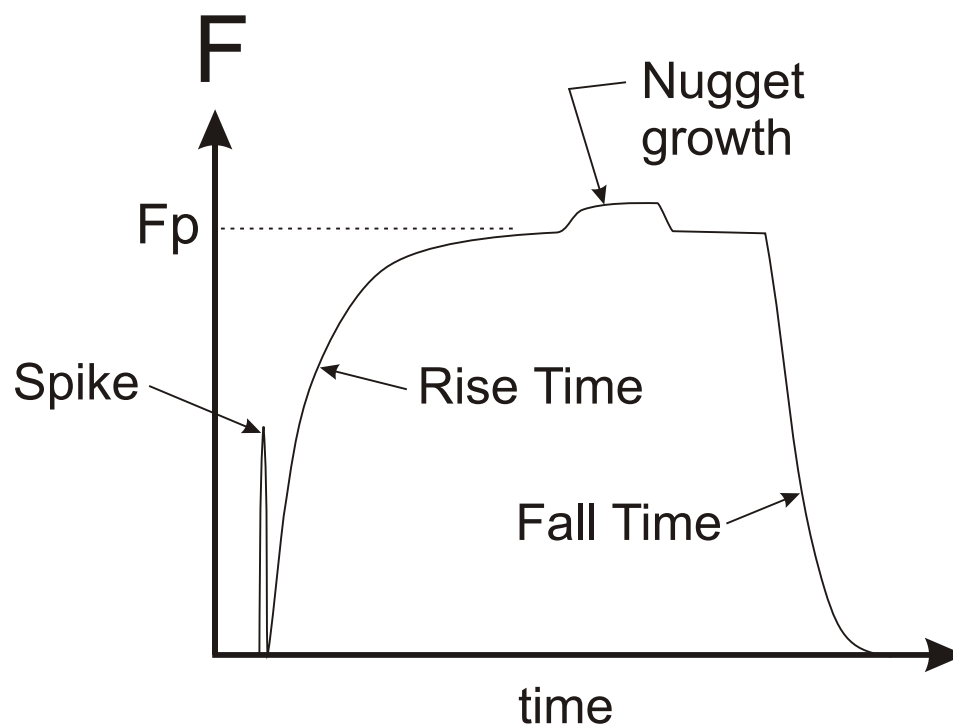


### The Basic Force Curve

The typical force trace for a spot weld is shown to the right. This output is typical from a WT9000 InLine sensor on a medium size pedestal welder. The basic parts of the force profile include:

- **Contact force spike.** This occurs when the electrode tips come into initial contact and this spike can sometimes be much higher than the peak welding force,  $F_p$ . Sensotec instruments filter the force signal to greatly reduce this spike.
- **Rise time.** All cylinders require a time for the force to build up to the peak level as the air enters the cylinder on top and exhausts out the bottom. The standard "squeeze" time in a weld process must be long enough to ensure the force is reached before current is fired.
- **Nominal Peak Force,  $F_p$ .** This is the "steady state" force the cylinder achieves for a given pressure regulator setting. This force must be high enough to eliminate expulsion and low enough to allow the nugget to form. In many critical welds, especially in micro joining applications, it is important to maintain this force, called follow-up, throughout weld nugget formation.
- **Nugget Expansion.** This expansion force varies significantly depending on the material type, machine characteristics, and weld parameters. The positive growth shown in this figure is typical for steel spot welds on most welders.
- **Fall Time.** Once the weld cycle is complete and the "hold" cycle has ended, the cylinder retracts and the force falls to zero.



Typical force trace for one weld.