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**Pneumatic Division**
Richland, Michigan USA
*www.parker.com/pneumatics*

*(11-18-2011)*

## TEC DOCUMENTS

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**Pneumatic Division North America**
Richland, Michigan 49083

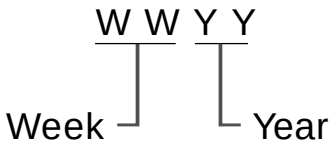
**TEC-1**
**Date Code System**

**ISSUED: January, 2003**
**Supersedes: December, 2000**

All components manufactured by the Pneumatic Division North America have date codes indicating their time of manufacture.

The date code consists of 4 numbers. The first 2 indicate the week of the year, the second 2 indicate the year (*Example:* 1501 indicates the 15th week of 2001).

Code letter may be stamped on the product, or appear on the product label.



**Pneumatic Division North America**
Richland, Michigan 49083

**TEC-4**
**Delrin/Celcon (Acetal)**
**Compatibility**

**ISSUED: October, 1998**
**Supersedes: March, 1991**

# CHEMICALS NOT COMPATIBLE WITH DELRIN/CELCON COMPOUNDS

- The generic name of these materials is acetal.
- Delrin is a Registered Trademark of E.I. DuPont.
- Celcon is a Registered Trademark of Celanese Corporation.

## CHEMICAL COMPOUNDS

ACETIC ACID
AMMONIUM HYDROXIDE
BUTYLAMINE
FORMIC ACID
HYDROCHLORIC ACID
HYDROGEN PEROXIDE
NITRIC ACID
PHENOL
PHOSPHORIC ACID
SODIUM BISULFITE
SODIUM HYDROXIDE
SODIUM HYPOCHLORITE
STANNOUS CHLORIDE
SULFURIC ACID

## COMMERCIAL PRODUCTS

ALKYLARYL SULFONATE (QUAKER)
DIANOL #11 CLEANER
IGEPAL - (HAIRWAVING & NEUTRALIZING SOLUTION)

NOTE: This is only a partial list of all harmful substances. Contact DuPont or Celanese Corporation for further information on acetal compatibility with other chemicals.

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**Pneumatic Division North America**
Richland, Michigan 49083

**TEC-13**
**General Guidelines and Rules of Thumb**

**ISSUED: November, 2006**
**Supersedes: October, 1998**

1. When to use Electric vs. Pneumatic vs. Hydraulic Power; if the required horsepower at the actuator or drive component is:
   0 to 1/4 HP ..... Use Electric Motors
   1/4 to 1-1/2 HP ..... Use Pneumatics
   1-1/2 and up HP .... Use Hydraulics

2. Compressor Capacity (HP) to Flow Capacity (SCFM) 1 HP $\simeq$ 4 SCFM.

3. A standard cubic foot of air is specified as 14.7 PSIA, at 68°F and 36% relative humidity to set conditions for air density and moisture content.

4. At sea level, atmospheric pressure is 14.696 PSIA, for every 1000 ft. in elevation gained, atmospheric pressure decreases by approximately 1/2 PSIA.

5. Receiver tank size should be sized at 3 times compressor output volume, so that the compressor is off twice as long as it is on.

6. Compressor to be sized for average flow demand, and the receiver tank sized to accommodate peak demand.

7. Air temperatures at compressor outlets can exceed 450°F. Hot air holds more moisture than cooler air. Relative humidity increase is proportional to compression factor. (Example: 36% relative humidity @ compressor inlet x 7.8:1 compression factor for 100 PSIG = 280% relative humidity @ outlet).

7A. Compressor Oils:
Varnish (tar) develops because hydrocarbon based oils break down at temperatures over 150°F. Synthetic oils (diester base) are sometimes used because they will not breakdown at temperature as readily, but they may not be compatible with other components in the system. Typically a New reciprocating compressor will pass 2 oz. of oil into the air stream. As the compressor wears, more oil will pass into the airstream. CAUTION: Diester based oils will cause a reaction with some common cleaning solvents (such as kerosine), fumes of which may be toxic or fatal.

8. Galvanized pipe should never be used in an air system. Reaction with oil residue causes electrolytic corrosion and will form sulfuric acid.

9. Solenoids (General)
   A. $\frac{\text{TIME OFF}}{\text{TIME ON}} \geq 3$ FOR STANDARD DUTY CYCLE
   Applications otherwise solenoid should be continuous duty cycle rated.

   B. Continuous Duty Pilots
   Continuous duty pilots are designed for applications where cycling is infrequent and the pilot is to be energized for indefinite periods of time . . . hours, days or weeks. Typical uses include fail-safe or emergency shutdown circuits where the pilot is to be energized and the valve open as long as the main control is "live" in order to shut off air to equipment in the event of power failure.

   Applications with pilot valves energized for ten (10) minutes or longer with a duty cycle greater than 70% are considered to be continuously energized.

   $$\text{Duty Cycle} = \frac{\text{Time energized}}{\text{Time energized + time off}} \times 100\% = \%\ \text{Duty Cycle}$$

   C. A solenoid can pull-in (complete magnetic field) in approximately .008 to .010 seconds depending upon mass of armature and strength of field.

   D. D.C. voltages are faster than A.C. voltages relative to solenoid pull-in time, because A.C. lags with sign-wave phase transition.

   E. D.C. voltage coils may experience up to 2-1/2 times the life of A.C. voltage coils.

   F. M.O.P.D. stands for Maximum Operating Pressure Differential.

   Example:

   If inlet ($P_1$) = 100 PSIG and
   the outlet ($P_2$) = 0 PSIG,
   Then the M.O.P.D. is 100 - 0 = 100
   If ($P_1$) = 100 PSIG and ($P_2$) = 80 PSIG,
   Then M.O.P.D. = 20 PSIG

   M.O.P.D. must be calculated to insure proper orifice size and maximize flow.

   G. Coil designs generally allow a +10%, -15% of rated voltage.

   Mobile coil designs generally allow a +25%, -30% if rated voltage.

H. Insulation Rating (class) of coils.

**Class A Coil Construction:**
Paper wound-impregnated with oil
Temperature Class 105°C (221°F)
Max. Allowable Heat Rise:
65°C by thermocouple method;
85°C by resistance method

**Class B Coil Construction:**
Epoxy Encapsulated
(moisture resistant)
Temperature Class 130°C (226°F)
Max. Allowable Heat Rise:
85°C by thermocouple method;
95°C by resistance method

**Class F Coil Construction:**
Epoxy or Polysufone Encapsulated
(moisture resistant)
Temperature Class 155°C (311°F)
Max. Allowable Heat Rise:
95°C by thermocouple method;
115°C by resistance method

**Class H Coil Construction:**
Epoxy or Polysulfone Encapsulated
(moisture resistant)
Temperature Class 180°C (356°F)
Max. Allowable Heat Rise:
115°C by thermocouple method;
135°C by resistance method

I. Hazardous Duty Solenoid Listing
Valves with solenoid operators designed for hazardous locations are UL & CSA Approved as follows:

| National Electric Code | Ambient Conditions | NEMA Classification |
|---|---|---|
| Class I Div. 1 Group C | Ethyl, Ether, Etc. Gases & Vapors | VII (7) |
| Class I Div. 1 Group D | Gasoline, Etc. Gases & Vapors | VII (7) |
| Class I Div. 2 Group B | Butadiene, Etc., Liquid, Fluid or Vapor Normally Contained, or Atmosphere Ventilated | VII (7) |
| Class II Div. 1 Group E | Metal Dust | IX (9) |
| Class II Div. 1 Group F | Coal, Coke, Carbon Black Dust | IX (9) |
| Class II Div. 1 Group G | Flour, Starch, Grain Dust | IX (9) |

See Article 500 – Hazardous (Classified) Locations, National Electric Code.

J. The combination of maximum heat rise and ambient temperature can not exceed temperature class of coil or coil will burn out.

10. **Typical port size to $C_V$ to response time relationships for valves:**

| PORT SIZE | $C_V$ RANGE | RESPONSE TIME (SECONDS) TO PRESSURE OR EXHAUST SPECIFIED VOLUME | | |
|---|---|---|---|---|
| | | 12 Cu.In. | 100 Cu.In. | 1000 Cu.In. |
| 1/8 Pipe | .2 to .8 | .100 | — | — |
| 1/4 Pipe | .5 to 2.0 | .060 | .300 | — |
| 3/8 Pipe | 1.5 to 3.5 | .040 | .090 | — |
| 1/2 Pipe | 2.5 to 5.0 | .035 | .070 | — |
| 3/4 Pipe | 4 to 9 | .030 | .075 | .550 |
| 1 Pipe | 6 to 16 | — | .065 | .400 |
| 1-1/4 Pipe | 11 to 28 | — | .030 | .200 |
| 1-1/2 Pipe | 20 to 30 | — | — | .170 |

11. **ISO Valve to $C_V$ Ranges** (PDN Target)

ISO 01 $C_V$ = 1.0
ISO 02 $C_V$ = 0.5
ISO 1 $C_V$ = 1.2 – 1.5
ISO 2 $C_V$ = 2.6 – 3.1
ISO 3 $C_V$ = 5.2 – 6.0
ISO 4 $C_V$ = 7.1 – 7.5

12. **Sensor Terminology**

**NPN**
NPN type open collector transistor outputs are solid state circuits that provide sinking output capabilities. When the transistor is on, the current for the load flows into the transistor. This output “sinks” toward 0VDC, 0mA.

**PNP**
PNP type open collector transistor outputs are solid state circuits that provide sourcing output capabilities. When the transistor is on, the current for the load flows out of the transistor. This output “sources” toward 24VDC, 125mA.

13. **SCFM to $C_V$ Equivalents for 100 PSI Inlet Pressure @ Various Pressure Drops:**

1 $C_V$ = 14.7 SCFM @ 2 $\Delta p$
1 $C_V$ = 22.9 SCFM @ 5 $\Delta p$
1 $C_V$ = 31.7 SCFM @ 10 $\Delta p$
1 $C_V$ = 42.6 SCFM @ 20 $\Delta p$
1 $C_V$ = 55.6 SCFM @ 50 $\Delta p$

14. **International ISO Standards**
Notification as specified in ISO8573 - 1

| | Solid | | | Water | | Oil | |
|---|---|---|---|---|---|---|---|
| **Class** | **Maximum particle size* (um)** | **Maximum Concentration** mg/m3** | **(ppm)** | **Maximum Pressure Dewpoint °F** | **(°C)** | **Maximum Concentration** mg/m3** | **(ppm)** |
| 1 | 0.1 | 0.1 | (.08) | -94 | (-70) | 0.01 | (.008) |
| 2 | 1 | 1 | (0.8) | -40 | (-40) | 0.1 | (.08) |
| 3 | 5 | 5 | (4.2) | -4 | (-20) | 1 | (.83) |
| 4 | 15 | 8 | (6.7) | 37 | (+3) | 5 | (4.2) |
| 5 | 40 | 10 | (8.3) | 45 | (+7) | 25 | (21) |
| 6 | - | - | - | 50 | (+10) | - | - |

* Particle size is based on a filtration ratio $\beta$ 20. The minimum accuracy of the measuring method used is 20% of the limiting value of the class.

** At 14.7 PSI (1 bar) absolute pressure, +70°F (+20°C) and a relative humidity of 60%.

It should be noted that at pressures above atmospheric, the contaminant concentration is higher.

Notes:

1. The quality of the air delivered by non-lubricated compressors is influenced by the quality of the intake air and the compressor design.
2. The minimum accuracy of the measuring method used is 20% of the limiting value of the class.

A. 78% of particles in air are 2 microns or smaller.

B. Average cost to produce compressed air at 100 PSI is $.30 / 1000 $ft^3$

15. **Cylinder Bore Size to Pipe Thread Size**
For industrial interchangeable cylinders.

| BORE SIZE | TAPERED PIPE THREAD |
|---|---|
| 1" | 1/4" |
| 1-1/2" | 3/8" |
| 2" | 3/8" |
| 2-1/2" | 3/8" |
| 3-1/4" | 1/2" |
| 4" | 1/2" |
| 5" | 1/2" |
| 6" | 3/4" |
| 7" | 3/4" |
| 8" | 3/4" |
| 10" | 1" |
| 12" | 1" |
| 14" | 1-1/4" |

Parker Pneumatic

**Pneumatic Division North America**
Richland, Michigan 49083

**TEC-14**

**ISSUED: November, 1998**

**Supersedes: None**

# Gas Laws

**Boyles Law;**

The pressure of a given mass of gas at a constant temperature is inversely proportional to its volume.

Example:

At constant temperature T

If V increases, P decresses

If V decreases, P increases

**Charles Law and Gay Lussac's Law;**

If the pressure remains constant, a given mass of gas will increase in its volume proportional to an increase in temperature. For every 1°C rise in temperature, a volume initially at 0°C will increase by 1/273, keeping the pressure constant.

Example:

At constant temperature P

If T increases, V increases

If T decreases, V decreases

**Perfect (Ideal) Gas Law;**

By combining the relationships found in Boyles and Charles Laws, the Perfect Gas Law is developed:

$$PV = nRT$$

Where;

P = Pressure (Absolute)

V = Volume

R = Gas Constant (Air = 639.6)

n = Molecular Weight of Gas (Moles)

T = Temperature of Gas (Absolute)

**Pascals Law;**

The ability of a gas to transmit equal pressure in all directions, at right angles to the wall of its container, regardless of the containers shape. Force is equal to Pressure (PSIG) times Area (cubic inches).

# Conversions and Equivalents

Commonly Used in Fluidpower

## Conventional U.S. Conversion Factors

| To Convert → Into | ← To Convert Into | Multiply By ← Divide By |
|---|---|---|
| atmospheres | in. of mercury (at 0°C) | 29.92 |
| atmospheres | kgs./sq.cm. | 1.0332 |
| atmospheres | pounds/sq.in. | 14.7 |
| atmospheres | bars | 1.0332 |
| bars | atmospheres | .9869 |
| bars | pounds/sq.in. | 14.5 |
| Btu | foot-lbs. | 778.3 |
| Btu/hr. | foot-lbs./sec. | .2162 |
| Btu/hr. | horsepower-hrs. | $3.929 \times 10^{-4}$ |
| Btu/hr. | watts | .2931 |
| Btu/min. | foot-lbs./sec. | 12.96 |
| Btu/min. | horsepower | .02356 |
| Btu/min. | kilowatts | .01757 |
| Btu/min. | watts | 17.57 |
| centimeters | inches | .3937 |
| centimeters/sec. | feet/min. | 1.1969 |
| centimeters/sec. | feet/sec. | .03281 |
| cubic centimeters | cu. inches | .06102 |
| cubic feet | cu. inches | 1.728 |
| cubic feet/min. | cu.cms./sec. | 472 |
| cubic feet/min. | gallons/sec. | .1247 |
| cubic feet/min. | liters/sec. | .4720 |
| cubic inches | cu.cms. | 16.39 |
| cubic inches | cu. feet | $5.787 \times 10^{-4}$ |
| cubic inches | liters | .01639 |
| diameter of circle | circumference | 3.1416 |
| diameter of circle | area | $.7854\ D^2$ |
| feet | centimeters | 30.48 |
| feet | meters | .3048 |
| feet | millimeters | 304.8 |
| feet/min. | cms./sec. | .508 |
| feet/min. | feet/sec. | .01667 |
| foot-pounds | Btu | $1.286 \times 10^{-3}$ |
| foot-pounds/min. | foot-pounds/sec. | .01667 |
| foot-pounds/min. | horsepower | $3.03 \times 10^{-5}$ |
| gallons | cu. feet | .1337 |
| gallons | cu. inches | 231 |
| gallons | liters | 3.785 |
| gallons/min. | cu. ft./sec. | $2.228 \times 10^{-3}$ |
| grams | kilograms | .001 |
| horsepower | Btu/min. | 42.44 |
| horsepower | foot-lbs./min. | 33,000 |
| horsepower | foot-lbs./sec. | 550 |
| horsepower | kilowatts | .7457 |
| horsepower | watts | 745.7 |
| horsepower (metric) (542.5 ft. lb./sec.) | horsepower (550 ft. lb./sec.) | .9863 |
| horsepower (550 ft. lb./sec.) | horsepower (metric) (542.5 ft. lb./sec.) | 1.014 |
| inches | centimeters | 2.54 |
| inches | millimeters | 25.40 |
| inches of mercury | atmosphere | .03342 |
| inches of mercury | kgs./sq. cm. | .03453 |
| inches of mercury | pounds/sq. in. | .4912 |
| joules | foot-pounds | .7376 |
| kilograms | grams | 1,000 |
| kilograms | joules/meter (newtons) | 9.807 |
| kilograms | pounds | 2.205 |
| kilowatts | horsepower | 1.341 |
| liters/min. | cu.ft./sec. | $5.886 \times 10^{-4}$ |
| liters/min. | gals./sec. | $4.403 \times 10^{-3}$ |
| meters | centimeters | 100 |
| meters | feet | 3.281 |
| meters-kilograms | pound-feet | 7.233 |
| millibars | lbs./sq. in. | .0145 |
| millimeters | inches | .03937 |
| milimeters | meters | .001 |
| ounces (fluid) | cu. inches | 1.805 |
| ounces (fluid) | liters | .02957 |
| pounds | joules/meter (newtons) | 4.448 |
| pounds | kilograms | .4536 |
| pounds/sq. in. | atmospheres | .06804 |
| pounds/sq. in. | inches of mercury | 2.036 |
| pounds/sq. in. | kgs./sq. meter | 703.1 |
| pounds/sq. in. | pounds/sq. ft. | 144 |
| pounds/sq. in. | millibars | 68.9 |
| quarts (liquid) | gallons | .25 |
| quarts (liquid) | liters | .9463 |
| square feet | sq. cms. | 929 |
| square feet | sq. inches | 144 |
| temperature (°C) + 273 | absolute temerature (Kelvin) | 1 |
| temperature (°C) + 17.78 | temperature (°F) | 1.8 |
| temperature (°F) + 460 | absolute temperature (Rankine) | 1 |
| temperature (°F) - 32 | temperature (°C) | 5 / 9 |
| watts | Btu/hr. | 3.4192 |
| watts | horsepower | $1.341 \times 10^{-3}$ |
| watts | kilowatts | .001 |

# Other Conversions And Equivalent

| QUANTITY MEASURE | SI UNIT | U.S. UNIT | CONVERSION |
|---|---|---|---|
| Flow | Cubic Decimeters Per Second; $dm^3_n/S$ | Standard Cubic Feet Per Minute; SCFM | $1dm^3_n/S$ = 2.12 SCFM |
| Force | Newton (N) | Pound Force-Feet (Foot Pounds) | 4.44N = 1 lb.-Feet (Foot Pounds) |
| Torque | Newton - Meter (N•m) | Pound Force-Inches (Inch Pounds) | 1 N•m = 8.88 lb.-Inches (Inch Pounds) |
| Pressure | Kilopascal (kPa) | PSIG | 1 PSIG = 6.895 kPa |

1 Millibar = .0145 bar
1 kPa = 10 Millibar (.145 bar)
1 Micro-meter = 1 millionth of a meter (micron)
= .000001 Meter
= .000039 Inches
1 Cu. Ft. = 1728 Cu. Inches
1 Cu. In. ≃ 330 drops of oil
1 Fluid Ounce (Oz) ≃ 600 drops of oil

# Common Formulae

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$F = PA$$

$$\text{SCFM (Standard Cubic Feet Per Minute)} = \frac{\text{Volume (Cubic Inches)}}{\text{Time (Seconds)}} \times \frac{\text{Compression Factor}}{28.8}$$

(28.8 is the conversion factor for cubic inches per second to cubic feet per minute.)

$$\text{Compression Factor} = \frac{\text{Atmospheric Pressure + Gauge Presure}}{\text{Atmospheric Pressure}}$$

$$\text{SCFM} = \text{CFM} \times \frac{\text{Atmospheric Pressure + Gauge Pressure}}{14.7} \times \frac{528}{\text{Air Temperature (°F)} + 528}$$

Absolute Temperature (°R) = Gauge Temperature (°F) +528

Absolute Pressure (PSIA) = Gauge Pressure (PSIG) + Atmospheric Pressure

$$\text{Power} = \frac{\text{Work}}{\text{Time}}$$

Work = Force x Distance

Area of a Circle = .7854 x Diameter$^2$

Diameter of Circle = $1.128 \sqrt{\text{Area}}$

$$C_v = \frac{Q}{22.48} \sqrt{\frac{GT}{(P_1 - P_2)P_2}}$$

Where:

$C_v$ = Dimensionless Number
Q = Flow (SCFM)
G = Ratio of molecular weight of gas of that of air. For air =1
T = Absolute Temperature (°R)
$P_1$ = Absolute inlet pressure (PSI)
$P_2$ = Absolute Secondary Pressure (PSI)
$P_2$ must be greater than $.53P_1$

Parker Pneumatic

**Pneumatic Division North America**
Richland, Michigan 49083

**TEC-15**
**Pipe Air Flow**

**ISSUED: January, 1999**
**Supersedes: June, 1998**

# Pipe Air Flow

The following pages contain 6 sets of curves for schedule 40 pipe that can be used to help select the appropriate pipe size for pneumatic systems, or given a system, allow system performance to be estimated.

Generally accepted practice for sizing piping for pneumatic systems is to use a pressure drop of 10% of gage for nominal pipe sizes up to and including 1/2", and 5% of gage for nominal pipe sizes of 3/4" and larger. The following curves allow the use of these guidelines for selecting piping sizes and include other pressure drop percentages for evaluating existing systems. Generally, curves of this type are shown only for 100 feet pipe lengths, but theoretic calculations show the curves for 10 feet are also valid.

Below is a listing of the charts involved with their identification:

| **Pipe Size Range** | **Pressure Drop** (Percentage of Inlet Gage Pressure) | | | | | |
|---|---|---|---|---|---|---|
| 1/8" - 1/2" | 5 | 10 | 15 | 5 | 10 | 15 |
| 3/4" - 3" | 2.5 | 5 | 7.5 | 2.5 | 5 | 7.5 |
| Pipe Length (Feet) | 100 | 100 | 100 | 10 | 10 | 10 |
| Chart | A | B | C | D | E | F |

Generally accepted practice.

Perhaps the best way to explain the use of these curves is by example.

## Example 1

Given a system with desired airflow of 700 SCFM and a supply pressure of 60 PSIG and a header length of 100 feet, what size pipe should be used? The generally accepted practice of 10% pressure drop for pipes up to 1/2" and 5% for 3/4" and larger should be used.

The above table indicates, Chart B should be used (Step 1). Along the bottom horizontal axis locate the 60 PSIG vertical line (Step 2). On the left vertical axis locate the 700 SCFM horizontal line (Step 3). Follow both of these lines to the point of intersection. This occurs between the sloping lines for the 2" and 2-1/2" pipes. The larger pipe size (2-1/2") should be selected (Step 4). Further evaluation of this chart shows that for the conditions given, the pipe will flow over 800 SCFM at 60 PSIG inlet and 3 PSI (5%) pressure drop. (The intersection of the 60 PSIG primary pressure line and the 2-1/2" pipe size line).

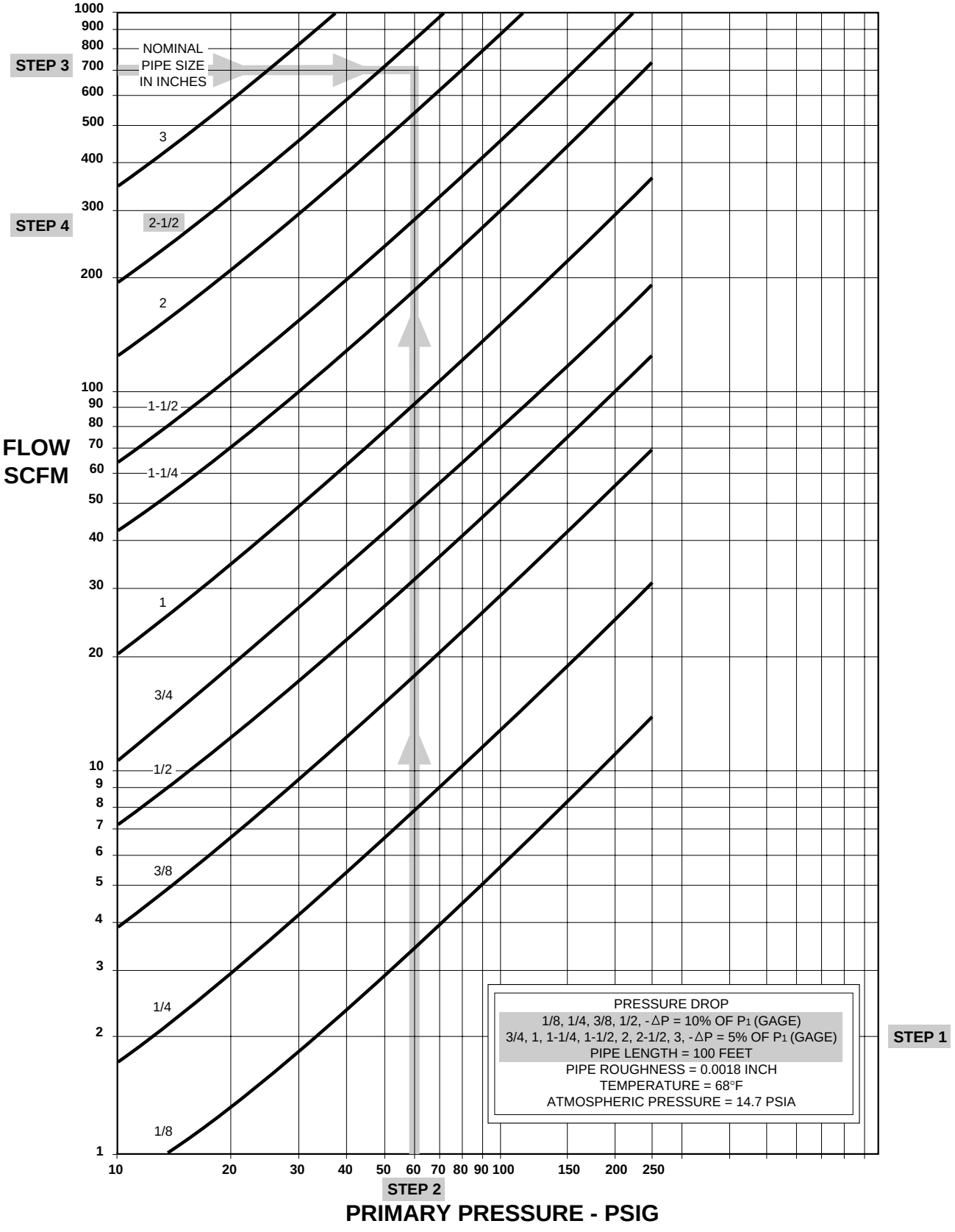
Further uses of the curves would be to compare the size pipe required at the other sets of pressure drops for 100 feet of pipe length. Using Chart A shows that if a more conservative pressure drop were used, the pipe size would increase to 3". Using Chart C shows that if a more aggressive pressure drop were allowed, perhaps a 2" pipe could be used.

Using the curves for 10 feet of pipe length, it can be seen because of the shorter length, much smaller pipe diameters could be used than if the length were at 100 feet.

These curves should only be used as general guidelines for selecting piping systems. Also, these curves are based on using schedule 40 steel pipe. Different types of plumbing with different internal roughness will have different results. If more detailed or precise information is required, the system should be designed by a competent professional.

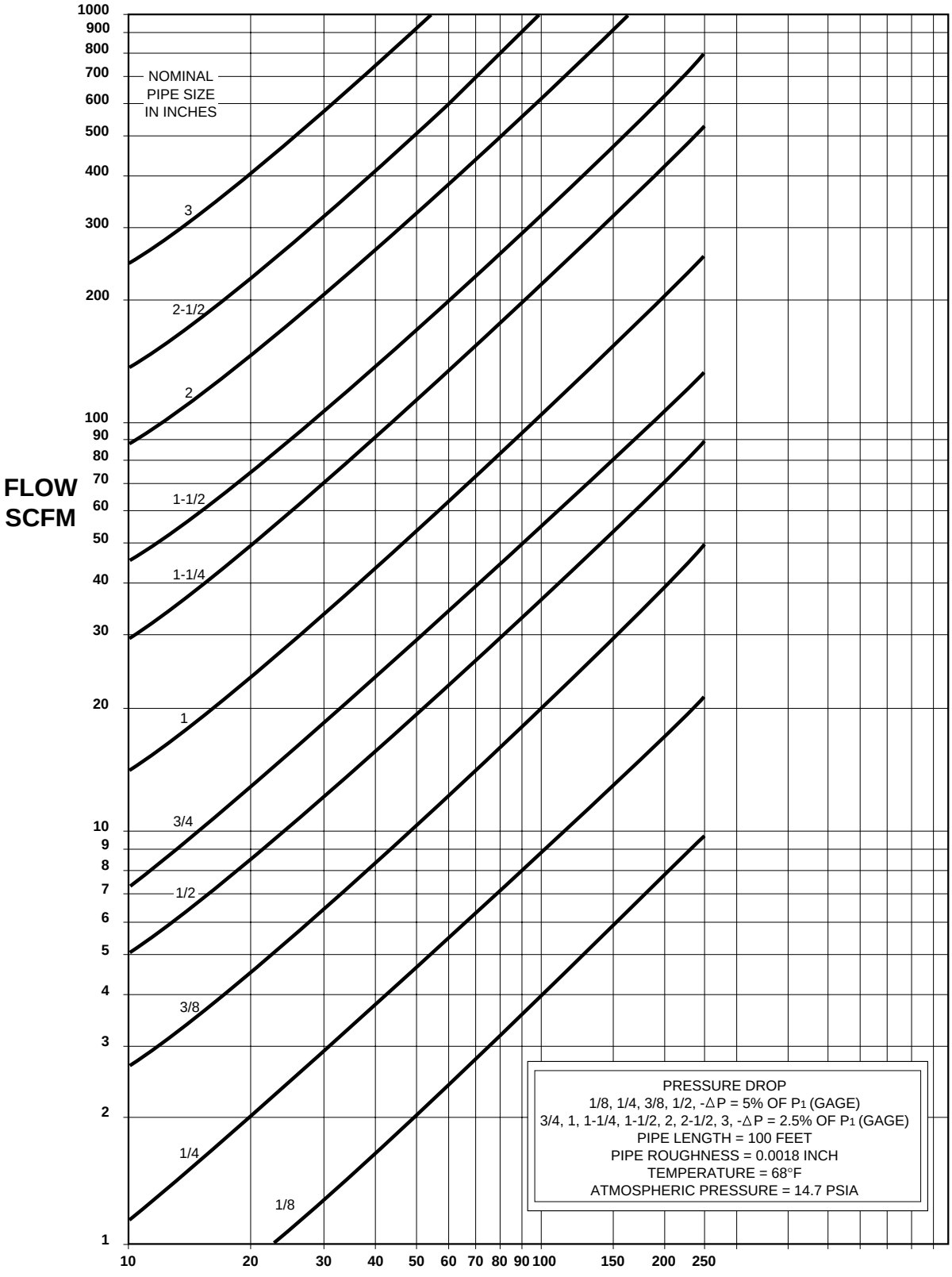
# Flow of Air Through a Pipe

Chart B (Example)



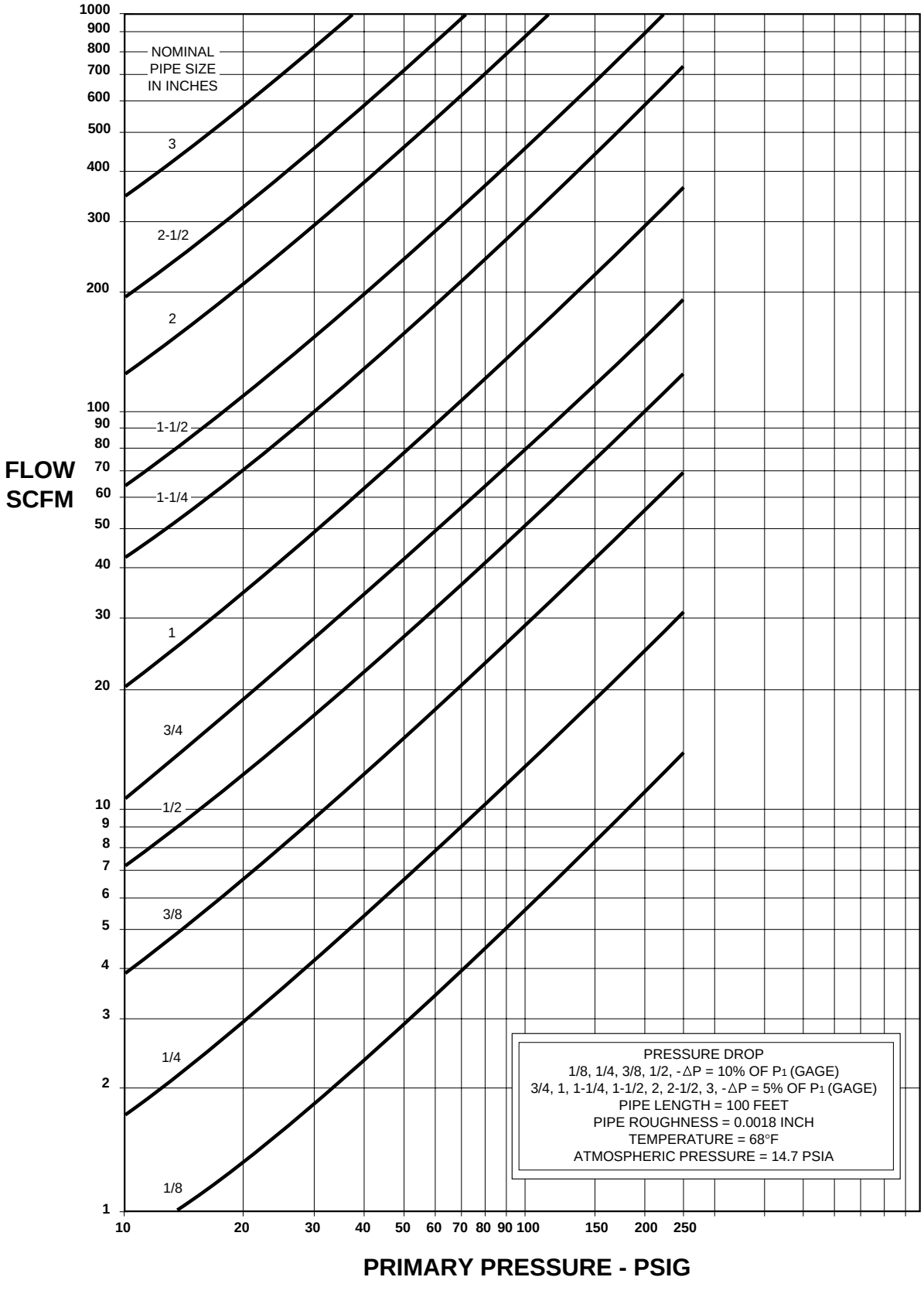
# Flow of Air Through a Pipe

Chart A



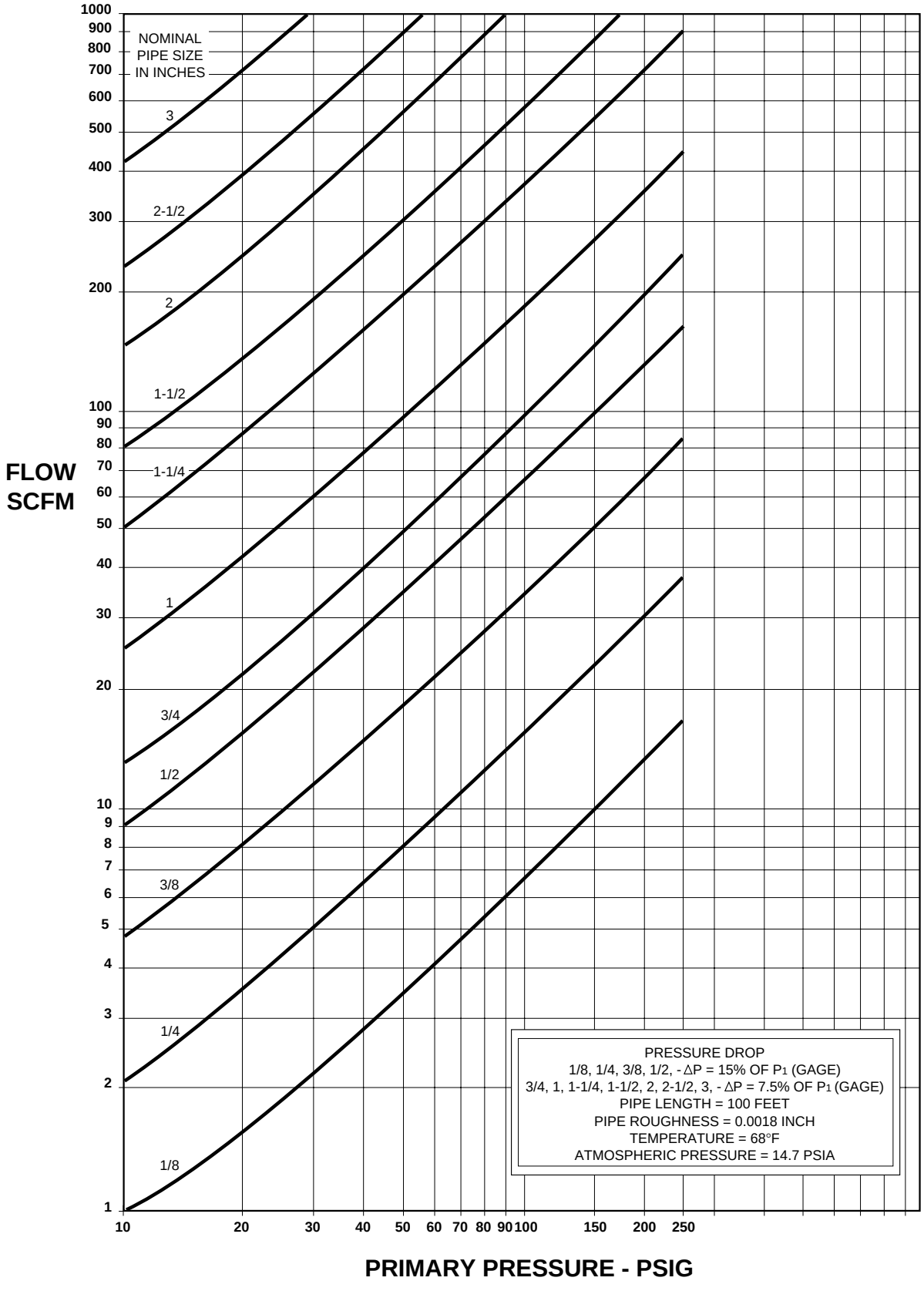
# Flow of Air Through a Pipe

Chart B



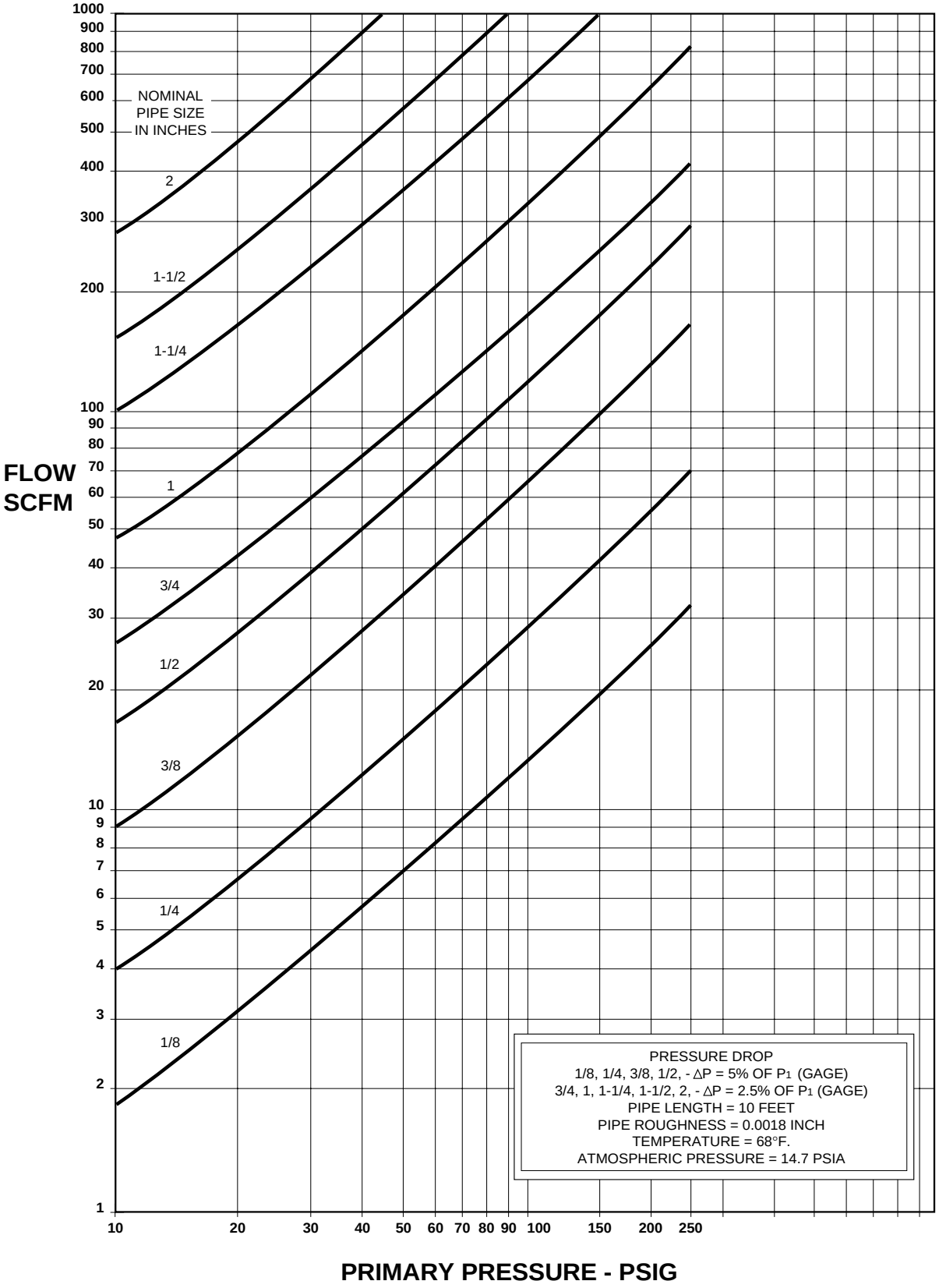
# Flow of Air Through a Pipe

Chart C



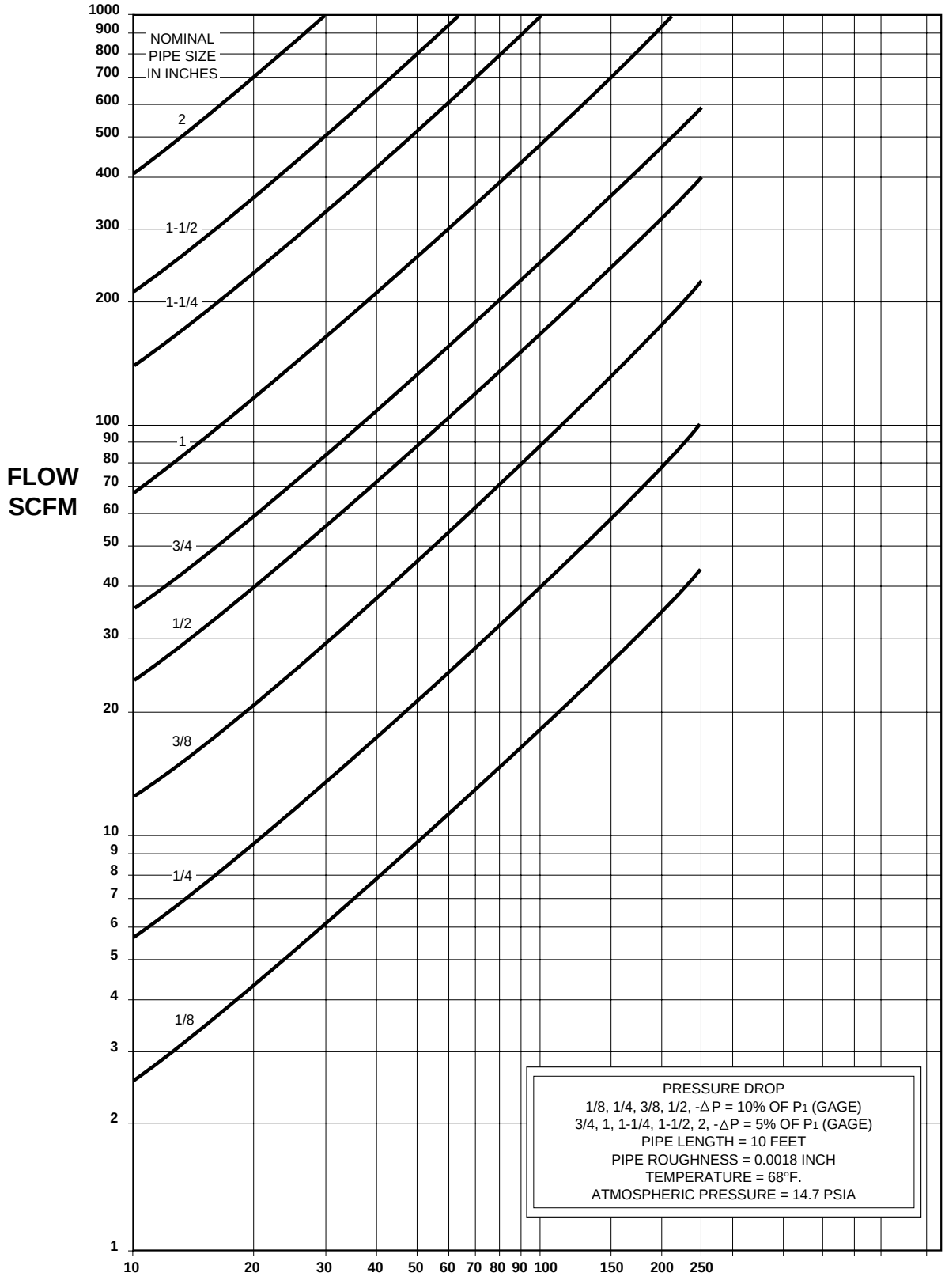
# Flow of Air Through a Pipe

Chart D



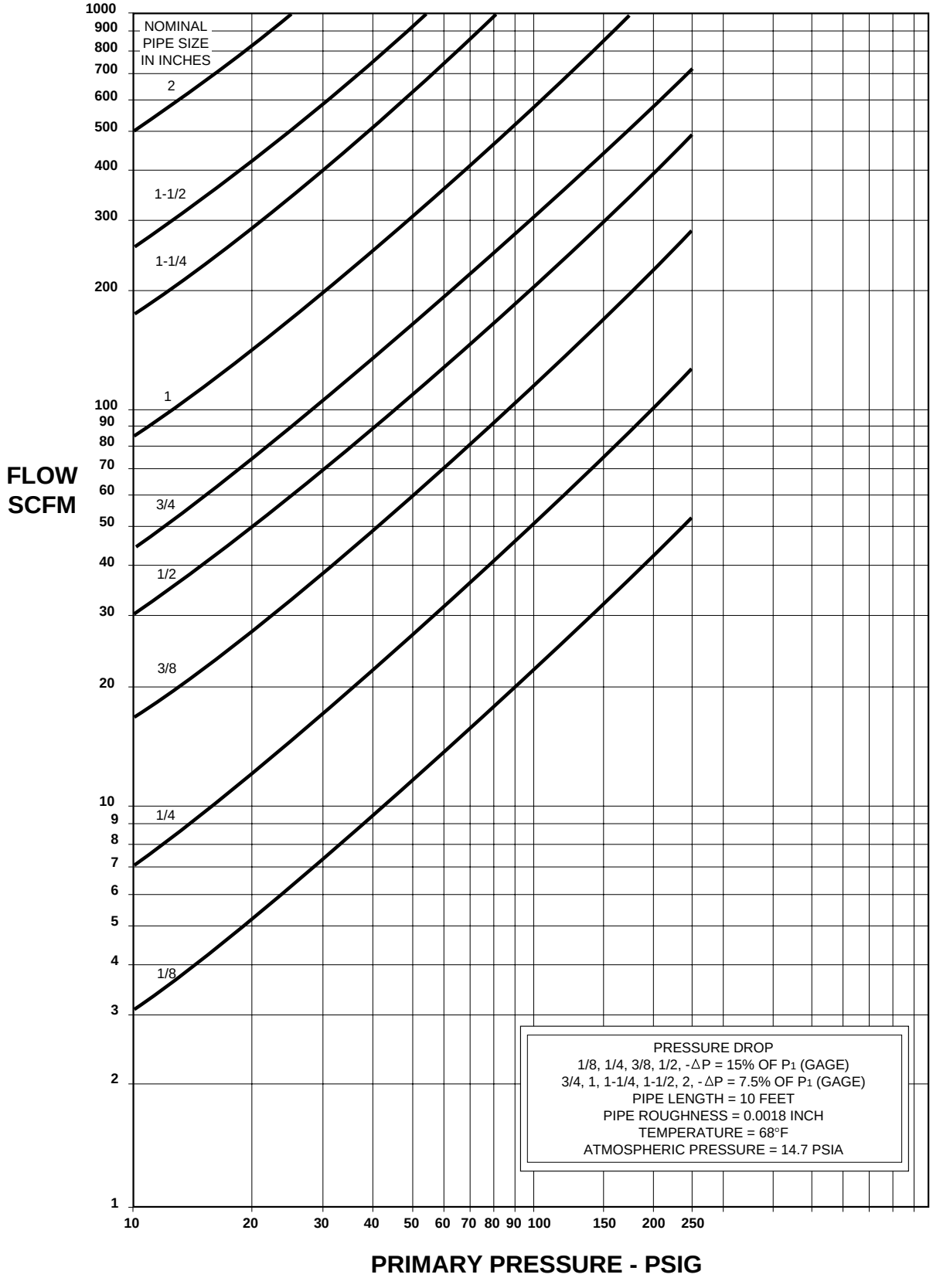
# Flow of Air Through a Pipe

Chart E



# Flow of Air Through a Pipe

Chart F



**Pneumatic Division**
Richland, Michigan 49083

**TEC-16**
**Electrical Enclosure Standards**

**ISSUED: March, 2007**
**Supersedes: None**

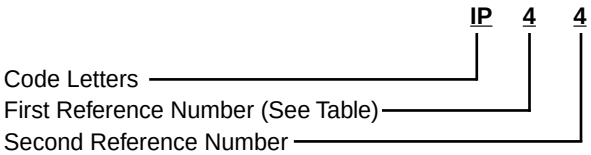
# IEC Enclosure Standards

The IEC publication 529 and DIN Standard number 40050 both address the classification of degrees of protection provided by enclosures. The following is a brief overview of the coding system described in these standards.

### General

The degrees of protection are indicated by a symbol consisting of the two code letters IP, always the same. (International Protection) and two reference numbers indicating the degree of protection.

### Example




An enclosure with this designation is protected against the penetration of solid objects of more than 1mm diameter and against splashed water.

## First Number

***Test and assessment in italic*

**0 = no special protection** **no test*

**1 = Protected Against a Rigid Sphere 50mm Ø.**
** A rigid 50mm sphere must not pass through an opening with an applied force of 50 N.*

**2 = Protected Against Solid Objects Greater than 12.5mm Ø.**
** A rigid 12mm sphere must not pass through an opening with an applied force of 30 N.*

**3 = Protected Against Solid Objects Greater than 2.5mm.**
** A straight rigid steel wire 2.5mm in dia. must not enter the equipment with an applied force of 3 N.*

**4 = Protected Against Solid Objects Greater than 1mm.**
** A straight rigid steel wire 1mm in dia. must not enter the equipment with an applied force of 1 N.*

**5 = Dust Protected.**
** A straight rigid steel wire 1mm in dia. must not enter the equipment with an applied force of 1 N. Also, dust chamber test to DIN 40 052.*

**6 = Dust-Tight and Complete Protection Against Contact.**
** A straight rigid steel wire 1mm in dia. must not enter the equipment with an applied force of 1 N. Also, dust chamber test to DIN 40 052.*

## Second Number

**Test and assessment in italic*

**0 = no special protection** **no test*

**1 = Protected Vertical Falling Water.**
** Dripping device or sprinkler nozzle in accordance with DIN 40 053 part 1 or part 5 respectively.*

**2 = Protected Against Vertical Falling Water Drops when Enclosure Tilted at 15°.**
** Dripping device or sprinkler nozzle in accordance with DIN 40 053 part 1 or part 5 respectively.*

**3 = Protected Against Splashing Water at an Angle up to 60°.**
** Oscillating tube or spray nozzle in accordance with DIN 40 053 part 2 or part 3 respectively depending on the shape and size of sample.*

**4 = Protected Against Splashing Water from Any Direction.**
** Oscillating tube or spray nozzle in accordance with DIN 40 053 part 2 or part 3 respectively depending on the shape and size of sample.*

**5 = Protected Against Water Jets.**
** Jet nozzle of nominal size 6 in accordance with DIN 40 053 part 4.*

**6 = Protected Against Powerful Water Jets.**
** Jet nozzle of nominal size 12 in accordance with DIN 40 053 part 4.*

**7 = Protected from the Effects of Temporary Immersion.**
** Enclosure is completely immersed in water and the following conditions must be met:*
*a) water must be at least 150mm over the highest point of the enclosure.*
*b) lowest part of the enclosure must be at least 1m below the surface.*
*c) test must last for 30 minutes.*
*d) water temperature must not deviate by more than 5°C; water must not enter in harmful quantities.*

**7 = Protected from the Effects of Continuous Immersion.**
** Test conditions have to be agreed to by the manufacturer and the customer but cannot be less stringent than those described in 7 above.*

**Note:** his Standard does not specify degree of protection of electrical against mechanical damage, against the risk of explosion of against conditions such as moisture (produced for example by condensation), corrosive vapors, fungus or vermin.

# NEMA Enclosure Standards

### The following is from NEMA Standard #250-2003

An enclosure is a surrounding case constructed to provide a degree of protection to personnel against incidental contact with the enclosed equipment and to provide a degree of protection to the enclosed equipment against specified environmental conditions.

In Non-Hazardous Locations, the specific enclosure Types, their applications, and the environmental conditions they are designed to protect against, **when completely and properly installed**, are as follows:

### Definitions Pertaining to Non-Hazardous Locations

**Type 1**
Enclosures constructed for indoor use to provide a degree of protection to personnel against access to hazardous parts and to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt).

**Type 2**
Enclosures constructed for indoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt); and to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping and light splashing).

**Type 3**
Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and windblown dust); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow); and that will be undamaged by the external formation of ice on the enclosure.

**Type 3R**
Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow); and that will be undamaged by the external formation of ice on the enclosure.

**Type 3S**
Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and windblown dust); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow); and for which the external mechanism(s) remain operable when ice laden.

**Type 3X**
Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and windblown dust); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow); that provides an additional level of protection against corrosion and that will be undamaged by the external formation of ice on the enclosure.

**Type 3RX**
Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow); that will be undamaged by the external formation of ice on the enclosure that provides an additional level of protection against corrosion; and that will be undamaged by the external formation of ice on the enclosure.

**Type 3SX**
Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and windblown dust); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow); that provides an additional level of protection against corrosion; and for which the external mechanism(s) remain operable when ice laden.

**Type 4**
Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and windblown dust); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water); and that will be undamaged by the external formation of ice on the enclosure.

**Type 4X**
Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (windblown dust); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water); that provides an additional level of protection against corrosion; and that will be undamaged by the external formation of ice on the enclosure.

**Type 5**
Enclosures constructed for indoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and settling airborne dust, lint, fibers, and flyings); and to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping and light splashing).

**Type 6**
Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of

# NEMA Enclosure Standards (Continued)

the equipment inside the enclosure against ingress of solid foreign objects (falling dirt); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (hose directed water and the entry of water during occasional temporary submersion at a limited depth); and that will be undamaged by the external formation of ice on the enclosure.

**Type 6P**
Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (hose directed water and the entry of water during prolonged submersion at a limited depth); that provides an additional level of protection against corrosion and that will be undamaged by the external formation of ice on the enclosure.

**Type 12**
Enclosures constructed (without knockouts) for indoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and circulating dust, lint, fibers, and flyings); and to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping and light splashing).

**Type 12K**
Enclosures constructed (with knockouts) for indoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and circulating dust, lint, fibers, and flyings); and to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping and light splashing).

**Type 13**
Enclosures constructed for indoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and circulating dust, lint, fibers, and flyings); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping and light splashing); and to provide a degree of protection against the spraying, splashing, and seepage of oil and non-corrosive coolants.

In Hazardous Locations, **when completely and properly installed and maintained**, Type 7 and 10 enclosures are designed to contain an internal explosion without causing an external hazard. Type 8 enclosures are designed to prevent combustion through the use of oil-immersed equipment. Type 9 enclosures are designed to prevent the ignition of combustible dust.

### Definitions Pertaining to Hazardous (Classified) Locations

**Type 7**
Enclosures constructed for indoor use in hazardous (classified) locations classified as Class I, Division 1, Groups A, B, C, or D as defined in NFPA 70.

**Type 8**
Enclosures constructed for either indoor or outdoor use in hazardous (classified) locations classified as Class I, Division 1, Groups A, B, C, and D as defined in NFPA 70.

**Type 9**
Enclosures constructed for indoor use in hazardous (classified) locations classified as Class II, Division 1, Groups E, F, or G as defined in NFPA 70.

**Type 10**
Enclosures constructed to meet the requirements of the Mine Safety and Health Administration, 30 CFR, Part 18.

# Intrinsic Safety Definitions & Standards

## Hazardous (Classified) Locations in Accordance with Article 500, National Electric Code-1990

**Class I Flammable Gases or Vapors**

**Division 1**
- Exists under normal conditions
- May exist because of:
  - repair conditions
  - maintenance operations
  - leakage
- Released concentrationbecause of:
  - breakdown of equipment
  - breakdown of process
  - faulty operation of equipment
  - faulty operation of process which causes simultaneous failure of electrical equipment

**Division 2**
- Liquids and gases in closed containers or the systems are:
  - handled-processed
  - used
- Concentrations are normally prevented by positive mechanical ventilation
- Adjacent to a Class I, Division 1 location

**Group A:** Atmospheres containing Acetylene

**Group B:** Atmospheres such as Butadiene, Ethylene Oxide, Propylene Oxide, Acrolein, or Hydrogen (or gases or vapors equivalent in hazard to hydrogen such as manufactured gas)

**Group C:** Atmospheres such as Cyclopropane, Ethyl Ether, Ethylene, or gases or vapors equivalent in hazard

**Group D:** Atmospheres such as Acetone, Alcohol,Ammonia, Benzene, Benzol, Butane, Gasoline, Hexane, Lacquer Solvent vapors, Naphtha, Natural Gas, Propane or gases or vapors equivalent in hazard

# Intrinsic Safety Definitions & Standards

## Hazardous (Classified) Locations in Accordance with Article 500, National Electric Code-1990

### Class II Flammable Gases or Vapors

**Division 1**
- Exists under normal conditions
- Combustible mixture produced by:
  - mechanical failure of equipment or machinery
  - abnormal operation of equipment and provide source of ignition from:
    - simultaneous failure of electrical equipment
    - simultaneous failure of operation protection devices
    - other causes
- Electrically conductive dusts may be present

**Division 2**
- Not normally in the air
- Accumulations normally sufficient to interfere with normal operation of electrical equipment or other apparatus.
- In the air as a result of infrequent malfunctioning of:
  - handling equipment
  - process equipment
- Accumulations are sufficient to interfere with the safe dissipation of heat from electrical equipment
- Accumulations may be ignitible by abnormal or failure of electrical equipment

**Group E:** Atmospheres containing combustible metal dusts (regardless of resistivity), dusts of similarly hazardous characteristics (<100 k½/cm) or electrically conductive dusts

**Group F:** Atmospheres containing combustible Carbon Black, Charcoal or Coke Dusts which have >8% total volatile material or if these dusts are sensitized so that they present an explosion hazard and having a resistivity >100 kΩ/cm but ≤100 MΩ/cm

**Group G:** Atmospheres containing combustible dusts having a resistivity >100 kΩ/cm or electrically nonconductive dusts

### Class III Ignitable Fibers or Flyings

**Division 1**
- Fibers or materials producingcombustible flyings are manufactured, stored or handled

**Not Grouped**
- Manufacturers such as textile mills, cotton-related mills orclothing plants
- Fibers and flyings including Rayon, Cotton, Sisal, Hemp, Jute and Spanish Moss

**Division 2**
- Fibers are handled except during the process of manufacture or are stored except during the process of manufacture

Parker Pneumatic

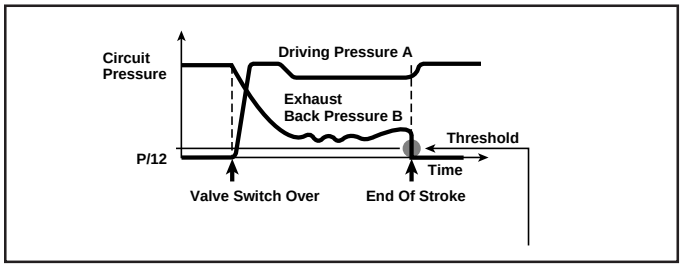
**Pneumatic Division North America**
Richland, Michigan 49083

**VAL-TEC-11**
**Threshold Sensors 10–32 to 1/2 Inch Ports**
**Operation & Application Examples**

**ISSUED: October, 1998**
**Supersedes: None**

## Operation

The threshold sensor provides electrical or pneumatic feedback information on pneumatic (air) cylinder status. These devices monitor the back pressure of the cylinder's exhausting chamber. Electrical sensors have a continuous electrical signal applied to the sensor device, while pneumatic sensors have a continuous pneumatic signal applied. The threshold sensor assembly mounted directly into the cylinder port provides an electrical or pneumatic output signal when the falling back pressure in the exhausting chamber of the cylinder reaches the operating threshold (approximately 6 to 9 PSIG).




## Application Examples:

### Typical Application

Threshold sensors can be used with all pneumatic actuators, eliminating the need to mount limit switches in the actuator work zone. The installation is simplified – no special brackets need to be designed and fabricated. Reliability is increased by eliminating a source of mechanical failure.

### Where limit switches are hard to place

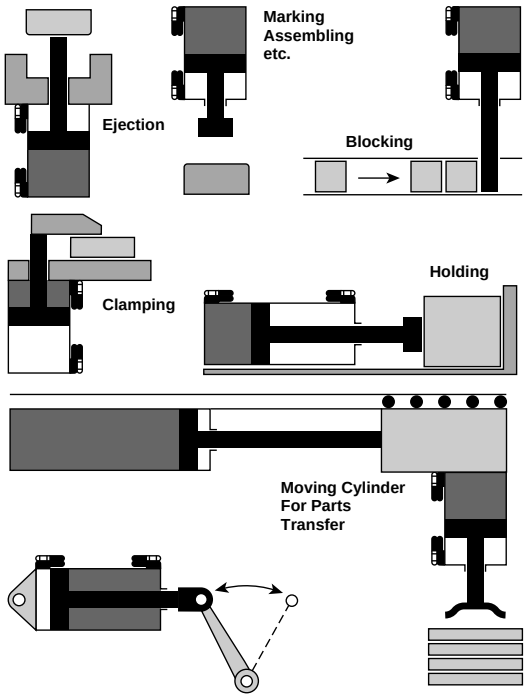
The end of stroke piston rod is often used directly as a tool, or to perform a function, making limit switch actuation difficult. Some examples are shown to the right. For these applications, threshold sensors are invaluable since the use of limit switches would significantly complicate and increase the cost of installation.

### Where cylinder strokes are variable

Cylinders performing functions, such as clamping, squeezing, marking, stacking and pick and place, often use a variable part of their stroke because part size may vary. For these applications, a fixed limit switch cannot used while adjustable brackets provide maintenance headaches. The threshold sensor automatically adjusts to the variable stroke, providing an output wherever the cylinder stops.

### Swivel mounted cylinders

Swivel mounted cylinders make limit switches hard to mount and increase switch failure. Again, threshold sensors simplify the machine and increase reliability.




**⚠ WARNING**

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Pneumatic

**Pneumatic Division North America**
Richland, Michigan 49083

**VAL-TEC-12**
**Chemical Resistance Information For Air Valves Using Resilient Seals**

**ISSUED: October, 1998**
**Supersedes: None**

# Chemical Resistance Information For Air Valves Using Resilient Seals

| | DYNAMIC SEAL MATERIAL | | | COMMENTS |
|---|---|---|---|---|
| **MEDIA** | **Nitrile (Buna-N)** | **Polyurethane** | **Fluorocarbon (Viton)** | **✓ = SATISFACTORY RATING** |
| Air (Over 200°F) | | | ✓ | 300°F Maximum Recommended |
| Air (0°F to 200°F) | ✓ | | ✓ | |
| Air (0°F to 180°F) | ✓ | ✓ | ✓ | Hot, Wet Air Will Cause Polyurethane to Unlink |
| Anderol L-774 (Di-Ester) | | | ✓ | Common Compressor Oils |
| Anderol L-826 (Di-Ester) | | | ✓ | Common Compressor Oils |
| Anderol L-829 (Di-Ester) | | | ✓ | Common Compressor Oils |
| Antifreeze (Methyl Alcohol) | ✓ | | ✓ | Also Called Tanner Gas (See CAUTION ⚠1) |
| Antifreeze (Prestone) | ✓ | | ✓ | Ethylene Glycol (See CAUTION ⚠1) |
| Brake Fluid (Non-Petroleum) | | | | Unsatisfactory for Listed Seal Materials |
| Brake Fluid (Delco) | | | | Unsatisfactory for Listed Seal Materials |
| Brake Fluid (Girling) | | | | Unsatisfactory for Listed Seal Materials |
| Brake Fluid (Mopar) | | | | Unsatisfactory for Listed Seal Materials |
| Brake Fluid (Wagner 21B) | | | | Unsatisfactory for Listed Seal Materials |
| Carbon Tetrachloride | | | ✓ | |
| Castor Oil | ✓ | ✓ | ✓ | |
| Chlorinated Solvents, Wet | | | ✓ | |
| Circo Light - Process Oil | ✓ | ✓ | ✓ | |
| Citgo AP Gear Oil 140 | ✓ | ✓ | ✓ | |
| Citgo Pacemaker #2 | ✓ | | ✓ | |
| Citgo #65, #120, #250 | ✓ | | ✓ | |
| Coolanol - Monsanto 45 | ✓ | | ✓ | |
| Creosote | ✓ | | ✓ | |
| Cutting Oil | ✓ | | ✓ | |
| Dextron (Transmission) | ✓ | | ✓ | |
| Diesel Oil | ✓ | | ✓ | |
| Di-Ester Lubricants | | | | Unsatisfactory for listed seal materials - Common compressor lubricant & additive |
| Ethanol | ✓ | | ✓ | |
| Fyrquel A60 | | | | Unsatisfactory for listed seal materials |
| Fyrquel 90, 100, 150 | | | ✓ | Phosphate Ester Base |
| Fyrquel 220, 300, 500 | | | ✓ | Phosphate Ester Base |
| Houghto-Safe 271, 620 | ✓ | | | |
| Houghto-Safe 5040 | ✓ | | ✓ | |
| Houghto-Safe 1010, 1055 | | | ✓ | |
| Houghto-Safe 1120 | | | ✓ | |
| Hydro-Drive MIH 50, 10 | ✓ | | ✓ | |
| Industron FF44, FF48 | ✓ | | ✓ | |
| Industron FF53, FF80 | ✓ | | ✓ | |
| Isopropyl Alcohol | | | ✓ | |
| JP 3, 4, 5, 6 | ✓ | | ✓ | |
| JPX | ✓ | | | |
| Kerosene | ✓ | ✓ | ✓ | |
| Lehigh X1169, X1170 | ✓ | ✓ | ✓ | |

| | DYNAMIC SEAL MATERIAL | | | COMMENTS |
|---|---|---|---|---|
| **MEDIA** | **Nitrile (Buna-N)** | **Polyurethane** | **Fluorocarbon (Viton)** | **✓ = SATISFACTORY RATING** |
| Lindol | | | | Hydraulic Fluid (Di-Ester Base), Unsatisfactory for listed seal materials |
| Lubricating Oils--Di-Ester Base | | | ✓ | |
| Lubricating Oils--Petroleum Base | ✓ | | ✓ | |
| Lubricating Oils--SAE 10 thru 50 | ✓ | | ✓ | |
| Marvel Mystery Oil | | | ✓ | |
| Methyl Alcohol (Methanol) | ✓ | | ✓ | Used as airline antifreeze additive (See CAUTION ⚠1 ) |
| Mineral Oil | ✓ | ✓ | ✓ | |
| Mineral Spirits (Stoddard Solvent) | ✓ | | ✓ | |
| Mobile DTE 24 | ✓ | | ✓ | |
| Mobile DTE 25 | ✓ | ✓ | ✓ | |
| Mobile HF | ✓ | | ✓ | |
| Mobile Oil SAE 20 | ✓ | ✓ | ✓ | |
| Mobile Therm 600 | ✓ | | ✓ | |
| Mobilux | ✓ | | ✓ | |
| Nonfluid Oil | ✓ | | ✓ | Recommended by Numatics…contains alcohol & unknown additives |
| Pydraul | | | ✓ | |
| Pyrogard 42, 43, 53, 55 | | | ✓ | Phosphate Ester Base |
| Sewage | ✓ | | ✓ | |
| Shell Iris 905 | ✓ | ✓ | ✓ | |
| Shell 3XF Mine Fluid | ✓ | | ✓ | Fire resistant hydraulic oil |
| Shell Tellus #27, #33 | ✓ | ✓ | ✓ | Petroleum Base |
| Skelly Solvent | ✓ | | ✓ | |
| Skydrol | | | | Unsatisfactory for listed seal materials |
| Stoddard Solvent (Mineral Spirits) | ✓ | | ✓ | |
| Sunoco SAE 10, #3661 | ✓ | ✓ | ✓ | |
| Sunsafe | ✓ | | ✓ | Fire resistant hydraulic fluid |
| Terpineol | | | ✓ | |
| Texaco 3450 Gear Oil | ✓ | ✓ | ✓ | |
| Texaco Capella A & AA | ✓ | | ✓ | |
| Texaco Regal B | ✓ | ✓ | ✓ | |
| Texaco Uni-Temp Grease | ✓ | ✓ | ✓ | |
| Texamatic “A” Transmission Oil | ✓ | | ✓ | |
| Texamatic 1581 Fluid | ✓ | | ✓ | |
| Texamatic 3401 Fluid | ✓ | | ✓ | |
| Texamatic 3525 Fluid | ✓ | | ✓ | |
| Texamatic 3528 Fluid | ✓ | | ✓ | |
| Texas 1500 Oil | ✓ | ✓ | ✓ | |
| Trichlorethylene | | | ✓ | Commonly used degreaser - solvent |
| Triethanol Amine | | | | Unsatisfactory for listed seal materials |
| Turpentine | ✓ | | ✓ | |
| Univis 40 Hydraulic Fluid | ✓ | ✓ | ✓ | |
| Univolt #35 (Mineral Oil) | ✓ | ✓ | ✓ | |
| Vegetable Oil | ✓ | | ✓ | |
| WD 40 | | | ✓ | |

**Notes:**

⚠1 **CAUTION:** We do not recommend using / injecting airline antifreeze agents into an air system. We state that when ambient temperatures are below 32°F, that the air used is to be moisture free. It is recommended that a dessicant dryer be applied to remove as much condensed liquid & water vapor as possible.

**2.** Except when noted, the chemical resistance rating is based on an ambient temperature not in excess of 75°F. Higher ambient temperatures may change (reduce) the polymer’s resistance.

**Pneumatic Division North America**
Richland, Michigan 49083

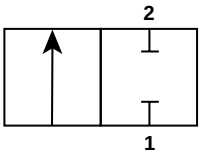
**VAL-TEC-16**

**Pneumatic Valve Fundamentals**

**ISSUED: November, 2008**
**Supersedes: October, 1998**

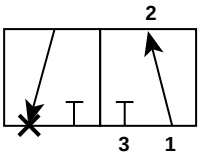
# Valve Type Information

## 2-Way, 2-Port, 2-Position



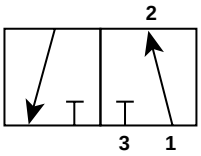

A 2-Way, 2-Port, 2-Position directional valve consists of two ports connected to each other with passages which are connected and disconnected. In one extreme spool or poppet position, the inlet (#1) port is open to the outlet (#2) port; the flow path through the valve is open. In the other extreme position, the large diameter of the spool or the poppet closes the path between the inlet (#1) port and the outlet (#2) port; the flow path is blocked. A 2-Way directional valve gives an on-off function. This function is used in many systems to serve as an interlock and to isolate and connect various system parts.

## 2-Way, 3-Port, 2-Position




A 2-Way, 3-Port, 2-Position directional valve consists of two open ports and one plugged or blocked exhaust (#3) port by the user. The two open ports are connected to each other with passages which are connected and disconnected. In one extreme spool or poppet position, the inlet (#1) port is open to the cylinder (#2) port; the flow path through the valve is open. In the other extreme position, the large diameter of the spool or the poppet closes the path between the inlet (#1) port and the cylinder (#2) port; the flow path is blocked. A 2-Way, 3-Port directional valve with one port plugged or blocked gives an on-off function. This function is used in many systems to serve as an interlock and to isolate and connect various system parts.

## 3-Way, 3-Port, 2-Postion



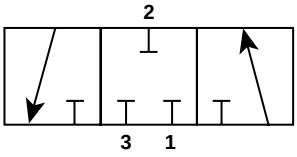

A 3-Way, 3-Port, 2-Position directional valve consists of 3 ports connected through passages within a valve body. These ports are usually labeled as inlet (#1), cylinder (#2), and exhaust (#3). If the cylinder (#2) port is connected to an actuator, the inlet (#1) port connected to a source of pressure, and the exhaust (#3) port is open to atmosphere, the valve will control the flow of air to (and the exhaust from) the cylinder (#2) port.

Usually, these valves can also be connected in two additional ways:

First, to serve as a pressure selector valve. By connecting a high pressure valve to the inlet (#1) port and a low pressure to the exhaust (#3) port, and by shifting the valve, the cylinder (#2) port will provide high or low pressure.

Second, to serve as a diverter valve. The source of pressure is connected to the cylinder (#2) port, and the inlet (#1) and exhaust (#3) ports are used as outlets to send the air to either of two different locations.

## 3-Way, 3-Port, 3-Position




A 3-Way, 3-Port, 3-Position directional valve consists of two ports connected through passages within a valve body. These ports are usually labeled as inlet (#1), cylinder (#2), and exhaust (#3). If the cylinder (#2) port is connected to an actuator, the inlet (#1) port connected to a source of pressure, and the exhaust (#3) port is open to atmosphere, the valve will control the flow of air

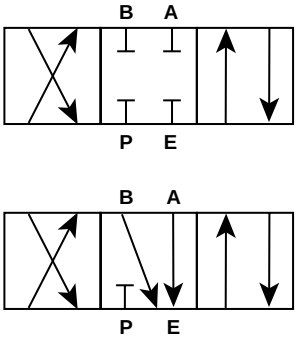
to (and the exhaust from) the cylinder (#2) port in the extreme positions, but it will not allow any flow of air in any direction in the center position (closed center).

Usually, these valves can also be connected in two additional ways:

First, to serve as a pressure selector valve. By connecting a high pressure valve to the inlet (#1) port and a low pressure valve to the exhaust (#3) port, and by shifting the valve, the cylinder (#2) port will provide high or low pressure in the extreme positions, but it will not allow any flow of air in the center position (closed center).

Second, to serve as a diverter valve. The source of pressure valve connected to the cylinder (#2) port, and the inlet (#1) and exhaust (#3) ports are used as outlets to send the air to either of two different locations. However, they will not allow any flow of air in the center position (closed center).

## 4-Way, 4-Port, 3-Position



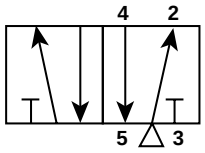

A 4-Way, 4-Port, 3-Position directional valve consists of four ports connected through passages within a valve body. These ports are usually labeled as inlet P, cylinder A, cylinder B, and exhaust E (common). If the cylinder A and cylinder B ports are connected to an actuator, the inlet P port connected to a source of pressure, and the exhaust E port is open to atmosphere, the valve will control the flow of air to cylinder A port and exhaust from cylinder B port and vice versa in the extreme positions.

The center position provides two different options depending on the valve ordered:

**Blocked Center** allows for no air flow in any direction in the center position of the valve.

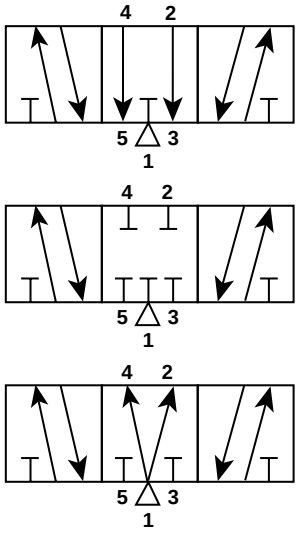
**Exhaust Center** allows for both cylinder A and cylinder B ports to be open to exhaust E in the center position of the valve.

## 4-Way, 5-Port, 2-Position




A 4-Way, 5-Port, 2-Position directional valve consists of five ports connected through passages within a valve body. These ports are usually labeled as inlet (#1), cylinder A (#2), exhaust cylinder A (#3), cylinder B (#4), and exhaust cylinder B (#5). If the cylinder A (#2) and cylinder B (#4) ports are connected to an actuator, the inlet (#1) port connected to a source of pressure, and the exhaust cylinder A (#3) and exhaust cylinder B (#5) ports are open to atmosphere, the valve will control the flow of air from the inlet (#1) port to cylinder A (#2) port and the exhaust from cylinder B (#4) port to the exhaust cylinder B (#5) port in one extreme position, and it will control the flow of air from the inlet (#1) port to cylinder B (#4) port and exhaust from the cylinder A (#2) port to the exhaust cylinder A (#3) port in the other extreme position.

## 4-Way, 5-Port, 3-Position




A 4-Way, 5-Port, 3-Position directional valve consists of five ports connected through passages within a valve body. These ports are usually labeled as inlet (#1), cylinder A (#2), exhaust cylinder A (#3), cylinder B (#4), and exhaust cylinder B (#5). If the cylinder A (#2) and cylinder

B (#4) ports are connected to an actuator, the inlet (#1) port connected to a source of pressure, and the exhaust cylinder A (#3) and exhaust cylinder B (#5) ports are open to atmosphere, the valve will control the flow of air from the inlet (#1) port to cylinder A (#2) port and exhaust from the cylinder B (#4) port to the exhaust cylinder B (#5) port in one extreme position. It will control the flow or air from the inlet (#1) port to cylinder B (#4) port and exhaust from the cylinder A (#2) port to the exhaust cylinder A (#3) port in the other extreme position.

The center position provides three different options depending on the valve ordered:

**Exhaust Center** allows for both cylinder A (#2) and cylinder B (#4) ports to be open to their respective exhaust ports, exhaust cylinder A (#3) and exhaust cylinder B (#5) in the center position of the valve.

**Blocked Center** allows for no air flow in any direction in the center position of the valve.

**Pressure Center** allows for the inlet (#1) port to be open to both cylinder A (#2) and cylinder B (#4) ports at the same time in the center position of the valve. The exhaust cylinder A (#3) and exhaust cylinder B (#5) ports are blocked in this position.

# Operator Type Information

## Solenoid, Direct, Single

These valves have the solenoid operator directly linked to the spool or poppet mechanism of the valve, and must remain energized to maintain the position of the spool or poppet. When the solenoid is de-energized, the spool or poppet returns to its rest position with the help of a spring, air pressure, or a combination of both.

## Solenoid, Direct, Double

These valves have the solenoid operators directly linked to the spool mechanism of the valve. It only takes an alternating momentary signal of each solenoid to shift the spool from one position to the other. When a solenoid is de-energized, the spool will not shift until the opposite solenoid is energized.

## Solenoid, Piloted, Single

These valves have the solenoid operator controlling a small, built-in, 3-Way valve which in turn pressurizes a chamber containing a piston connected to the spool or poppet mechanism of the valve. This solenoid must remain energized to maintain the position of the spool or poppet. When the solenoid is de-energized, this chamber is exhausted (normally closed operators) to atmosphere or is pressurized (normally open operators), and the spool or poppet returns to its at rest position with the help of a spring, air pressure, or a combination of both.

## Solenoid, Piloted, Double

These valves have the solenoid operators controlling two small, built-in, 3-Way valves which in turn pressurize two chambers containing a piston, in each chamber, connected to each end of the spool mechanism of the valve. It only takes an alternating momentary signal of each solenoid to shift the spool from one position to the other. When a solenoid is de-energized, the chamber that it controls is exhausted (normally closed operators) to atmosphere or is pressurized (normally open operators), but the spool will not shift until the opposite solenoid is energized.

## Air, Single

These valves are operated with an air signal by filling a chamber containing a piston connected to a spool or poppet mechanism of the valve. By applying this air signal, the spool or poppet is shifted to one position of the valve. This air signal must remain energized to maintain the position of the spool or poppet. When the air signal is removed and the chamber exhausted to atmosphere, the spool or poppet returns to its at rest position with help of a spring, air pressure, or combination of both.

## Air, Double

These valves are operated with air signals controlling two chambers. Each chamber contains a piston, which is connected to each end of the spool mechanism of the valve. It only takes an alternating momentary air signal to shift the spool from one position to the other. When the air signal is removed form one end, the chamber that it controls is exhausted to atmosphere. However, the spool will not shift until the opposite air signal is applied.

## Manual, Mechanical

These valves are operated with some type of manual mechanical device, i.e., a lever, pedal, etc., directly linked to the spool or poppet mechanism of the valve. By manually actuating the operator,

the spool or poppet is shifted to one position of the valve. The spool or poppet then may be kept in position by either holding the actuator in place or by equipping the actuator with a detent. On non-detented valves, if the manual actuator is left free, the spool or poppet returns to its at rest position with the help of a spring, air pressure, or a combination of both. On detented valves, a force must be applied to the manual actuator in the opposite direction to return the spool to its original position.

# Mounting Type Information

### Inline

An inline valve is a valve for which all piping is done directly onto the body of the valve.

### Subbase

A subbase is a single station block to which a valve is mounted and all the piping connections are done. Also, in some cases all the electrical connections are done through the subbase. The main benefit of a subbase mounted valve is that when a valve needs maintenance, it may be removed and replaced quickly without disturbing the piping.

### Stacking

A stack of valves consists of one or more valves mounted side by side. All the piping connections are done directly to the valve and to the end plates of the stack. The main benefit for stack mounted valves is space savings in connecting fittings.

### Manifold / Add-A-Fold

A manifold is a single or multiple station block, to where one or more valves are mounted and all the piping connections are done. Also, in some cases all the electrical connections are done through the manifold. The main benefit for manifold mounted valves is that when a valve needs maintenance, it may be removed and replaced quickly without disturbing the piping.

# Wiring Connection

A **conduit** is a shield over the wires that protects and maintains water integrity while routing the wire through the machine. Conduit connections can be made at either the valve body or base, depending on what body style was previously selected.

Other connections include:

**3-Pin:** a plug-style connection that accepts a female adapter for easy disconnects. 3-Pin includes rectangular DIN, square ISO, and round Brad Harrison connectors.

**5-Pin:** a Brad Harrison plug-style connector

**Quick Disconnect:** a miniature plug adapter similar to a modular phone jack

**Flying Leads:** grommeted or otherwise sealed wire leads coming directly out of the coil

**Note:** Conduit, Quick Disconnect, and Flying Leads have 18" normal leads and 72" long leads.

# Valve Position

Valves can either be open (passing) or closed (non-passing) – when the actuator is not energized. The open valve allows gas to flow through, and the closed valve does not. Valves can also be classified as 2 or 3-Position. 3-Position valves have a variety of center positions and methods of centering.

### Center Position

*All Ports Blocked* – This position has inlet pressure and cylinder ports blocked.

*Cylinder to Exhaust* – This position has inlet pressure blocked and the cylinder ports open to exhaust.

*Pressure to Cylinder* – This position has inlet pressure open to both cylinder ports simultaneously.

### Centering Methods

*Spring Centered* – In the de-energized or at rest position, air or mechanical springs automatically center the valve. This type is most commonly used with solenoid and remote pilot-operated 3-Position valves.

*Detented* – This method is used only with manual/mechanical type operators. The valve is manually shifted into one of three positions and is held in place by detents until it is manually shifted to an alternate position.

Parker Pneumatic

**Pneumatic Division**
Richland, Michigan 49083

**VAL-TEC-17**

**IP vs. NEMA Ratings**

**ISSUED: August, 2002**
**Supersedes: None**

Below is a detailed explanation between the IP Code and the NEMA rating along with the products that Parker Hannifin has engineered to meet these ratings.

**Definitions:**

**IP Code**: A coding system to indicate the degrees of protection provided by an enclosure.

**NEMA Rating**: This standard covers enclosures for electrical equipment rated not more than 1000 volts.

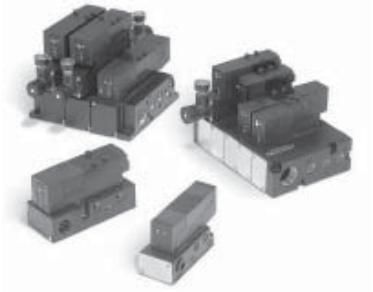
**Products:**

**Air Control Valves**

- Solstar, PVLB, PVLC, F Series
  IP-65: Use Sub D 25-Pin, or 19-Pin Connectors
- 15 mm Solenoid Valve, MicroKing (Valvetronic)
  IP-65: Only when properly installed
- Interface 2000
  IP-65: Use Sub D 25-Pin, 19-Pin, DeviceNet®, Profibus-DP, Interbus-S, and ASI Bus Module
- B Series
  IP-65: When properly installed with Valvetronic, or 3-PIN with Enclosure “5” or 1/2" Conduit

**PAR™-15**

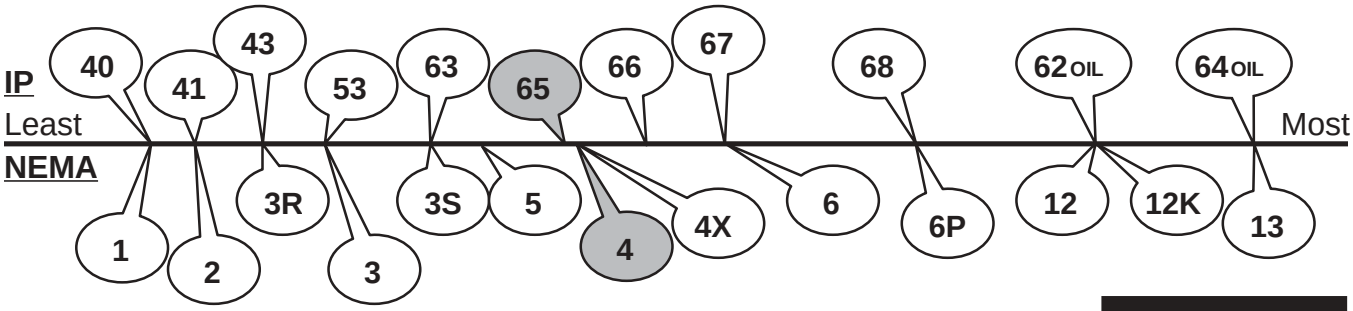
- IP-65: Only with NEMA 4 enclosure



**P3P-R**

- IP-65: Only when properly installed

## Protection Line




anything Parker
**Possible.**

# NEMA Rating

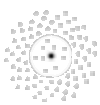
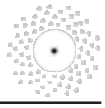
## INDOOR Nonhazardous Locations

| Provides a Degree of Protection Against The Following Environmental Conditions | Type of Enclosures | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 4 | 4X | 5 | 6 | 6P | 12 | 12K | 13 |
| Incidental Contact With Enclosed Equipment | X | X | X | X | X | X | X | X | X | X |
| Falling Dirt | X | X | X | X | X | X | X | X | X | X |
| Falling Liquids and Light Splashing | — | X | X | X | X | X | X | X | X | X |
| Circulating Dust, Lint, Fibers and Flyings | — | — | X | X | — | X | X | X | X | X |
| Settling Airborne Dust, Lint, Fibers and Flyings | — | — | X | X | X | X | X | X | X | X |
| Hosedown and Splashing Water | — | — | X | X | — | X | X | — | — | — |
| Oil and Coolant Seepage | — | — | — | — | — | — | — | X | X | X |
| Oil or Coolant Spraying and Splashing | — | — | — | — | — | — | — | — | — | X |
| Corrosive Agents | — | — | — | X | — | — | X | — | — | — |
| Occasional Temporary Submersion | — | — | — | — | — | X | X | — | — | — |
| Occasional Prolonged Submersion | — | — | — | — | — | — | X | — | — | — |

## OUTDOOR Nonhazardous Locations

| Provides a Degree of Protection Against The Following Environmental Conditions | Type of Enclosures | | | | | | |
|---|---|---|---|---|---|---|---|
| | 3 | 3R | 3S | 4 | 4X | 6 | 6P |
| Incidental Contact With Enclosed Equipment | X | X | X | X | X | X | X |
| Rain, Snow, Sleet | X | X | X | X | X | X | X |
| Sleet | — | — | X | — | — | — | — |
| Wind Blown Dust, Lint, Fibers and Flyings | X | — | X | X | X | X | X |
| Hosedown | — | — | — | X | X | X | X |
| Corrosive Agents | — | — | — | — | X | — | X |
| Occasional Temporary Submersion | — | — | — | — | — | X | X |
| Occasional Prolonged Submersion | — | — | — | — | — | — | X |

# IP Code

| 1st IP Number | Protection against Solid Bodies | |
|---|---|---|
| 0 | No protection from solid bodies is provided. | |
| 1 | Enclosure provides protection from objects larger than 50 mm. e.g. contact with hand. |  |
| 2 | Enclosure provides protection from objects larger than 12 mm. e.g. contact with finger. |  |
| 3 | Enclosure provides protection from bodies larger than 2.5mm. e.g. contact with wires. |  |
| 4 | Enclosure provides protection from bodies larger than 1mm. e.g. contact with fine wires. |  |
| 5 | Enclosure provides protection from harmful levels of dust. |  |
| 6 | Enclosure provides total protection from dust. |  |

| 2nd IP Number | Protection against Liquid | |
|---|---|---|
| 0 | No protection from liquid is provided. | |
| 1 | Enclosure provides protection from vertically falling water only. |  |
| 2 | Enclosure provides protection from water falling at up to 15° from vertical. |  |
| 3 | Enclosure provides protection from water falling at up to 60° from vertical. |  |
| 4 | Enclosure provides protection from water splashed from all directions. |  |
| 5 | Enclosure provides protection from low pressure water jets. |  |
| 6 | Enclosure provides protection from high pressure water jets. |  |
| 7 | Enclosure provides protection from temporary submersion in water, up to 1 meter in depth. |  |
| 8 | Enclosure provides protection from extended periods of immersion, up to a specific depth. |  |

**Pneumatic Division**
Richland, Michigan 49083
269-629-5000

**PDNSG-1**
**Pneumatic Division Safety Guide**
**ISSUED: August 1 , 2006**
**Supersedes: June 1, 2006**

# Safety Guide For Selecting And Using Pneumatic Division Products And Related Accessories

## ⚠ WARNING:

**FAILURE OR IMPROPER SELECTION OR IMPROPER USE OF PNEUMATIC DIVISION PRODUCTS, ASSEMBLIES OR RELATED ITEMS ("PRODUCTS") CAN CAUSE DEATH, PERSONAL INJURY, AND PROPERTY DAMAGE. POSSIBLE CONSEQUENCES OF FAILURE OR IMPROPER SELECTION OR IMPROPER USE OF THESE PRODUCTS INCLUDE BUT ARE NOT LIMITED TO:**

- Unintended or mistimed cycling or motion of machine members or failure to cycle
- Work pieces or component parts being thrown off at high speeds.
- Failure of a device to function properly for example, failure to clamp or unclamp an associated item or device.
- Explosion
- Suddenly moving or falling objects.
- Release of toxic or otherwise injurious liquids or gasses.

Before selecting or using any of these Products, it is important that you read and follow the instructions below.

### 1. GENERAL INSTRUCTIONS

**1.1. Scope:** This safety guide is designed to cover general guidelines on the installation, use, and maintenance of Pneumatic Division Valves, FRLs (Filters, Pressure Regulators, and Lubricators), Vacuum products and related accessory components.

**1.2. Fail-Safe:** Valves, FRLs, Vacuum products and their related components can and do fail without warning for many reasons. Design all systems and equipment in a fail-safe mode, so that failure of associated valves, FRLs or Vacuum products will not endanger persons or property.

**1.3 Relevant International Standards:** For a good guide to the application of a broad spectrum of pneumatic fluid power devices see: ISO 4414:1998, Pneumatic Fluid Power – General Rules Relating to Systems. See www.iso.org for ordering information.

**1.4. Distribution:** Provide a copy of this safety guide to each person that is responsible for selection, installation, or use of Valves, FRLs or Vacuum products. Do not select, or use Parker valves, FRLs or vacuum products without thoroughly reading and understanding this safety guide as well as the specific Parker publications for the products considered or selected.

**1.5. User Responsibility:** Due to the wide variety of operating conditions and applications for valves, FRLs, and vacuum products Parker and its distributors do not represent or warrant that any particular valve, FRL or vacuum product is suitable for any specific end use system. This safety guide does not analyze all technical parameters that must be considered in selecting a product. The user, through its own analysis and testing, is solely responsible for:

- Making the final selection of the appropriate valve, FRL, Vacuum component, or accessory.
- Assuring that all user's performance, endurance, maintenance, safety, and warning requirements are met and that the application presents no health or safety hazards.
- Complying with all existing warning labels and / or providing all appropriate health and safety warnings on the equipment on which the valves, FRLs or Vacuum products are used; and,
- Assuring compliance with all applicable government and industry standards.

**1.6. Safety Devices:** Safety devices should not be removed, or defeated.

**1.7. Warning Labels:** Warning labels should not be removed, painted over or otherwise obscured.

**1.8. Additional Questions:** Call the appropriate Parker technical service department if you have any questions or require any additional information. See the Parker publication for the product being considered or used, or call 1-800-CPARKER, or go to www.parker.com, for telephone numbers of the appropriate technical service department.

### 2. PRODUCT SELECTION INSTRUCTIONS

**2.1. Flow Rate:** The flow rate requirements of a system are frequently the primary consideration when designing any pneumatic system. System components need to be able to provide adequate flow and pressure for the desired application.

**2.2. Pressure Rating:** Never exceed the rated pressure of a product. Consult product labeling, Pneumatic Division catalogs or the instruction sheets supplied for maximum pressure ratings.

**2.3. Temperature Rating:** Never exceed the temperature rating of a product. Excessive heat can shorten the life expectancy of a product and result in complete product failure.

**2.4. Environment:** Many environmental conditions can affect the integrity and suitability of a product for a given application. Pneumatic Division products are designed for use in general purpose industrial applications. If these products are to be used in unusual circumstances such as direct sunlight and/or corrosive or caustic environments, such use can shorten the useful life and lead to premature failure of a product.

**2.5. Lubrication and Compressor Carryover:** Some modern synthetic oils can and will attack nitrile seals. If there is any possibility of synthetic oils or greases migrating into the pneumatic components check for compatibility with the seal materials used. Consult the factory or product literature for materials of construction.

**2.6. Polycarbonate Bowls and Sight Glasses:** To avoid potential polycarbonate bowl failures:

- Do not locate polycarbonate bowls or sight glasses in areas where they could be subject to direct sunlight, impact blow, or temperatures outside of the rated range.
- Do not expose or clean polycarbonate bowls with detergents, chlorinated hydro-carbons, keytones, esters or certain alcohols.
- Do not use polycarbonate bowls or sight glasses in air systems where compressors are lubricated with fire resistant fluids such as phosphate ester and di-ester lubricants.

**2.7. Chemical Compatibility:** For more information on plastic component chemical compatibility see Pneumatic Division technical bulletins Tec-3, Tec-4, and Tec-5

**2.8. Product Rupture:** Product rupture can cause death, serious personal injury, and property damage.
- Do not connect pressure regulators or other Pneumatic Division products to bottled gas cylinders.
- Do not exceed the maximum primary pressure rating of any pressure regulator or any system component.
- Consult product labeling or product literature for pressure rating limitations.

## 3. PRODUCT ASSEMBLY AND INSTALLATION INSTRUCTIONS

**3.1. Component Inspection:** Prior to assembly or installation a careful examination of the valves, FRLs or vacuum products must be performed. All components must be checked for correct style, size, and catalog number. DO NOT use any component that displays any signs of nonconformance.

**3.2. Installation Instructions:** Parker published Installation Instructions must be followed for installation of Parker valves, FRLs and vacuum components. These instructions are provided with every Parker valve or FRL sold, or by calling 1-800-CPARKER, or at www.parker.com.

**3.3. Air Supply:** The air supply or control medium supplied to Valves, FRLs and Vacuum components must be moisture-free if ambient temperature can drop below freezing

## 4. VALVE AND FRL MAINTENANCE AND REPLACEMENT INSTRUCTIONS

**4.1. Maintenance:** Even with proper selection and installation, valve, FRL and vacuum products service life may be significantly reduced without a continuing maintenance program. The severity of the application, risk potential from a component failure, and experience with any known failures in the application or in similar applications should determine the frequency of inspections and the servicing or replacement of Pneumatic Division products so that products are replaced before any failure occurs. A maintenance program must be established and followed by the user and, at minimum, must include instructions 4.2 through 4.10.

**4.2. Installation and Service Instructions:** Before attempting to service or replace any worn or damaged parts consult the appropriate Service Bulletin for the valve or FRL in question for the appropriate practices to service the unit in question. These Service and Installation Instructions are provided with every Parker valve and FRL sold, or are available by calling 1-800-CPARKER, or by accessing the Parker web site at www.parker.com.

**4.3. Lockout / Tagout Procedures:** Be sure to follow all required lockout and tagout procedures when servicing equipment. For more information see: OSHA Standard – 29 CFR, Part 1910.147, Appendix A, The Control of Hazardous Energy – (Lockout / Tagout)

**4.4. Visual Inspection:** Any of the following conditions requires immediate system shut down and replacement of worn or damaged components:
- Air leakage: Look and listen to see if there are any signs of visual damage to any of the components in the system. Leakage is an indication of worn or damaged components.
- Damaged or degraded components: Look to see if there are any visible signs of wear or component degradation.
- Kinked, crushed, or damaged hoses. Kinked hoses can result in restricted air flow and lead to unpredictable system behavior.
- Any observed improper system or component function: Immediately shut down the system and correct malfunction.
- Excessive dirt build-up: Dirt and clutter can mask potentially hazardous situations.

**Caution: Leak detection solutions should be rinsed off after use.**

**4.5. Routine Maintenance Issues:**
- Remove excessive dirt, grime and clutter from work areas.
- Make sure all required guards and shields are in place.

**4.6. Functional Test:** Before initiating automatic operation, operate the system manually to make sure all required functions operate properly and safely.

**4.7. Service or Replacement Intervals:** It is the user's responsibility to establish appropriate service intervals. Valves, FRLs and vacuum products contain components that age, harden, wear, and otherwise deteriorate over time. Environmental conditions can significantly accelerate this process. Valves, FRLs and vacuum components need to be serviced or replaced on routine intervals. Service intervals need to be established based on:
- Previous performance experiences.
- Government and / or industrial standards.
- When failures could result in unacceptable down time, equipment damage or personal injury risk.

**4.8. Servicing or Replacing of any Worn or Damaged Parts:** To avoid unpredictable system behavior that can cause death, personal injury and property damage:
- Follow all government, state and local safety and servicing practices prior to service including but not limited to all OSHA Lockout Tagout procedures (OSHA Standard – 29 CFR, Part 1910.147, Appendix A, The Control of Hazardous Energy – Lockout / Tagout).
- Disconnect electrical supply (when necessary) before installation, servicing, or conversion.
- Disconnect air supply and depressurize all air lines connected to system and Pneumatic Division products before installation, service, or conversion.
- Installation, servicing, and / or conversion of these products must be performed by knowledgeable personnel who understand how pneumatic products are to be applied.
- After installation, servicing, or conversions air and electrical supplies (when necessary) should be connected and the product tested for proper function and leakage. If audible leakage is present, or if the product does not operate properly, do not put product or system into use.
- Warnings and specifications on the product should not be covered or painted over. If masking is not possible, contact your local representative for replacement labels.

**4.9. Putting Serviced System Back into Operation:** Follow the guidelines above and all relevant Installation and Maintenance Instructions supplied with the valve FRL or vacuum component to insure proper function of the system.