How To Select Liquid Flow Switches

1. What function will the flow switch perform?
McDonnell & Miller Flow Switches are equipped with either one or two SPDT switches except for Model FS7-4A (Pneumatic). They can make or break an electrical circuit when flow starts or when flow stops, and can be used to:

- Actuate a signal when flow stops
- Start a motor with flow
- Shut off an alarm when flow is adequate
- Stop a motor with no flow

2. Size of pipe
McDonnell & Miller Flow Switches may be used on pipe sizes 1/2" - 36" NPT.

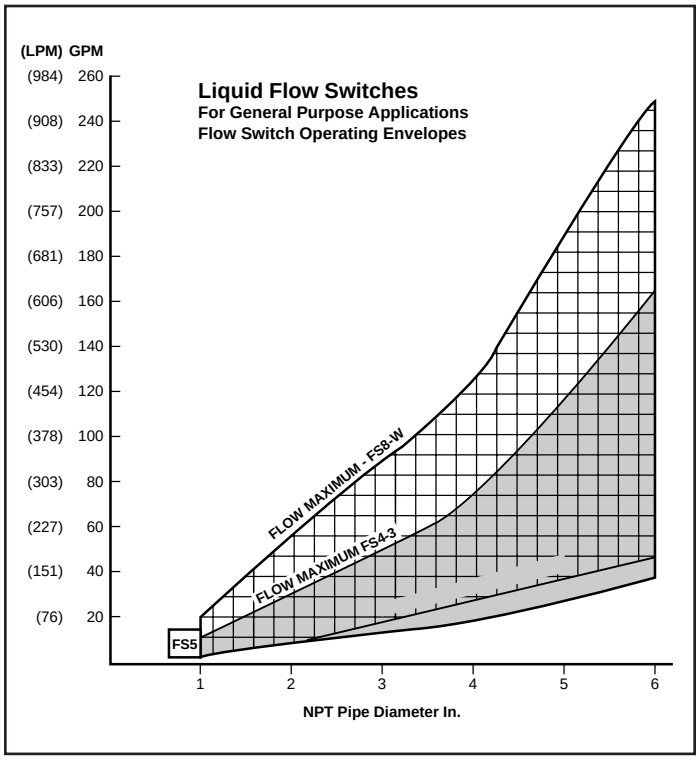
3. How much flow is present?
The flow rate at which the flow switch is to respond should be determined next. McDonnell & Miller Flow Switches are actuated (make or break) with an increase in flow. The term "Flow" represents the actual movement (velocity) of liquid within a pipe sufficient to actuate the switch. The term "No-Flow" represents a decrease in velocity, or total flow stoppage, which will permit the switch to return to its original position. **IMPORTANT:** In operation, the switch must be actuated by "Flow" before it can be reversed again by "No-Flow". All McDonnell & Miller Flow Switches can easily be adjusted in the field to require a higher actuating "Flow" or "No-Flow".

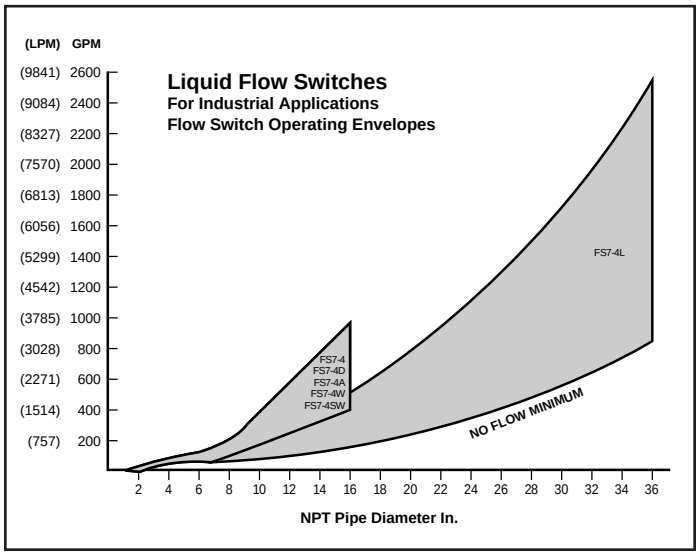
4. Maximum liquid pressure in pipe
The maximum pipeline pressure should be considered when selecting a particular model. Different flow switch models can accommodate a range of pipeline pressures up to 1000 psi (70kg/cm^2).

5. Maximum temperature
Determine the liquid and ambient atmospheric temperature when selecting the flow switch model. Various McDonnell & Miller Flow Switches can be used at ambient temperatures from 32°F (0°C) and liquid temperatures up to 300°F (149°C). If ambient temperatures are lower than 32°F (0°C) use the FS7-4W.

6. Type of liquid
McDonnell & Miller Flow Switch models have wetted parts of brass, monel or stainless steel. Depending on the particular model they may be used with water, certain light viscous fluids, some oils, various caustic solutions and other fluids.

7. Atmosphere surrounding flow switch
It should be determined if the location will be subject to high humidity, weather conditions or explosive atmospheres. Standard, water tight and hazardous duty flow switch models are available.





NOTE: DO NOT USE LIQUID FLOW SWITCHES ON SYSTEMS WITH FLOW GREATER THAN 10 FEET (3M) PER SECOND.

8. Incompressible fluids

Fluid flow within a pipe contains both laminar and turbulent flow. The desired placement of any flow switch is in the more predictable laminar flow regions. Turbulent flow is unpredictable, can cause false indications of flow speed and can cause damage to the flow sensing device. An obstruction of flow such as an elbow, fitting or inlet generates a turbulent wave or wake. For that reason placement is recommend at least 5 pipe diameters downstream for liquid flow switches.

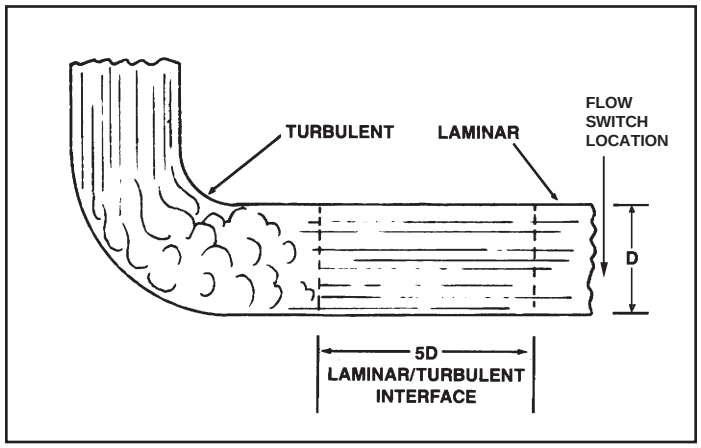
In any flow problem, the flow rate in either feet per second (fps) or gallons per minute (gpm) must be established. For your convenience, we have provided the formulas for determining flow in your application. Use the table (below right) to quickly determine the inside area of standard pipes. For nonstandard pipe schedules, determine the inside area by finding the inside diameter and applying the formula to the right.

Position of the Flow Switch

Installing the flow switch in a horizontal run of pipe is recommended. However because of space limitations, the only available installation may be in a vertical section of pipe. The Series FS4-3, FS8-W and FS5 may be used in this situation as they will generally operate satisfactorily when installed in a vertical pipe with either upward or downward flow (upward flow is preferable) **PROVIDED THERE IS NO UNUSUAL AMOUNT OF DIRT OR SEDIMENT IN THE WATER.**

Flow rates required to actuate the Series FS4-3, FS8W and FS5 are not available for vertical pipe installation. A “factory adjusted” flow switch normally does not require any field adjustment for upward or downward flow. But to make sure, it is advisable to hold flow switch in position to be installed and check for “no flow” switch operation by hand operation of the paddle.

The Series FS7-4, FS6, and FS1 must be mounted on upperside of horizontal pipe. These units will not operate properly on a vertical pipe.



Formulas

Area = $D^2\pi/4$
D = Inside Diameter
π = 3.14

Formula for large pipe, higher velocities

1. Velocity in ft. per sec. (FPS) = $\dfrac{\text{GPM x 0.321}}{\text{Pipe Area in sq. in.}}$

Example: With a flow of 1200 GPM through an 8" pipe, determine velocity.

Velocity = $\dfrac{1200 \times 0.321}{50.0}$ or 7.7 ft. per sec.

2. GPM = $\dfrac{\text{Velocity in ft. per sec. x Pipe Area sq. in.}}{0.321}$

Example: With a flow of 6.5 ft. per sec. through a 10" pipe, determine GPM.

GPM = $\dfrac{6.5 \times 78.9}{0.321}$ or 1600 GPM

3. LPM = Liters per Minute

Velocity in meters per sec. (MPS) = $\dfrac{\text{LPM x .163}}{\text{Pipe Area in cm}^2}$

LPM = $\dfrac{\text{Velocity in meters per sec. x Pipe Area in cm}^2}{.163}$

GPM = LPM x .264 LPM = $\dfrac{\text{GPM}}{.264}$

Nominal Standard Pipe Size in.	Pipe Schedule No.	Inside Area Sq. in. (cm^2) “A”	
1/2	40	.304	(1.96)
3/4	40	.533	(3.44)
1	40	.864	(5.57)
1 1/4	40	1.496	(9.65)
1 1/2	40	2.036	(13.14)
2	40	3.36	(21.68)
2 1/2	40	4.79	(30.90)
3	40	7.39	(47.68)
3 1/2	40	9.89	(63.81)
4	40	12.73	(82.13)
5	40	20.01	(129)
6	40	28.89	(186)
8	40	50.0	(322)
10	40	78.9	(509)
12	30	113.1	(730)
14	30	137.9	(890)
16	30	182.6	(1181)

Liquid Flow Switch Specification Chart

General Purpose Applications															
Model Number	Use on NPT Pipe Sizes	Connection		Wetted Parts						Maximum Pressure		Fluid Temperature °F (°C)		Minimum Ambient Temp.°F (°C)	Switch Enclosure
	in.	NPT	BSPT	Brass	Stainless Steel	Monel	Buna N	Viton	Solder	psi	kg/cm²	Min.	Max.		
FS4-3[2]	1-6	•		•	•	•			•	160	11.3	32 (0)	300 (149)	32 (0)	General Purpose
FS4-3D[1,2]	1-6	•		•	•	•			•	160	11.3	32 (0)	300 (149)	32 (0)	General Purpose
FS4-3J[2]	1-6		•	•	•	•			•	160	11.3	32 (0)	300 (149)	32 (0)	General Purpose
FS4-3RP[2]	1-6	•		•	•	•			•	160	11.3	32 (0)	300 (149)	32 (0)	General Purpose
FS4-3S[2]	1-6	•			•	•			•	160	11.3	32 (0)	300 (149)	32 (0)	General Purpose
FS5-3/4	3/4	•		•			3			150	10.5	32 (0)	250 (121)	32 (0)	General Purpose
FS5-1	1	•		•			3			150	10.5	32 (0)	250 (121)	32 (0)	General Purpose
FS5-D-3/4[1]	3/4	•		•			3			150	10.5	32 (0)	250 (121)	32 (0)	General Purpose
FS5-D-1[1]	1	•		•			3			150	10.5	32 (0)	250 (121)	32 (0)	General Purpose
FS5-J-1	1		•	•			3			150	10.5	32 (0)	250 (121)	32 (0)	General Purpose
FS5-DJ-3/4[1]	3/4		•	•			3			150	10.5	32 (0)	250 (121)	32 (0)	General Purpose
FS5-S-1	1	•			•		•			150	10.5	32 (0)	225 (107)	32 (0)	General Purpose
FS5-DS-1[1]	1	•			•		•			150	10.5	32 (0)	225 (107)	32 (0)	General Purpose
FS8-W	1-6	•		•	•	•			•	160	11.3	32 (0)	225 (107)	32 (0)	NEMA 4-X
FS8-WJ	1-6		•	•	•	•			•	160	11.3	32 (0)	225 (107)	32 (0)	NEMA 4-X
High Sensitivity Applications															
FS6-3/4	3/4	•		•				•		100	7	32 (0)	225 (107)	32 (0)	General Purpose
FS6-1	1	•		•				•		100	7	32 (0)	225 (107)	32 (0)	General Purpose
FS6-J-3/4	3/4		•	•				•		100	7	32 (0)	225 (107)	32 (0)	General Purpose
FS6-J-1	1		•	•				•		100	7	32 (0)	225 (107)	32 (0)	General Purpose
FS6-W-3/4	3/4	•		•				•		100	7	32 (0)	225 (107)	32 (0)	NEMA 4-X
FS6-W-1	1	•		•				•		100	7	32 (0)	225 (107)	32 (0)	NEMA 4-X
FS6-WJ-3/4	3/4		•	•				•		100	7	32 (0)	225 (107)	32 (0)	NEMA 4-X
FS6-WJ-1	1		•	•				•		100	7	32 (0)	225 (107)	32 (0)	NEMA 4-X
FS1	1/2	•		•	•			•		100	7	32 (0)	225 (107)	32 (0)	General Purpose
FS1-J	1/2		•	•	•			•		100	7	32 (0)	225 (107)	32 (0)	General Purpose
FS1-W	1/2	•		•	•			•		100	7	32 (0)	225 (107)	32 (0)	NEMA 4-X

1 "D" Denotes 2 SPDT Switches
2 With reinforced Stainless Steel paddle
3 Ethylene-Propylene Elastomer
4 Brazed
NEMA 4X flow switches are water tight, dust tight and corrosion resistant
NEMA7, 9 flow switches are rated for hazardous duty

NOTE: DO NOT USE LIQUID FLOW SWITCHES ON SYSTEMS WITH FLOW GREATER THAN 10 FEET (3M) PER SECOND.

Liquid Flow Switch Specification Chart (continued)

Industrial/Heavy Duty Applications														
Model Number	Use on NPT Pipe Sizes	Connection		Wetted Parts					Maximum Pressure		Fluid Temperature °F (°C)		Minimum Ambient Temp.°F (°C)	Switch Enclosure
	in.	NPT	BSPT	Brass	Stainless Steel	Bronze	Teflon	Solder	psi	kg/cm²	Min.	Max.		
FS7-4	1¼ - 16	•		•	•	•	•	4	300	21	32 (0)	300 (149)	32 (0)	General Purpose
FS7-4A	1¼ - 16	•		•	•	•	•	4	300	21	32 (0)	300 (149)	32 (0)	General Purpose
FS7-4D[1]	1¼ - 16	•		•	•	•	•	4	300	21	32 (0)	300 (149)	32 (0)	General Purpose
FS7-4E	1¼ - 16	•		•	•	•	•	4	300	21	32 (0)	300 (149)	32 (0)	NEMA 7, 9
FS7-4EJ	1¼ - 16		•	•	•	•	•	4	300	21	32 (0)	300 (149)	32 (0)	NEMA 7, 9
FS7-4EL	8 - 32	•		•	•	•	•	4	300	21	32 (0)	300 (149)	32 (0)	NEMA 7, 9
FS7-4ELJ	8 - 32		•	•	•	•	•	4	300	21	32 (0)	300 (149)	32 (0)	NEMA 7, 9
FS7-4J	1¼ - 16		•	•	•	•	•	4	300	21	32 (0)	300 (149)	32 (0)	General Purpose
FS7-4DJ[1]	1¼ - 16		•	•	•	•	•	4	300	21	32 (0)	300 (149)	32 (0)	General Purpose
FS7-4L	8 - 32	•		•	•	•	•	4	300	21	32 (0)	300 (149)	32 (0)	General Purpose
FS7-4LJ	8 - 32		•	•	•	•	•	4	300	21	32 (0)	300 (149)	32 (0)	General Purpose
FS7-4S	1¼ - 16	•			•		•	4	1000	70	32 (0)	300 (149)	32 (0)	General Purpose
FS7-4DS[1]	1¼ - 16	•			•		•	4	1000	70	32 (0)	300 (149)	32 (0)	General Purpose
FS7-4SE	1¼ -16	•			•		•	4	1000	70	32 (0)	300 (149)	32 (0)	NEMA 7, 9
FS7-4SEJ	1¼ - 16		•		•		•	4	1000	70	32 (0)	300 (149)	32 (0)	NEMA 7, 9
FS7-4SJ	1¼ - 16		•		•		•	4	1000	70	32 (0)	300 (149)	32 (0)	General Purpose
FS7-4SDJ	1¼ - 16		•		•		•	4	1000	70	32 (0)	300 (149)	32 (0)	General Purpose
FS7-4SW	1¼ - 16	•			•		•	4	1000	70	-65 (-54)	300 (149)	-65 (-54)	NEMA 4-X
FS7-4SWJ	1¼- 16		•		•		•	4	1000	70	-65 (-54)	300 (149)	-65 (-54)	NEMA 4-X
FS7-4W	1¼ -16	•		•	•	•	•	4	300	21	-65 (-54)	300 (149)	-65 (-54)	NEMA 4-X
FS7-4WJ	1¼ - 16		•	•	•	•	•	4	300	21	-65 (-54)	300 (149)	-65 (-54)	NEMA 4-X
FS7-4WL	8 - 32	•		•	•	•	•	4	300	21	-65 (-54)	300 (149)	-65 (-54)	NEMA 4-X
FS7-4WLJ	8 - 32		•	•	•	•	•	4	300	21	-65 (-54)	300 (149)	-65 (-54)	NEMA 4-X

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Flow Velocities

Gallons Per Minute (GPM)

Velocity FPS	Pipe Size (NPT)											
	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	3 1/2"	4"	5"	6"
	GPM											
.2	.19	.33	.54	.94	1.27	2.1	3.0	4.8	6.2	7.9	12.5	18
.4	.38	.66	1.08	1.88	2.54	4.2	6.0	9.6	12.4	15.8	25.0	36
.6	.57	.99	1.62	2.92	3.81	6.2	8.9	13.4	18.6	23.7	37.5	54
.8	.76	1.32	2.16	3.76	5.08	8.3	11.9	19.2	24.8	31.6	50.0	72
1.0	.95	1.66	2.70	4.70	6.30	10.5	14.9	23.0	30.8	39.7	65.4	90
1.5	1.42	2.50	4.05	7.10	9.48	15.8	22.4	34.5	46.2	59.6	98.1	135
2.0	1.89	3.32	5.40	9.40	12.6	21.0	29.8	46.0	61.6	79.4	131	180
2.5	2.37	4.16	6.75	11.8	15.8	26.3	37.3	57.5	77.0	99.3	164	225
3.0	2.84	4.94	8.10	14.1	19.0	31.5	44.7	69.0	92.4	119	196	270
3.5	3.31	5.82	9.45	16.5	22.1	36.8	52.2	80.5	108	139	229	315
4.0	3.78	6.65	10.8	18.8	25.3	42.0	59.6	92.0	123	159	262	360
4.5	4.26	7.48	12.2	21.2	28.4	47.3	67.1	104	139	179	294	405
5.0	4.74	8.32	13.5	23.5	31.6	52.5	74.5	115	154	199	327	450
6.0	5.68	9.99	16.2	28.2	37.9	63.0	89.4	138	185	238	392	540
7.0	6.62	11.61	18.9	32.9	44.2	73.5	104	161	216	278	458	630
8.0	7.56	13.32	21.6	37.6	50.5	84.0	119	184	246	318	523	720
9.0	8.52	15.02	24.3	42.3	56.8	94.5	134	207	277	357	589	810
10.0	9.48	16.62	27.0	47.0	63.0	105	149	230	308	397	654	900

Liters Per Minute (LPM)

Velocity MPS	Pipe Size (NPT)											
	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	3 1/2"	4"	5"	6"
LPM												
.06	.72	1.25	2.04	3.56	4.81	7.95	11.4	18.2	23.5	29.9	47.3	68.1
.12	1.44	2.5	4.09	7.12	9.61	15.9	22.7	36.3	46.9	60	94.6	136.2
.18	2.16	3.75	6.13	11.1	14.4	23.5	33.7	50.7	70.4	89.7	141.6	204.4
.24	2.88	5	8.18	14.2	19.2	31.4	45	72	93.9	119.6	189.2	272.5
.30	3.6	6.3	10.2	17.8	23.9	39.7	56.4	87	116.6	150.3	247.5	340.7
.46	5.4	9.5	15.3	26.9	35.9	59.8	84.8	130.6	174.9	225.6	371.3	511
.61	7.2	12.6	20.5	35.4	47.6	79.5	112.8	174.1	233.2	300.5	495.8	681.3
.76	9	15.8	25.6	44.7	59.8	99.6	141.2	217.6	291.5	375.9	620.8	851.6
.91	10.8	18.7	30.7	53.4	71.9	119.2	169.2	261.2	349.7	450.4	741.9	1021.9
1.07	12.6	22	35.8	62.5	83.7	139.3	197.6	304.7	408.8	526.1	866.8	1192.3
1.22	14.3	25.2	40.9	71.2	95.8	159	225.6	348.2	465.6	601.8	991.7	1362.6
1.37	16.1	28.3	46.2	81.2	107.5	179	254	393.6	526.2	677.5	1112.8	1532.9
1.52	17.9	31.5	51.1	89	119.6	198.7	282	435.3	582.9	752.2	1237.7	1703.3
1.83	21.5	37.8	61.3	106.7	143.5	238.5	338.4	522.3	700.2	900.8	1483.7	2043.9
2.13	25.1	43.9	71.5	124.5	167.3	278.2	393.6	609.4	817.6	1052.2	1733.5	2384.6
2.44	28.6	50.4	81.8	144.3	191.1	317.9	450.4	696.4	931.1	1203.6	1979.6	2725.2
2.74	32.3	56.9	92	160.1	215	357.7	507.2	783.5	1048.5	1351.3	2229.4	3065.3
3.05	35.9	62.9	102.2	177.9	238.5	397.4	564	870.6	1165.8	1502.7	2475.4	3406.5

Pressure Drop

PSI

Pipe Size NPT (in.)	Series	Flow Rate (GPM)															
		.2	.5	1.0	2.0	4.0	8.0	10.0	15.0	20.0	25.0	30.0	50.0	75.0	100.0	150.0	200.0
1/2	FS1	.26	.32	.47	.72	2.74	9.74	14.4									
3/4 & 1	FS6	.01	.02	.03	.04	.36	1.44	2.16	4.86	7.94	12.3						
3/4	FS5 3/4"				1.75	2.25	2.80	3.10									
1	FS5 1"				1.75	2.25	2.80	3.10									
1	FS4-3					.15	.32	.54	1.26	2.20							
1	FS8-W				.01	.05	.20	.33	.74	1.30							
1 1/4	FS7-4					.03	.08	.17	.39	.72							
2	FS7-4						.02	.02	.04	.09	.13	.19	.51	.90			
3	FS4-3									.01	.01	.02	.05	.10	.18	.40	.79
3	FS8-W									.01	.01	.02	.06	.10	.13	.17	.19
4	FS7-4												.01	.02	.03	.05	.06
6	FS7-4													.01	.01	.02	.02

Kg/cm²

Pipe Size NPT (in.)	Series	Flow Rate (LPM)															
		.76	1.89	3.79	7.57	15.1	30.3	37.9	56.8	75.7	94.6	113.6	189.3	283.9	378.5	567.8	757
1/2	FS1	.02	.02	.03	.05	.19	.68	1.01									
3/4 & 1	FS6	.001	.001	.002	.003	.025	.10	.15	.34	.56	.86						
3/4	FS5 3/4"				.12	.16	.20	.22									
1	FS5 1"				.12	.16	.20	.22									
1	FS4-3					.01	.02	.04	.09	.15							
1	FS8-W				.001	.004	.01	.02	.05	.09							
1 1/2	FS7-4					.002	.006	.01	.03	.05							
2	FS7-4						.08	.08	.15	.34	.49	.72	1.93	3.41			
3	FS4-3									.001	.001	.001	.004	.001	.001	.028	.055
3	FS8-W									.001	.001	.001	.004	.001	.009	.012	.013
4	FS7-4												.001	.001	.002	.004	.004
6	FS7-4													.001	.001	.001	.001

NOTE: DO NOT USE LIQUID FLOW SWITCHES ON SYSTEMS WITH FLOW GREATER THAN 10 FEET (3M) PER SECOND.