

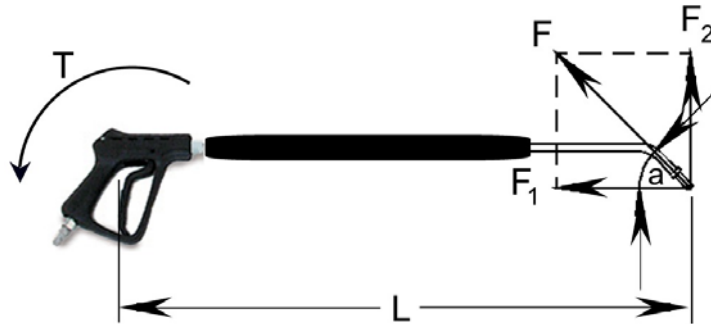
Impact, Reaction Force, and Torque for Bent Wands

The impact force of a water spray from a straight wand, which is equal to the reaction force against the person holding the gun/wand, is given by this formula:

$$\text{Impact Force or Reaction Force, } F = 0.0526 \times \text{gpm} \times \sqrt{\text{psi}} \text{ (lb)}$$

The impact force is proportional to the square root of the pressure, so to double the impact force requires four times the pressure.

For a bent wand, two forces act on the operator: a reaction force pushing back on the operator (F_1 in the diagram), and a force due to the bend that acts to "lift" the wand (F_2 in the diagram). The "lifting" force acts on the operator as a torque.



Calculating Reaction Force for a Bent Wand

$$\text{Reaction Force, } F_1 = F \times \cos(a) = 0.0526 \times \text{gpm} \times \sqrt{\text{psi}} \times \cos(a) \text{ (lb)}$$

where

F = Impact force (lb)

F_1 = Reaction force on operator (lb)

a = angle of wand bend

cos = cosine

gpm = gallons per minute

psi = pounds per square inch

Calculating Torque for a Bent Wand

$$\text{Torque} = F_2 \times L = F \times \sin(a) \times L = 0.0526 \times \text{gpm} \times \sqrt{\text{psi}} \times \sin(a) \times L \text{ (lb-ft)}$$

where

F = Impact force (lb)

F_2 = "Lifting" force on wand (lb)

a = angle of wand bend

sin = sine

L = length from trigger to nozzle (ft.)

Example: What are the force and torque at the gun for a nozzle running 8 gpm at 2500 psi, with a wand bent at 15 degrees that measures 36 in. from trigger to nozzle?

$$\text{Reaction Force, } F_1 = 0.0526 \times 8 \times \sqrt{2500} \times \cos(15^\circ) = 20.3 \text{ lb}$$

$$\text{Torque} = 0.0526 \times 8 \times \sqrt{2500} \times \sin(15^\circ) \times 3 = 5.5 \text{ lb-ft}$$

Caution: All of the foregoing formulas allow precise calculations, but the results are nonetheless approximate, because of the many variables in an actual system.