Three roles of PFG

1. **Coherence selection: 6 factors:**
   - **Gradient strength**
   - **Duration**
   - **Sign**
   - **Coherence order p**
   - **Coherence order sign**
   - **Gyromagnetic ratio γ**

a $B_{g(z)}$ gradient with a duration τ_g applies on a magnetization vector and make it rotate a spatially dependent phase angle $\Phi_{(z)}$:

$$\Phi_{(z)} = B_{g(z)}\, \tau_g\, \Sigma p_I \gamma_I$$

•So dephasing degree is determined by coherence order p and gyromagnetic ratio γ. DQ coherences dephase two times faster than SQ, and ZQ is not sensitive to the field gradient; also H^1 SQ coherences dephase 4 times faster than C^{13} SQ, and 10 times faster than N^{15} SQ. This two feathers provide the key to the coherence selection by PFG. The major purpose of PFGs is to selectively refocus the desired coherences and defocus the others and make them unobservable.

•PFGs can not alter coherence order p, but rf pulses can, so a combination of rf pulses generates desired coherence orders, together with PFGs to select them.

2. Water (solvent) suppression --- the ability of PFGs completely destroying a NMR resonance is also used for solvent suppression, and it's the most efficient approach to the date.

Watergate (water suppression by gradient-tailored excitation):
$G_1 - S - G_1$,
element "S" can be "3919", "W5", or "soft",
"W5" excitation profile gives narrower notch than "3919" at "tof", and wider uniform excitation region, so more solute peaks near the solvent will show up.

"soft" (90_xsoft-180_xhard-90_xsoft pulses make the water resonance a net 360° rotation) needs two phase corrections for the two soft pulses in practice.

DPFGSE (double PFG spin echo) (or excitation sculpting):
$G_1 - S - G_1 - G_2 - S - G_2$,
It has the advantage of refocusing homonuclear couplings, and less baseline distortion. But the twisted solvent suppression peak is wider since it is applied twice.

3. Eliminating unwanted magnetization from imperfections.

Z1 room temperature shim coil in Varian NMR systems can provide homospoil gradient, but its strength is weaker than PFG and recovery times are longer. Use of PFG coils on the probe is preferred if it's available.

Homospoil pulses can dephase the residual transverse magnetization caused by an imperfect 180° pulse, which can not be removed by the short phase cycle.
After the homospoil z-gradient pulse, transverse magnetization in the slices of sample will acquire additional phase, which will vary with height. So net x-y plane magnetization will be zero. All wanted magnetization are required to sit along the z-axis, and won't be influenced.