss psi (kPa)**
Double Check	CMB Ind. Febco Div.	805Y, 805YD	8 (203)	1500 (5680) 2000 (7570) 2500 (9465)	5.0 (34.5) 6.8 (47.0) 10.4 (71.0)
		805Y, 80YTD	10 (254)	3000 (11 355) 4000 (15 140) 5000 (18 925)	8.6 (59.5) 13.9 (96.0) 20.1 (139.0)
	Conbraco Ind. Inc.	40-109-02 40-109-03	2-½ (64)	50 (190) 150 (570) 275 (1040)	6.3 (45) 6.9 (50) 10.0 (70)
		40-100-02 40-100-03	3 (76)	100 (380) 300 (1135) 500 (1895)	5.9 (40) 8.0 (55) 21.0 (145)
		40-10A-02 40-10A-03	4 (102)	500 (1895) 750 (2840) 1000 (3785)	6.9 (45) 11.6 (80) 20.0 (140)
		40-10C-02 40-10C-03	6 (152)	1000 (3785) 1500 (5680) 1900 (7190)	6.5 (45) 14.6 (101) 25.0 (172)
	Hersey Products, Inc. Sub Grinnell Corp.	No.2	3 (76)	300 (1135) 400 (1515) 500 (1895)	7.9 (55) 11.6 (80) 16.9 (115)

*1 kPa = 0.01 bar

Table 2 (cont'd.)

Type	*Manufacturer*	*Model*	*Size, in. (mm)*	*Flow Rate, gal/min (cu dm/min)*	*Friction Loss psi (kPa)**
Double Check	Hersey Products, Inc. Sub Grinnell Corp.	No.2	4 (102)	500 (1895) 750 (2840) 1000 (3785)	7.0 (50) 9.5 (65) 14.6 (100)
			6 (152)	1000 (3785) 1500 (5680) 1750 (6625)	7.2 (50) 12.9 (90) 18.3 (125)
			8 (203)	1500 (5680) 2000 (7570) 2500 (9465)	5.4 (40) 6.9 (50) 10.6 (75)
			10 (254)	3000 (11 355) 4000 (15 140) 5000 (18 925)	11.3 (80) 16.1 (110) 20.2 (140)
	Mueller Co.	H-9505	4 (102)	500 (1895) 750 (2840)	7.9 (54.5) 15.6 (107.5)
			6 (152)	1000 (3785) 1250 (4730) 1500 (5680)	6.4 (44.0) 10.0 (69.0) 12.7 (87.5)
			8 (203)	1500 (5680) 2000 (7570) 2500 (9465)	5.8 (40.0) 8.2 (56.5) 12.7 (87.5)
10 (254)			4260 (16 125) 4900 (18 550) 5950 (22 525)	19.99 (135) 25.85 (180) 39.60 (275)	

*1 kPa = 0.01 bar

Table 2 (Cont.)

Type	*Manufacturer*	*Model*	*Size, in. (mm)*	*Flow Rate, gal/min (cu dm/min)*	*Friction Loss psi (kPa)**
Double Check	The Viking Corp.	A-1	4 (102)	500 (1895) 750 (2840) 1000 (3785)	8.0 (55.0) 11.0 (76.0) 12.5 (86.0)
			6 (152)	1000 (3785) 1500 (5680) 2000 (7570)	7.2 (50.0) 8.4 (58.0) 9.4 (65.0)
			8 (203)	2000 (7570) 3000 (11 355) 4000 (15 140)	4.5 (31.0) 4.8 (33.0) 5.0 (34.5)
			10 (254)	2250 (8515) 4500 (17 035) 6750 (15 550)	3.9 (27.0) 4.7 (32.5) 5.3 (36.5)
	Watts Regulator Co.	709	3 (76)	300 (1135) 400 (1515) 500 (1895)	7.6 (52.5) 11.2 (77.0) 17.4 (120.0)
			4 (102)	500 (1895) 750 (2840) 1000 (3785)	5.8 (40.0) 10.7 (74.0) 19.3 (133.0)
			6 (152)	1000 (3785) 1500 (5680) 1750 (6625)	7.0 (48.5) 14.1 (97.0) 19.2 (132.5)
8 (203)			1500 (5680) 2000 (7570) 2500 (9465)	5.3 (36.5) 7.2 (49.5) 10.0 (69.0)	
10 (254)			3000 (11 355) 4000 (15 140) 4500 (17 035)	5.9 (41.0) 8.6 (59.5) 10.9 (75.0)	

*1 kPa = 0.01 bar

Table 3. Approved Backflow Prevention Devices

Type	*Manufacturer*	*Model*	*Size, in. (mm)*	*Flow Rate, gal/min (cu dm/min)*	*Friction Loss psi (kPa)**
Double Check Detector Check	Ames Co., Inc.	3000 DCDC 3000 DCDA	4 (102)	500 (1895) 750 (2840) 1000 (3785)	11.2 (77.0) 11.9 (82.0) 13.5 (93.0)
			6 (152)	1000 (3785) 1300 (4920) 1500 (5680)	9.1 (62.5) 9.8 (67.5) 10.2 (70.5)
			8 (203)	2000 (7570) 2500 (9465) 3000 (11 355)	7.3 (50.5) 10.7 (73.5) 15.5 (107.0)
		3000 DCDC	10 (254)	4000 (15 140) 4900 (18 550) 5500 (20 820)	25.5 (180.0) 36.0 (248.5) 44.0 (303.5)
	CMB Industries Febco Div.	806, 806YD	4 (102)	500 (1895) 750 (2840) 1000 (3785)	8.0 (55.0) 10.8 (74.5) 18.4 (127.0)
			6 (152)	1000 (3785) 1500 (5680) 1750 (6625)	10.2 (70.5) 12.4 (85.5) 13.4 (92.5)
			8 (203)	1500 (5680) 2000 (7570) 2500 (9465)	9.4 (65.0) 10.4 (72.0) 12.0 (83.0)
			10 (254)	3000 (11 355) 4000 (15 140) 5000 (18 925)	11.3 (78.0) 13.5 (93.0) 16.5 (114.0)

*1 kPa = 0.01 bar

Table 3 (cont'd.)

Type	*Manufacturer*	*Model*	*Size, in. (mm)*	*Flow Rate, gal/min (cu dm/min)*	*Friction Loss psi (kPa)**
Double Check Detector Check	Hersey Products Inc. Sub Grinnell Corp.	DDC II	3 (76)	300 (1135) 400 (1515) 500 (1895)	10.0 (70) 12.2 (85) 16.0 (110)
			4 (102)	500 (1895) 750 (2840) 1080 (4090)	9.1 (65) 11.6 (80) 20.3 (140)
			6 (152)	1000 (3785) 1500 (5680) 1750 (6625)	9.5 (65) 12.8 (90) 17.5 (120)
			8 (203)	1500 (5680) 2000 (7570) 2500 (9465)	8.0 (55) 8.8 (60) 10.6 (75)
			10 (254)	3000 (11 355) 4000 (15 140) 5000 (18 925)	10.4 (70) 13.0 (90) 16.7 (115)
	Watts Regulator Co.	709 DDC	3 (76)	300 (1135) 400 (1515) 500 (1895)	9.10 (63.0) 12.3 (85.0) 17.6 (121.0)
			4 (102)	500 (1895) 750 (2840) 1000 (3785)	7.5 (52.0) 11.3 (78.0) 18.7 (129.0)
			6 (152)	1000 (3785) 1500 (5680) 1750 (6625)	9.0 (62.0) 14.2 (98.0) 19.2 (132.5)
			8 (203)	1500 (5680) 2000 (7570) 2500 (9465)	8.8 (61.0) 10.0 (69.0) 12.2 (84.0)
			10 (254)	3000 (11 355) 4000 (15 140) 4500 (17 035)	9.9 (68.5) 11.2 (77.5) 12.7 (87.5)

*1 kPa = 0.01 bar

2.1.1.7 When maintenance of backflow prevention assemblies is necessary, the following precautions should be taken to prevent impairments to protection:

a) Operation of valves should be done by or under the jurisdiction of the building owner or his representative, who should take appropriate precautions in connection with the impairment.

b) Where there are multiple fire-service connections from public mains, overhaul and clean one assembly at a time, leaving the others in service.

c) When there is only one connection from a public main and a secondary supply is from a fire pump, operate the pump to maintain pressure at the sprinklers while the public water connection is shut off. If the secondary supply is from a tank, see that it is full and that all tank control valves are open.

d) Open one check valve at a time, so that in the event of fire the cover can be replaced and protection restored with the least possible delay.

3.0 SUPPORT FOR RECOMMENDATIONS

3.1 American Water Works Policy.

This and subsequent quoted material is reprinted from AWWA Manual M14, Recommended Practice for Backflow Prevention and Cross-Connection Control, published by the American Water Works Association (AWWA), 6666 West Quincy Avenue, Denver, CO 80235.

The American Water Works Association recognizes that the water purveyor has a responsibility to provide its customers at the service connection with water that is safe under all foreseeable circumstances. Thus, in the exercise of this responsibility, the water purveyor must take reasonable precaution to protect the community distribution system from the hazards originating on the premises of its customers that may degrade the water in the community distribution system.

Cross-connection control, and plumbing inspections on the premises of water customers are regulatory in nature and should be handled through the rules, regulations, and recommendation of the health authority or the plumbing code enforcement agencies having jurisdiction. The water purveyor, however, should be aware of any situation requiring inspection or re-inspection necessary to detect hazardous conditions resulting from cross connections. If, in the opinion of the utility, effective measures consistent with the degree of hazard have not been taken by the regulatory agency, the water purveyor should take such measures as he may deem necessary to ensure that the community distribution system is protected from contamination. Such action would include the installation of a backflow prevention assembly, consistent with the degree of hazard, at the service connection or discontinuance of the service.

In addition, customer use of water from the community distribution system for cooling or other purposes within the customer's system, and later return of the water to the community distribution is not acceptable and is opposed by AWWA.

To guide the water utilities, the AWWA Joint Committee on Backflow Prevention published Manual M14, *Recommended Practice for Backflow Prevention and Cross-Connection Control*. This manual provides guidance for protection of water supplies against contamination or pollution resulting from backflow or objectionable fluids through piping connections to public water systems. It is intended to supplement, not supersede, local laws and regulations.

3.2 Discussion

Potential contamination and possible liability resulting from contamination of public potable water supplies due to lack of, or faulty cross connection control assemblies has forced local and state agencies to enact various laws and regulations. Any interconnected piping between a consumer's water system and a public potable water system requires the approval of local and/or state water or public health authorities. Backflow prevention methods are usually required when a public potable water source is interconnected to a consumer's nonpotable water system.

Of all types of cross-connection backflow prevention methods, the type incorporating the principle of *air gap separation* is accepted by all states. However, air gap separation at connections to fire protection systems is not usually practical. Consequently, most states have accepted the principle of *reduced pressure by a backflow preventer* in lieu of the air gap separation, and have revised their codes to permit the use of this assembly. Reduced pressure principle backflow prevention assemblies (RPBA) have a relatively high friction

loss and a recommended limit to their flow capacity. Therefore, fire protection systems using these devices must have a water supply at a pressure high enough to compensate for this loss. See Table 1 for friction losses.

Approved *double check valve assemblies* (DCVA), properly installed and maintained, can also provide protection against backflow. However, their acceptance by health authorities varies considerably. Permission for their use depends upon the evaluation of the health hazard. These devices are usually considered by health authorities to provide minimum protection against backflow. Friction loss in double check valve assemblies is generally somewhat less than that in reduced pressure principle backflow prevention assemblies.

There is generally no accepted standard practice for the protection of potable water supplies from non-potable supplies. The majority of local and state health agencies accept backflow prevention assemblies approved by either the Foundation for Cross-Connection Control & Hydraulic Research of the University of Southern California (FCCCHR of USC) or the American Society of Sanitary Engineering (ASSE). Some cities or states may have their own plumbing testing laboratories where backflow prevention assemblies are tested and approved for use within their jurisdiction. Many local and state agencies also have adopted the AWWA Manual M14 as a means of determining the need, if any, of cross-connection control assemblies for fire protection systems.

The pertinent section on fire protection in this AWWA manual is:

Industrial fire protection systems consist of sprinklers, hose connection(s) and hydrants. Sprinkler systems may be dry or wet, open or closed. Systems may be designed for protection of ignitable liquids and other hazardous processes. It is standard practice, especially in cities, to equip automatic sprinkler systems with fire department pumper connections.

For cross connection control, fire protection systems may be classified on the basis of water source and arrangement of supplies as follows:

Class 1. Direct connections from public water mains only; no pumps, tanks, or reservoirs; no physical connection from other water supplies; no antifreeze or other additives of any kind; all sprinkler drains discharging to atmospheres, dry wells, or other safe outlets.

Class 2. Same as Class 1, except that booster pumps may be installed in the connections from the street mains. (Booster pumps do not affect the potability of the system; it is necessary, however, to avoid drafting so much water that pressure in the water main is reduced below 10 psi.)

Class 3. Direct connection from public water supply mains plus one or more of the following: elevated storage tanks; fire pumps taking suction from above-ground covered reservoirs or tanks; and pressure tanks. (All storage facilities are filled or connected to public water only, the water in the tanks is to be maintained in a potable condition. Otherwise, Class 3 systems are the same as Class 1.)

Class 4. Directly supplied from public mains similar to Class 1 and Class 2, with an auxiliary water supply on or available to the premises; or an auxiliary supply may be located within 1700 ft (m) of the pumper connection.

Class 5. Directly supplied from public mains, and interconnected with auxiliary supplies, such as: pumps taking suction from reservoirs exposed to contamination, or from rivers and ponds; driven wells, mills or other industrial water systems; or where antifreeze or other additives are used.

Class 6. Combined industrial and fire protection systems supplied from the public water mains only, with or without gravity storage or pumps suction tanks.

Class 1 and 2 fire protection systems will generally not require backflow protection at the service connection. Pumper connections of automotive fire department equipment to street hydrants are not ordinarily health hazards.

Class 3 systems will generally require minimum protection (approved double check valve assemblies) to prevent stagnant waters from backflowing into the public potable water system.

Class 4 systems will normally require backflow protection at the service connection. The type (air gap, reduced-pressure backflow-prevention assembly, or double check valve assembly) will generally depend on the quality of the auxiliary supply.

Class 4 and 5 systems normally would need maximum protection (air gap or reduced pressure principle backflow prevention assembly), to protect the public potable water system.

Class 6 system protection would depend on the requirements of both industry and fire protection, and can only be determined by a survey of the premises.

A meter (compound, detector check) should not normally be permitted as part of a backflow protection assembly. An exception may be made if the meter and backflow prevention assembly are specifically designed for that purpose.

4.0 REFERENCES

4.1 FM

Data Sheet 3-10, *Installation and Maintenance of Private Fire Mains and Their Appurtenances*.

4.2 Other

AWWA, Manual M14, *Recommended Practice for Backlfow Prevention and Cross Connection Control*.

There are no comparable NFPA standards.

APPENDIX A GLOSSARY OF TERMS

Approved: references to ‘‘Approved’’ in this data sheet means the product and services have satisfied the criteria for Factory Mutual Research Approval. Refer to the *Approval Guide* for a complete listing of products and services that are Factory Mutual Research Approved.

The AWWA Manual M14 defines certain common terms used in cross-connection work. Those pertinent to this data sheet follow:

Air gap (AG): the unobstructed vertical distance through free atmosphere between the lowest opening from any pipe or faucet conveying water or waste to a tank, plumbing fixture, receptor, or other assembly and the flood level rim of the receptacle. These vertical, physical separations must be at least twice the diameter of the water supply outlet, never less than 1 in. (25 mm). Local codes and regulations may have more stringent requirements.

Assembly: an assemblance of one or more approved body components and including approved shutoff valves.

Atmospheric pressure: the pressure exerted by the atmosphere at any point. Such pressure decreases as the elevation of the point above sea level increases. One atmosphere is equivalent to 14.7 psi (101.4 kPa) 29.92 in. (760 mm) of mercury, or 33.9 ft (10.1 m) of water column at average sea level.

Atmospheric vacuum breaker (AVB): the AVB consists of a float check, a check seat, and an air inlet port. A shutoff valve immediately upstream may be an integral part of the assembly. The AVB is designed to allow air to enter the downstream water line to prevent back-siphonage. This unit may never be subjected to a backpressure condition or have a downstream shutoff valve, or be installed where it will be in continuous operation for more than 12 hours.

Auxiliary water supply: any water supply on or available to the premises other than the purveyor’s approved public water supply. These auxiliary waters may include water from another purveyor’s public potable water supply or any natural source(s), such as a well, lake, spring, river, stream, harbor, and so forth; or used waters or industrial fluids. These waters may be contaminated or polluted or they may be objectionable and constitute an unacceptable water source over which the water purveyor does not have sanitary control.

Backflow: the undesirable reversal of flow into a potable water distribution system as a result of a cross connection.

Backflow preventer: an assembly or means that prohibits the backflow of water into the potable water supply.

Backpressure: a pressure, higher than the supply pressure, caused by a pump, elevated tank, boiler, air/steam pressure, or any other means, which may cause backflow.

Back-siphonage: backflow caused by negative or reduced pressure in the supply piping.

Certified backflow-prevention assembly tester: a person who is certified by the approving authority to test, repair, and maintain backflow prevention assemblies.

Consumer: the owner or operator having a service from a public potable water system.

Contamination: an impairment of a potable water supply by the introduction or admission of any foreign substance that degrades the quality and creates a health hazard.

Critical level: a reference line representing the level of the check valve seat within a back-siphonage control unit. It is used to establish the height of the unit above the highest outlet or flood level rim.

Cross connection: a connection or a potential connection between any part of a potable water system and any other environment containing other substances in a manner that, under any circumstances, would allow such substances to enter the potable water system. ‘‘Other’’ substances may be gases, liquids, or solids, such as chemicals, water products, steam, water from other sources (potable or nonpotable), or any matter that may change the color or add odor to the water.

Bypass arrangements, jumper connections, removable sections, swivel or changeover assemblies, or any other temporary or permanent connecting arrangement through which backflow may occur are considered to be cross connections.

Double check valve assembly (DCVA): an assembly composed of two independently acting, approved check valves, including tightly closing resilient-seated shutoff valves located at each end of the assembly and fitting with properly located resilient-seated test cocks. This assembly shall only be used to protect against a nonhealth hazard (that is, a pollutant).

Effective opening: the minimum cross-sectional area at the point of water supply discharge, measured or expressed in terms of the diameter of a circle, or if the opening is not circular, the diameter of a circle of equivalent cross-sectional area.

Flood level rim: the level from which liquid in plumbing fixtures, appliances, or vats could overflow onto the floor, when all drain and overflow openings built into the equipment are obstructed.

Health hazard: a cross connection or potential cross connection involving any substance that could, if introduced into the potable water supply, cause death, illness, or spread disease, of have a high probability of causing such effects.

Internal isolation: fixture isolation and/or isolation of an area or zone. Isolation at the fixture means installing an approved backflow preventer at the source of the potential contamination. Area or zone isolation is confining the potential source of contamination to a specific area.

Nonhealth hazard: a cross connection or potential cross connection involving any substance that generally would not be a health hazard but would constitute a nuisance, or be aesthetically objectionable, if introduced into the potable water supply.

Pollution: the presence of any foreign substance in water that tends to degrade its quality so as to constitute a nonhealth hazard or impair the usefulness of the water.

Potable water: water that is safe for human consumption as described by the public health authority having jurisdiction.

Premises isolation: preventing backflow into a public water system from a user’s premises by installing a suitable backflow preventer at the user’s connection.

Pressure vacuum breaker assembly (PVB): an assembly consisting of an independently operating internally loaded check valve, an independently operating loaded air inlet valve located on the discharge side of the check valve, with properly located resilient-seated test cocks and tightly closing resilient-seated shutoff valves attached at each end of the assembly designed to operate under pressure for prolonged periods of time to prevent back-siphonage. The pressure vacuum breaker may not be subjected to any backpressure.

Reduced-pressure principle backflow-prevention assembly (RPBA): the approved reduced-pressure principle backflow-prevention assembly consists of two independently acting approved check valves together with a hydraulically operating, mechanically independent pressure differential relief valve located between the check valves and below the first check valve. These units are located between two tightly closing resilient-seated shutoff valves as an assembly and are equipped with properly located resilient-seated test cocks.

Service connection: a piping connection between the water purveyor’s main and a user’s system.

Water purveyor: the owner or operator of a public potable waterworks system.

APPENDIX B DOCUMENT REVISION HISTORY

This document does not have any revision history.

APPENDIX C REDUCED PRESSURE PRINCIPLE ASSEMBLIES

C.1 Description

The assembly consists of two internally loaded check valves operating in series and a spring-loaded diaphragm-actuated differential pressure relief valve, connected to the zone between the check valves. These components may or may not all be incorporated in one body casting. Two tightly closing resilient seat Approved indicating gate valves and four test cocks complete the assembly.

Leakage through one or both check valves or the relief valve is indicated by the discharge of water from the relief valve port. From the backflow prevention standpoint, this factor is an advantage over the double check valve assembly.

C.2 Operation

The reduced pressure principle assemblies operate on the principle that water will not flow from a zone of lower pressure to one of higher pressure.

Normal (Fig. 1). The check valves remain closed until there is a demand for water. When passing through the upstream check valve, the water is reduced in pressure by a predetermined amount. The differential pressure relief valve remains in a closed position because of the differential between the supply pressure and reduced pressure within the zone between the check valves. The second check valve is lightly loaded, and remains open as water flows through the device in the normal direction.

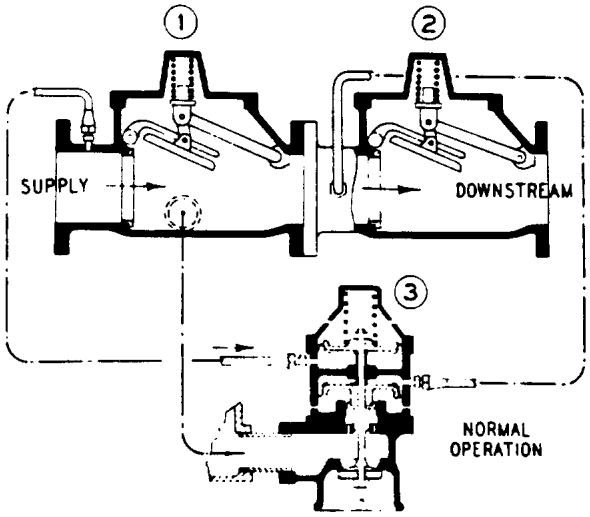

Fig. 1. Operation of reduced pressure principle device under normal conditions. Approved indicating gate valves not shown for clarity.

Backpressure (Fig. 2). In the event pressure increases downstream of the device, tending to reverse the direction of water flow, both check valves close to prevent backflow. If the downstream check valve is

prevented from closing tightly, leakage back into the zone between the check valves increases the zone pressure to within a few pounds of the supply pressure. The differential pressure relief valve will open and water will be discharged to atmosphere. The relief valve operates automatically to maintain pressure within the zone between the check valves lower than the supply pressure.

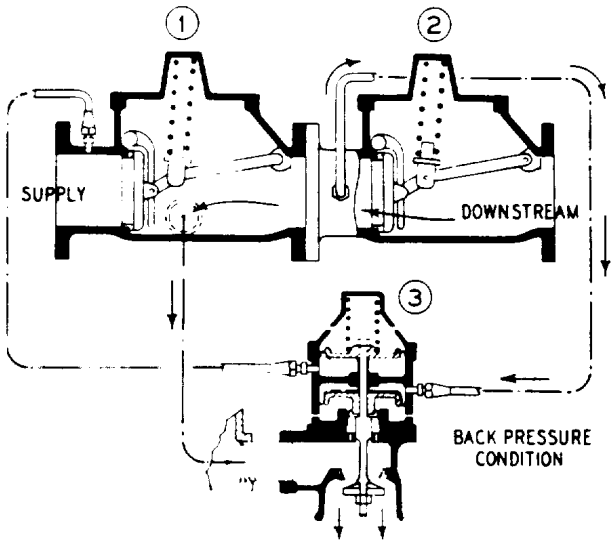

Fig. 2. Operation of reduced pressure principle device under back-pressure condition. Approved indicating gate valves not shown for clarity.

Back-Siphonage (Fig. 3). In the event the supply pressure drops to cause a back siphonage condition, both check valves close to prevent backflow. The differential pressure relief valve opens automatically and drains enough water to atmosphere to maintain pressure in the zone between the check valves lower than the supply pressure.

When the supply pressure drops below the minimum pressure required to close the differential pressure relief valve, pressure in the zone will be 0 psi (0 kPa, 0 bar) if the leakage through the downstream check valve is less than the capacity of the relief valve.

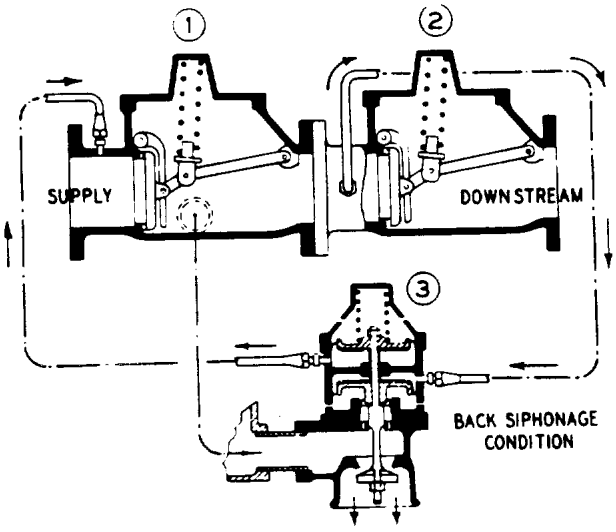

Fig. 3. Operation of reduced pressure principle device under back siphonage condition. Approved indicating gate valves not shown for clarity.

C.3 Testing

Test Equipment

1 – Differential Pressure Gauge, 0-15 psi (0-103 kPa, 0-1.03 bar) range.

3 – 6 ft (1.8m) length rubber hoses with ¼in. (6mm) watertight screw couplings. (¼in. [6mm] I.D. welding hose is suggested.)

6 – ¼in. (6mm) I.P. thread to welding hose thread couplings. (Sometimes called regulator outlet fittings.)

4 – ¼in. (6mm) valves, brass, needle-type.

2 – ¼in. (6mm) brass tees.

2 – ¼in. (6mm) brass close nipples.

1 – Mounting board or box.

NOTES:
[1] Additional fittings or bushings may be added if test cocks are not ¼ in. (6 mm) in size.
[2] Factory-assembled test kits are currently available on the market.

Test No. 1. To test operation of the differential pressure relief valve. The differential pressure relief valve should operate to maintain the pressure within the zone between the two check valves at least 2 psi (14 kPa, 0.14 bar) less than the supply pressure.

a. Open each test cock individually to flush out sediment, scale, or trapped air. All test cocks and fittings should be tight.

b. Close control valve B.

c. Install bypass hose from test cock No. 2 through bypass valves to test cock No. 3 as shown in Figure 4.

d. Connect the ‘‘high’’ side of the differential pressure gauge to test cock No. 2 and the ‘‘low’’ side between the bypass valve on the bypass hose and test cock No. 3.

e. Open test cocks No. 2 and No. 3 and vent the gauge by opening the air vent valves.

f. Successively open the two bypass valves (the latter very slowly) until the differential pressure gauge needle starts to drop. Hold the valve at this position and observe gauge reading at the moment the first discharge is noted from the relief valve.

g. Close the bypass valves.

h. If the test indicates a malfunction of the relief valve repair it promptly.

Test No. 2. To test No. 1 check valve for tightness against reverse flow. Valve must be tight against reverse flow under all pressure differentials.

a. If the differential pressure relief valve is operating on reduced pressure, and there is no drainage from it with control valve B closed, No. 1 check valve is "closed tight". If there is drainage from the differential pressure relief valve, the No. 1 check valve is leaking.

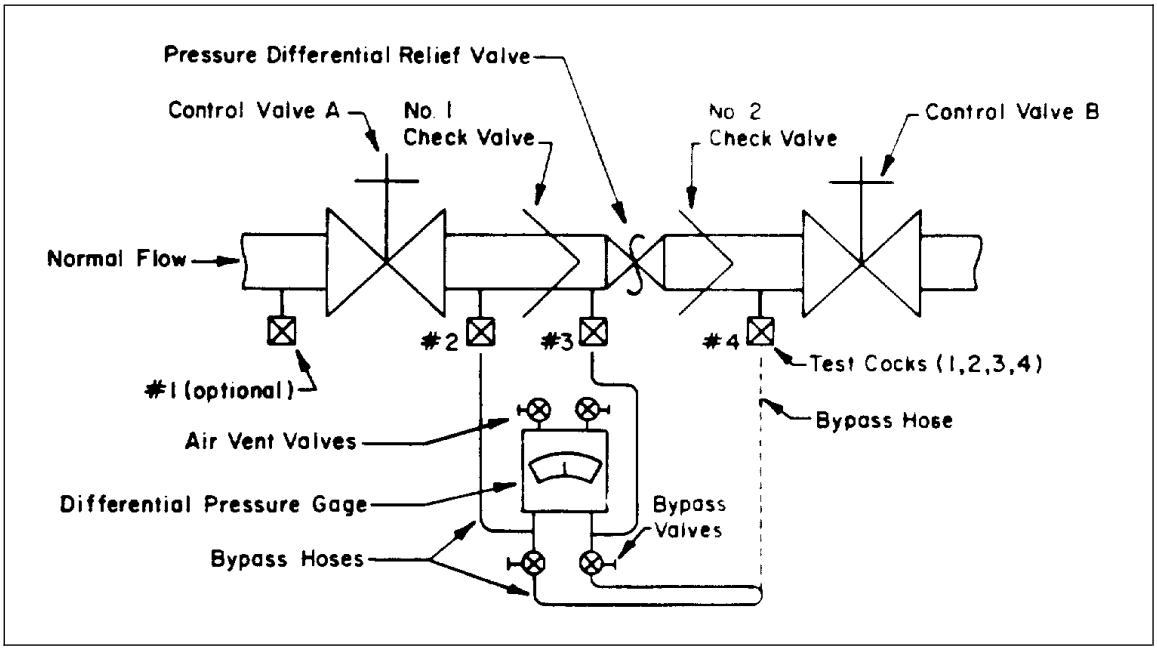

Fig. 4. Diagrammatic sketch of reduced pressure principle backflow prevention device with test setup. (Equipment shown ready to be attached for Test Nos. 1 and 2. Dashed bypass hose position shows arrangement for Test No. 3.)

Test No. 3. To test No. 2 check valve for tightness against reverse flow. Valve must be tight against reverse flow under all pressure differentials.

a. Bypass the No. 2 check valve by installing a bypass hose from test cock No. 2 through a bypass valve to test cock No. 4.

b. Open test cocks No. 2 and No. 4 and the bypass valve. If there is drainage from the differential pressure relief valve, the No. 2 check valve is leaking.

REMOVE ALL TEST EQUIPMENT AND RETURN THE CONTROL VALVES TO THE OPEN POSITION.

If tests No. 2 or No. 3 indicate that the check valves are leaking, investigate the condition of the differential pressure relief valve before attempting to repair the check valves.

APPENDIX D DOUBLE CHECK VALVE ASSEMBLIES

D.1 Description

A double check valve assembly consists of an assembly of two independently acting, internally loaded check valves mounted in series with two tightly closing resilient seat Approved indicating gate valves and four test cocks. Some assemblies are approved with a metered bypass line also equipped with double check valves. These assemblies are commonly called double check-detector check assemblies, and are used where backflow prevention is required in conjunction with metering of low flows.

D.2 Operation

The prevention of backflow depends solely on the proper operation of at least one of the independently acting check valves. It is unusual to find one of the check valves in a leaky condition, and it is highly improbable that both check valves in one set would be found in a leaky condition simultaneously.

D.3 Testing

Test Equipment

2 – Pressure gauges, good quality, recalibration feature, 4-½in. (114 mm) dial, calibrated in 1 or 2 psi (7 or 14 kPa, 0.07 or 0.14 bar) increments, highest reading about twice the expected maximum water line pressure (160 psi [1100 kPa, 11.0 bar]).
3 – 6ft (1.8m) lengths rubber hose with ¼in. (6mm) watertight screw couplings (¼in. [6mm] I.D. welding hose is suggested).
2 – ¼ in. (6mm) valves, brass, needle type.
2 – ¼ in. (6mm) galvanized tees.
2 – ¼ in. (6mm) galvanized close nipples.
6 – ¼ in. (6mm) I.P. thread to welding hose thread couplings. Required when welding hose fittings are used.
1 – Mounting board or box.

Preliminary Steps:

a. All test cocks and fittings must be absolutely tight. Small leaks may give false indications and make accurate testing difficult.

b. Open each test cock individually to flush out sediment, scale, or trapped air.

c. Close control valves A and B. If valves work hard, back up two or three turns and reclose. When this is down, some distance should be gained. Repeat until no further movement results.

d. With both control valves closed, open test cocks No. 2 and No. 4 successively. If the rate of flow continues, control valves A and/or B are leaking.

e. Close test cocks and carry out the control valve flushing procedures appearing at the end of this section before continuing.

Test No. 1. To test No. 1 check valve for tightness against reverse flow. Valve must be tight against reverse flow under all pressure differentials.

a. After preliminary steps are completed, reopen control valve A leaving control valve B closed.

b. Install pressure gauges and control cocks (closed) at test cocks No. 2 and No. 3.

c. Blow out the control cocks under the gauges to ensure clear connections.

d. Open test cocks No. 2 and No. 3. Close control valve A.

e. Drain slowly from control cock at test cock No. 2 until the gauge at test cock No. 2 reads 2 psi (14 kPa, 0.14 bar) less than the gauge at test cock No. 3. Close the control cocks. If the gauges hold the established differential pressure, the check valve is not leaking. If gages drop simultaneously (no differential maintained), the check valve is leaking.

Verification of a leaking check valve may be made as follows:

a) Adjust the pressure within the backflow device to be about 10 psi (69 kPa, 0.69 bar) less than the supply pressure by draining from a control cock.

b) Install a bypass hose between the No. 1 test cock and the control cock (shut) at the gauge on the No. 3 test cock.

c) Slowly open both control cocks simultaneously. If the gauges show that a greater pressure differential is created, then the check valve is tight. If a continuous flow of water occurs from the control cock at test cock No. 2, and a pressure differential is not maintained, the check valve is leaking.

Test No. 2. To test No. 2 check valve for tightness against reverse flow. Valve must be tight against reverse flow under all pressure differentials.

a. Open control valve A and re-establish pressure in the device.

b. Install pressure gauges and control cocks on test cocks No. 3 and No. 4.

c. Open test cocks No. 3 and No. 4. Close control valve A.

d. Drain slowly from the control cock at test cock No. 3 until the gauge at test cock No. 3 reads 2 psi (14 kPa, 0.14 bar) less than the gauge at test cock No. 4. Close the control cock. If the gauges hold the established differential pressure, the check valve is not leaking. If the gauges drop simultaneously (no differential maintained), the check valve is leaking.

Verification of a leaking check valve may be made as follows:

a) Adjust the pressure within the backflow device to be about 10 psi (69 kPa, 0.69 bar) less than the supply pressure by draining from a control cock.

b) Install a bypass hose between test cock No. 1 and the control cock (shut) at the gauge on test cock No. 4. Open test cock No. 1.

c) Slowly open both control cocks simultaneously. If the gauges show that a greater pressure differential is created, the check valve is tight. If a continuous water flow occurs from the control cock at test cock No. 3, and a pressure differential is not maintained, the check valve is leaking.

Control Valve Flushing Procedure.

Open control valves A and B (Fig. 5). Operate the yard valves to cause the entire flow to pass through valves A and B when a yard hydrant is open. Open a yard hydrant and gradually close control valve A. When the valve is nearly shut, the rapid flow of water over the seat of valve A should sweep clear any obstructing material from under the valve disk, and permit it to close tightly. Next open valve A and repeat for valve B so as to have both valves clear. After cleaning, reopen both valves A and B and shut off the hydrant, restoring system pressure to normal. Open any division valves closed while flushing valves A and B. Repeat steps c and d under Testing, Preliminary Steps. If valves cannot be cleared by flushing, overhaul may be necessary in order to obtain a proper test of the double check valves.

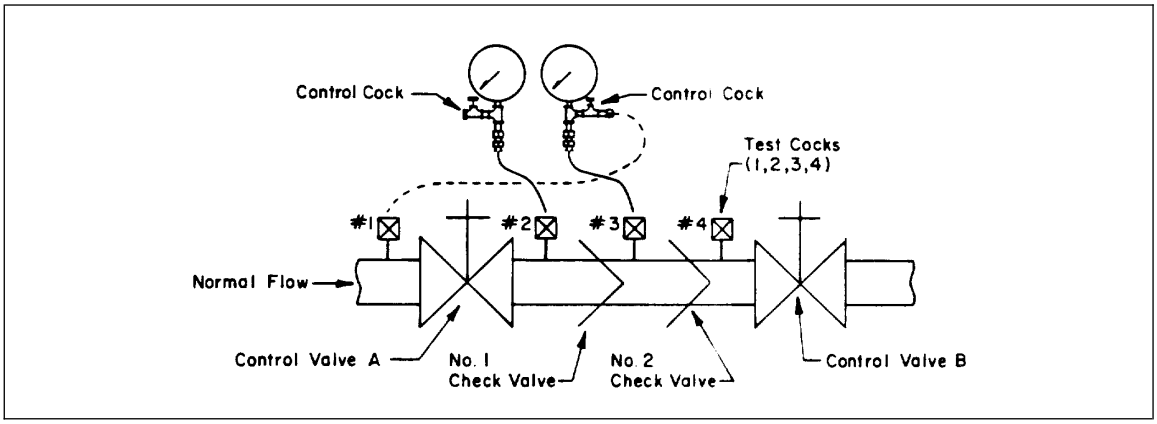

Fig. 5. Diagrammatic sketch of double check valve assembly with test setup.
(Equipment shown ready to connect for Test No. 1. Dotted bypass hose location is for verification test.)