

# TECH SHEET

## PEM® REF/ PRESSURE TO FORCE CONVERSION



### **SUBJECT: USING EQUIPMENT PRESSURE SETTINGS TO ESTIMATE FASTENER INSTALLATION FORCE (KN / LBS.)**

Installation forces published in PennEngineering catalogs for self-clinching and broaching fasteners are always shown in units of force. Values are in pounds for unified parts and in KiloNewtons for metric parts. Of course, our PEMSERTER® presses can be easily set for the prescribed unit of force required for accurate fastener installation. However, we do realize that sometimes other types of presses are used for installing our fasteners.

For presses using pressure settings rather than units, a common question that we get is how to convert the pressure reading to an installation force.

We recommend that in these cases the customer contact the press manufacturer to obtain an equation, graph or table which defines the pressure to force relationship. If this information is not available, it may then be possible to estimate the force by converting the pressure using the following procedure.

The vital piece of information needed for this conversion is the bore diameter of the cylinder. This may be on a name plate affixed to the cylinder or may need to be estimated based on the measured OD of the cylinder and an assumption about wall thickness. After the bore has been determined, it is important to confirm that the pressure displayed on the gage is in fact the pressure applied to the cylinder of the press. This will be the case unless there is some type of pressure boosting hardware present. It is also important to confirm that the ram or rod of the cylinder applies the force directly, without the help of any force multiplying linkage. A quick visual check can determine if linkage is present.

If it can be determined that the pressure display is accurately and directly measuring the pressure in the cylinder, the force for any given pressure can then be calculated using one of the following equations:

#### Inch Units

$$F = P \times D^2 \times \text{Pi}/4$$

Where: F = Force in pounds

P = Pressure in psi

D = Cylinder bore in inches

Pi = the natural constant 3.14159

#### Metric Units

$$F = P \times D^2 \times \text{Pi}/4 \times \text{UCF}$$

Where: F = Force in kN

P = Pressure in Bars, kPa or MPa

D = Cylinder bore in mm

Pi = the natural constant 3.14159

UCF is a Unit Conversion Factor based on the pressure units used

=1/1,000,000 for pressure units of kPa

=1/10,000 for pressure units of Bars

=1/1000 for pressure units of MPa

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For convenience, the forces corresponding to some common pressures and bore diameters for pneumatic presses are given in Tables I and IM below and for hydraulic presses in Tables II and IIM. Pneumatic presses can be used for broaching fasteners and are often incorporated into projection welders used to install PEM® weld nuts. Self-clinching fasteners typically require the higher installation forces achievable with hydraulic presses.

### Pressure to Force Conversions Typical of Pneumatic Fastener Installation Presses

Table I - Unified

Pressure PSI	Force in Pounds for Cylinder Bore Diameter in inches Shown in Column Heading					
	<b>3.00</b>	<b>4.00</b>	<b>5.00</b>	<b>6.00</b>	<b>7.00</b>	<b>8.00</b>
<b>10</b>	71	126	196	283	385	503
<b>20</b>	141	251	393	565	770	1,005
<b>30</b>	212	377	589	848	1,155	1,508
<b>40</b>	283	503	785	1,131	1,539	2,011
<b>50</b>	353	628	982	1,414	1,924	2,513
<b>60</b>	424	754	1,178	1,696	2,309	3,016
<b>70</b>	495	880	1,374	1,979	2,694	3,519
<b>80</b>	565	1,005	1,571	2,262	3,079	4,021
<b>90</b>	636	1,131	1,767	2,545	3,464	4,524
<b>100</b>	707	1,257	1,963	2,827	3,848	5,027
<b>110</b>	778	1,382	2,160	3,110	4,233	5,529

Table IM - Metric

Pressure		Force in kN for Cylinder Bore Diameter in mm Shown in Column Heading					
<b>bar</b>	<b>kPa</b>	<b>80</b>	<b>100</b>	<b>125</b>	<b>140</b>	<b>160</b>	<b>180</b>
0.5	50	0.3	0.4	0.6	0.8	1.0	1.3
1.0	100	0.5	0.8	1.2	1.5	2.0	2.5
1.5	150	0.8	1.2	1.8	2.3	3.0	3.8
2.0	200	1.0	1.6	2.5	3.1	4.0	5.1
2.5	250	1.3	2.0	3.1	3.8	5.0	6.4
3.0	300	1.5	2.4	3.7	4.6	6.0	7.6
3.5	350	1.8	2.7	4.3	5.4	7.0	8.9
4.0	400	2.0	3.1	4.9	6.2	8.0	10.2
5.0	500	2.5	3.9	6.1	7.7	10.1	12.7
6.0	600	3.0	4.7	7.4	9.2	12.1	15.3
7.0	700	3.5	5.5	8.6	10.8	14.1	17.8

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### Pressure to Force Conversions Typical of Hydraulic Fastener Installation Presses

Table II - Unified

Pressure PSI	Force in Pounds for Cylinder Bore Diameter in inches Shown in Column Heading					
	1.50	2.00	2.50	3.00	3.50	4.00
<b>200</b>	353	628	982	1,414	1,924	2,513
<b>400</b>	707	1,257	1,963	2,827	3,848	5,027
<b>600</b>	1,060	1,885	2,945	4,241	5,773	7,540
<b>800</b>	1,414	2,513	3,927	5,655	7,697	10,053
<b>1,000</b>	1,767	3,142	4,909	7,069	9,621	12,566
<b>1,200</b>	2,121	3,770	5,890	8,482	11,545	15,080
<b>1,400</b>	2,474	4,398	6,872	9,896	13,470	17,593
<b>1,600</b>	2,827	5,027	7,854	11,310	15,394	20,106
<b>1,800</b>	3,181	5,655	8,836	12,723	17,318	22,619
<b>2,000</b>	3,534	6,283	9,817	14,137	19,242	25,133
<b>2,200</b>	3,888	6,912	10,799	15,551	21,166	27,646

Table IIM - Metric

Pressure		Force in kN for Cylinder Bore Diameter in mm Shown in Column Heading					
MPa	bar	40	50	63	80	100	125
1	10	1.3	2.0	3.1	5.0	7.9	12
2	20	2.5	3.9	6.2	10	16	25
3	30	3.8	5.9	9.4	15	24	37
4	40	5.0	7.9	12	20	31	49
5	50	6.3	10	16	25	39	61
6	60	7.5	12	19	30	47	74
8	80	10	16	25	40	63	98
10	100	13	20	31	50	79	123
12	120	15	24	37	60	94	147
14	140	18	27	44	70	110	172
16	160	20	31	50	80	126	196

This information offered in this Tech Sheet is for general reference only. There are many variables including but not limited to press types, components, equipment wear, pressure settings and calculations that can affect the accuracy of this data. For best results, we recommend using the appropriate PEMserter® press for all of your installation requirements.