

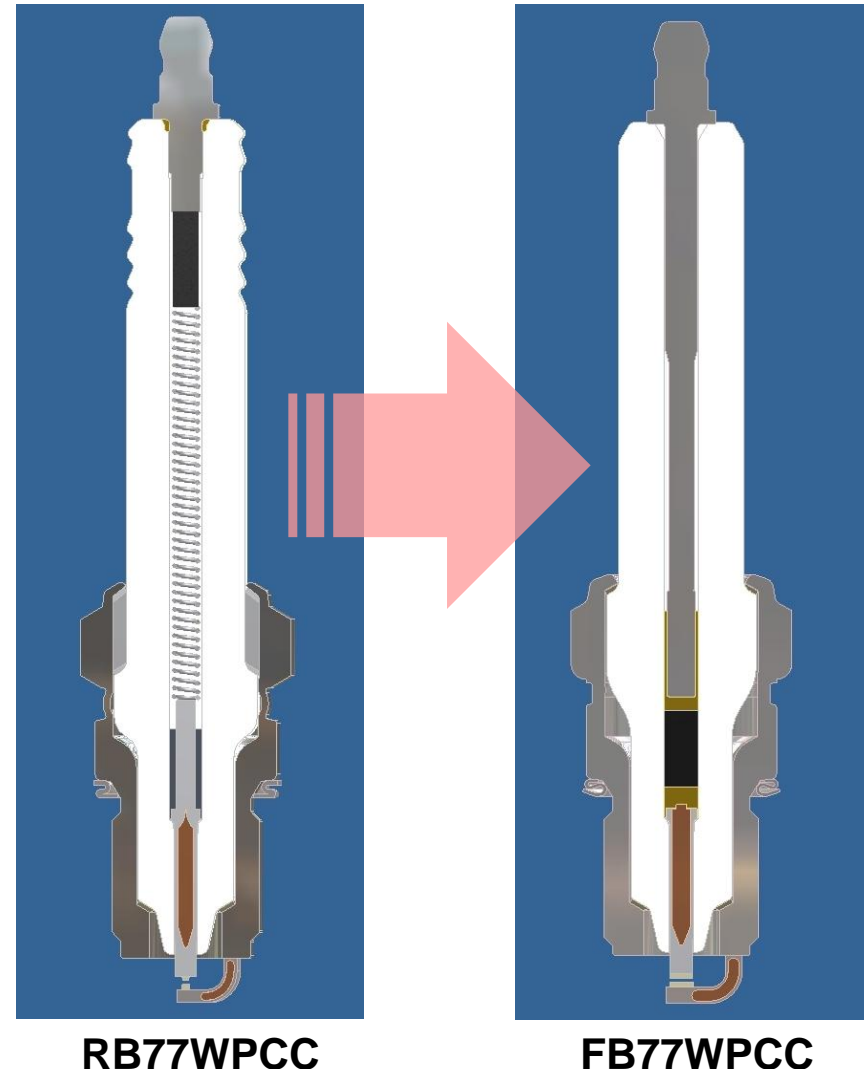


FB M-18 Iridium Spark Plug



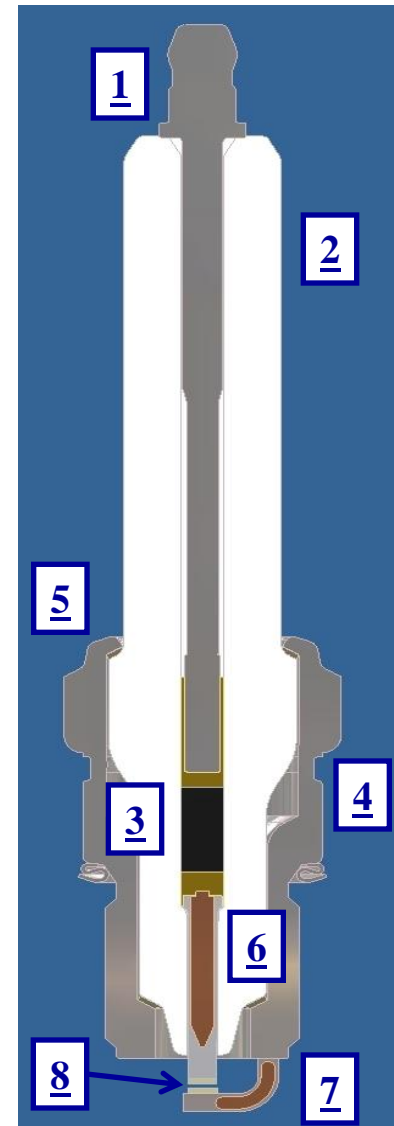
FB M-18 Design Evolution

- Federal-Mogul/Champion was the first industrial ignition to market with a Pt alloy and Ir alloy dual precious metal product in 1988 and has been the global market leader for industrial ignition technology.
- The RB77WP was introduced in the late 1980's, it evolved into the RB77WPC, and then later became the RB77WPCC in the late 1990's.
- After 20+ years of production experience, over three million RB77WPCC's have been produced, servicing a global gas compression and generator market.
- In 2011, Federal-Mogul/Champion has taken the next step in the evolution to the FB M18 Iridium Spark Plug.
- The evolution of the FB M18 Iridium Spark Plug has been driven by advancements in market/application technologies and requirements. Increased engine thermal efficiencies/BMEP loads, higher operating temperatures, more corrosive fuels, and longer service life intervals have all paved the way to the new 'FB' design.



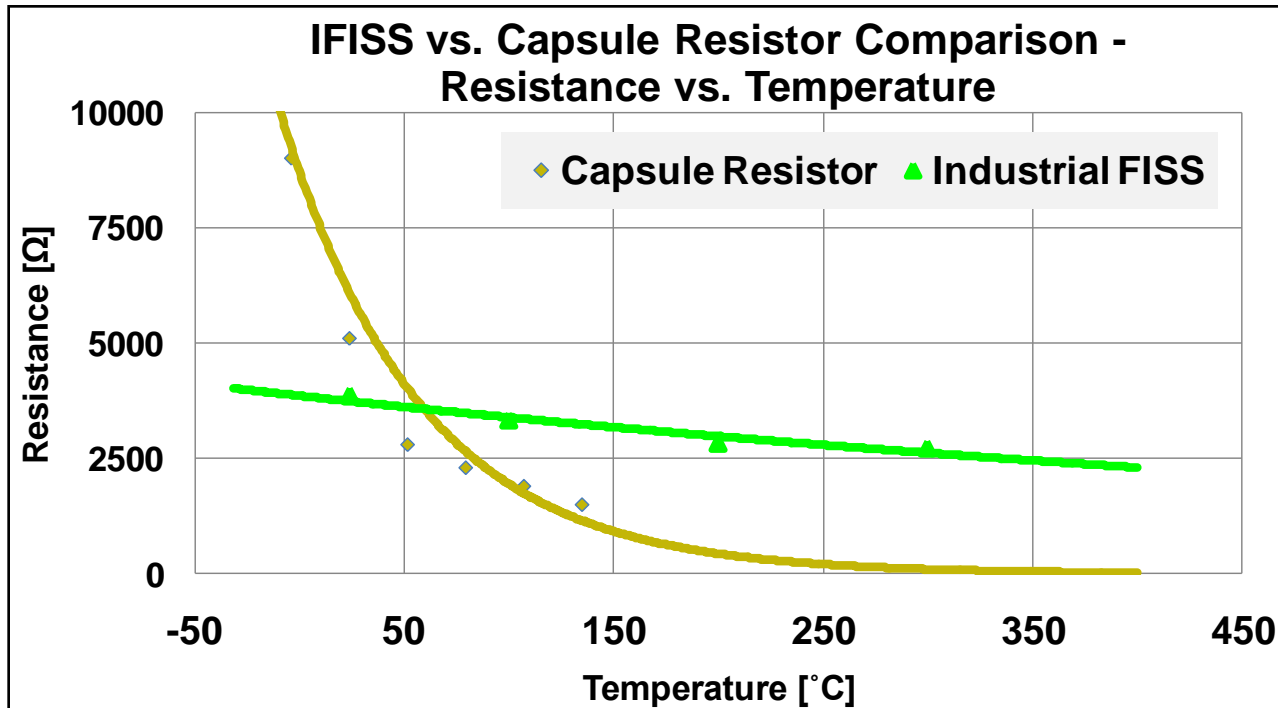
FB M-18 Iridium Design Characteristics

- 1
 - **Terminal**
 - Solid Post, C1018 Steel, Ni Plated
- 2
 - **Insulator**
 - 2140 ceramic, ribless
- 3
 - **Core Seal and Supressor**
 - IFISS – Industrial Fired-In Suppressor Seal
- 4
 - **Shell**
 - C1010 Extruded, Ni-Plated
- 5
 - **Shell Seal**
 - Hot Lock
- 6
 - **Center Electrode**
 - Thin-walled Ni with enlarged copper core
- 7
 - **Ground Electrode**
 - Inconnel 600 Ni with enlarged copper core
- 8
 - **Electrode Precious Metals**
 - Ir- Alloy Center Electrode, Pt-Alloy Ground Electrode

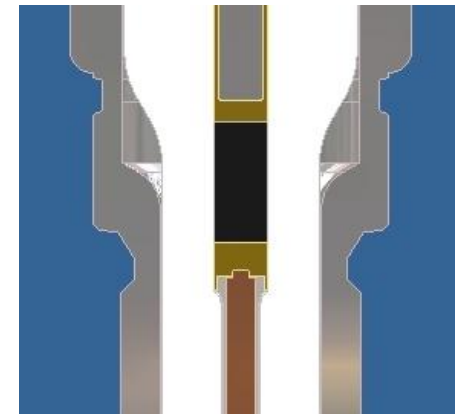


FB M-18 IFISS Core Technology

IFISS vs. Capsule Resistor



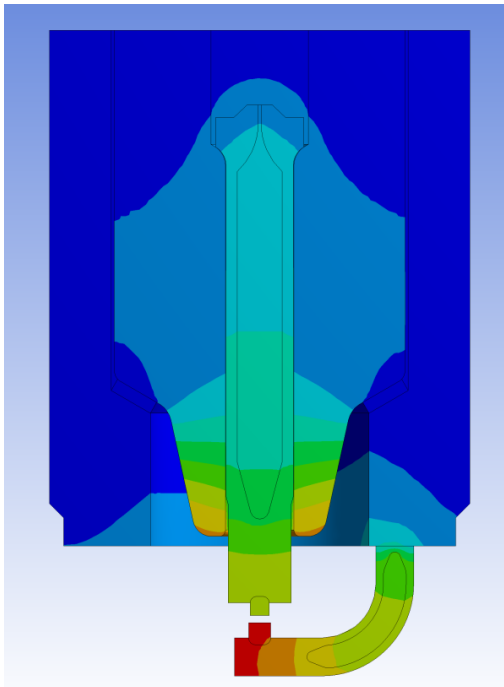
Specifically designed for industrial applications, IFISS is a fired in suppressor seal, which significantly improves both resistance and suppression capability over the life of the plug.



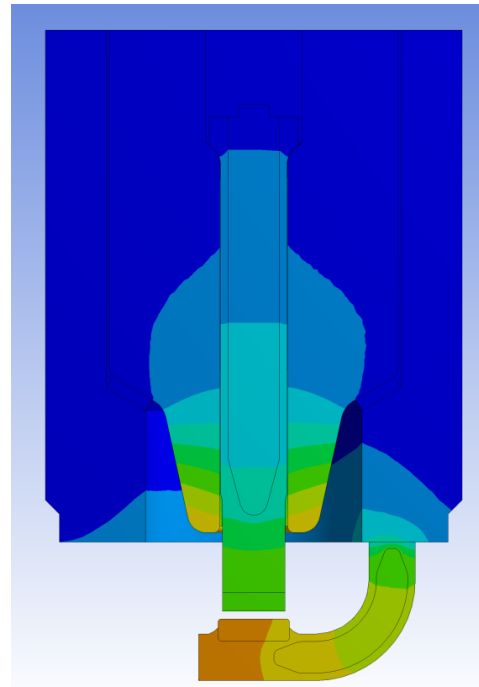
IFISS offers tight resistance control across the entire temperature operating window, magnitudes improvement vs. capsule resistor

FB M-18 Electrode Enhancements

Center Electrode and Ground Electrode Temperature Comparisons

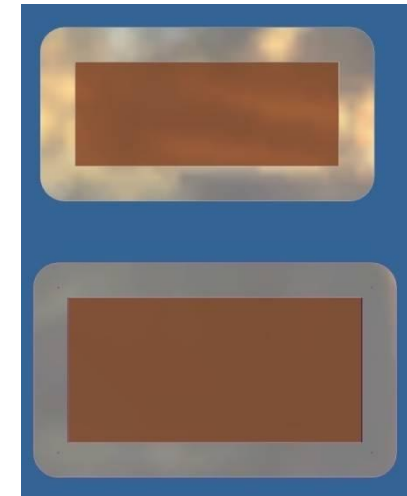


RB77WPCC



FB M-18

RB77WPCC GE Cross Section

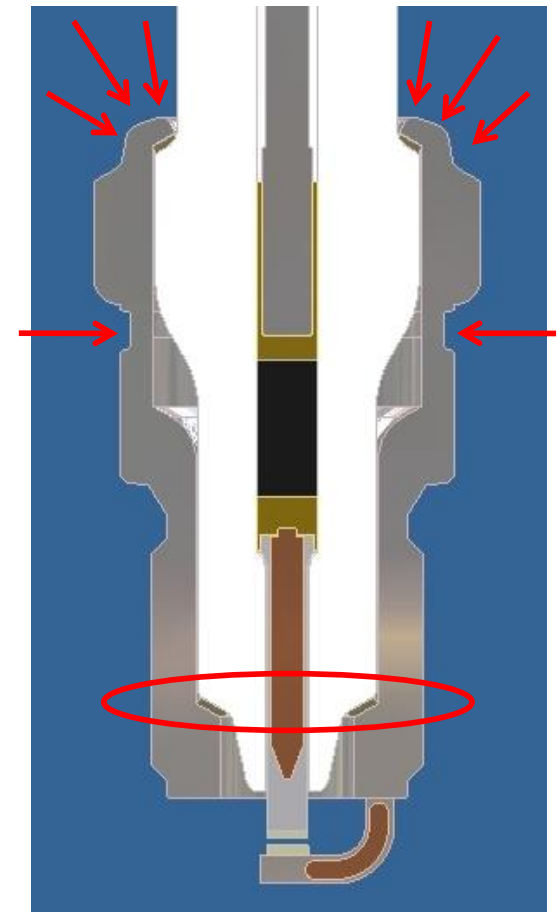
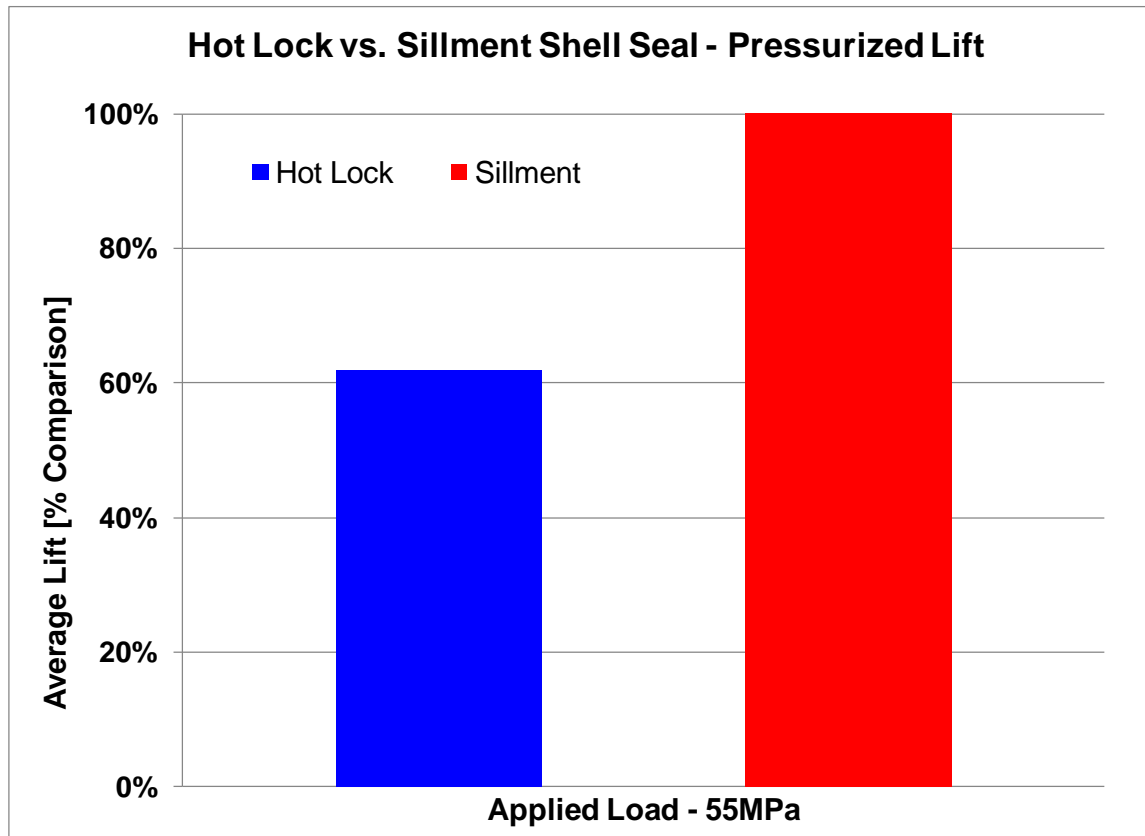


FB M-18 GE Cross Section

- Thin-walled and exposed Cu on new design provides cooler running temperature at center electrode tip of 65-125°C.
- Core seal on IFISS design shows lower temperature of less than 50°C compared to RB77WPCC design
- 25% increase in cross section area (ground electrode) equates to less than 15°C cooler temperature at electrode tip and significantly improved heat transfer out.

FB M-18 Hot Lock Shell Seal

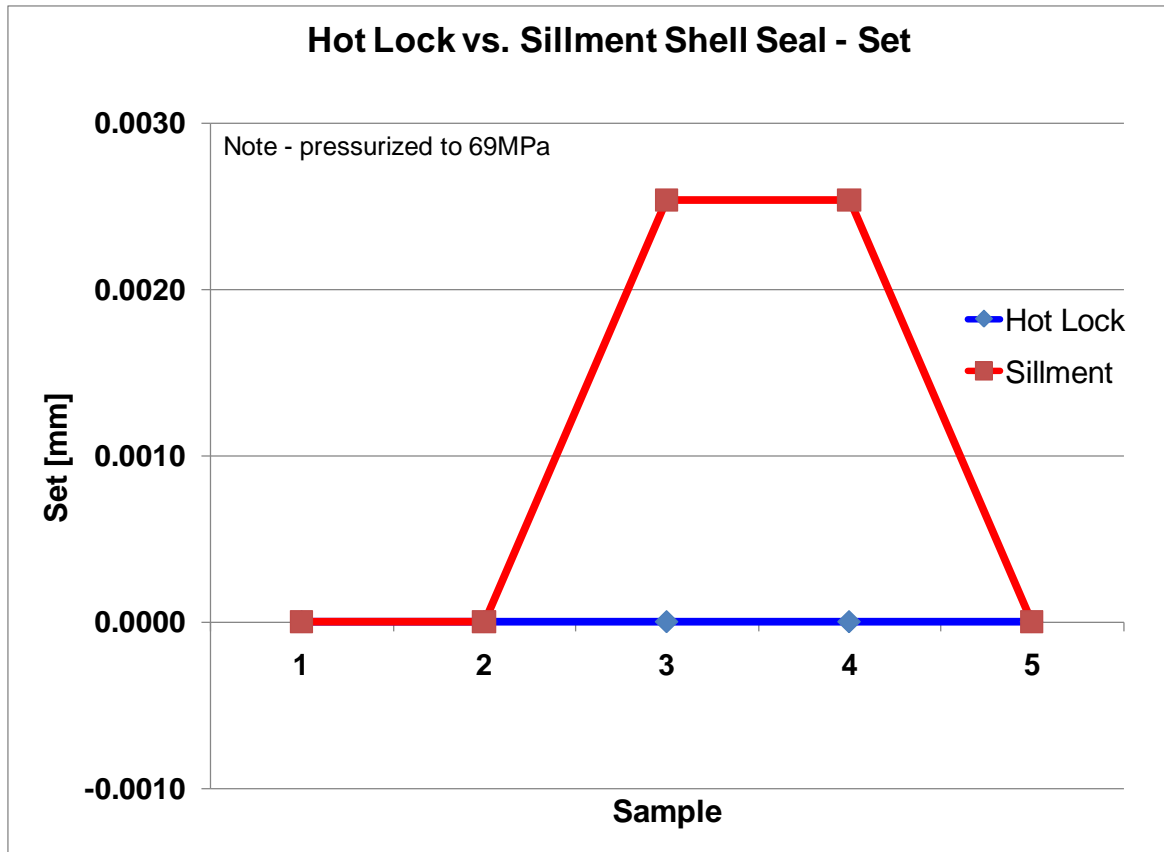
Hot Lock vs. Sillment Shell Seal Comparisons



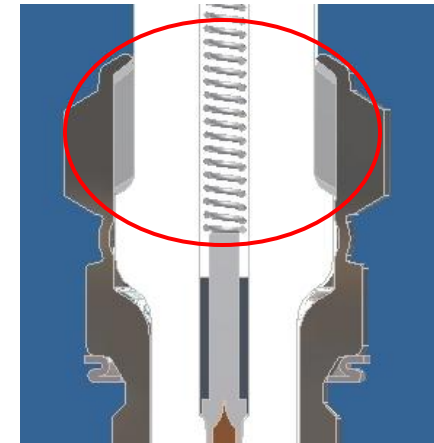
- At 55MPa applied pressure the new hot-lock design shows a 40% reduction in core lift due to increased shell rigidity and pre-assembled load.
- Increased rigidity and pre-assembled load also provide a more consistent, evenly distributed, and higher compression load at the lower shell seat, resulting in improved sealing against combustion gases.

FB M-18 Hot Lock Shell Seal

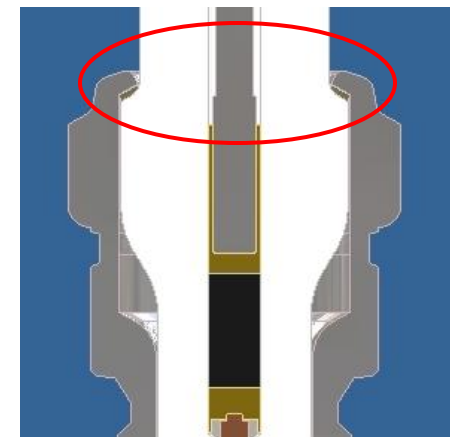
Hot Lock vs. Sillment Shell Seal Comparisons



- At 69MPa applied pressure the new hot-lock design results display “zero” set after release of pressure compared to 0.0025mm lift measured from the Sillment design.



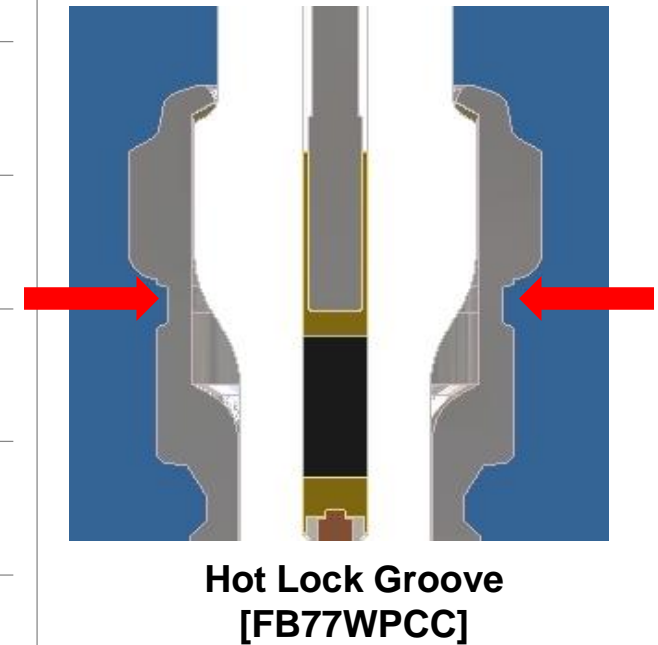
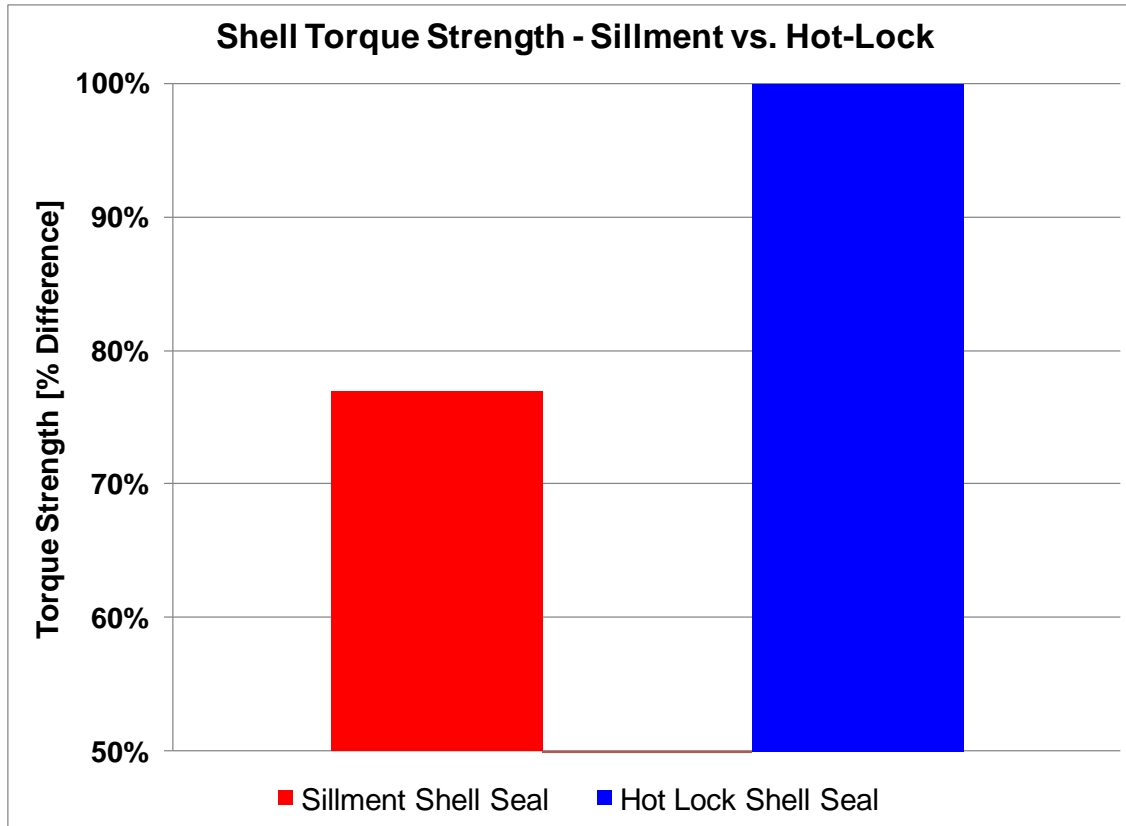
**Sillment
[RB77WPCC]**



**Hot Lock
FB M-18**

FB M-18 Assembly Robustness

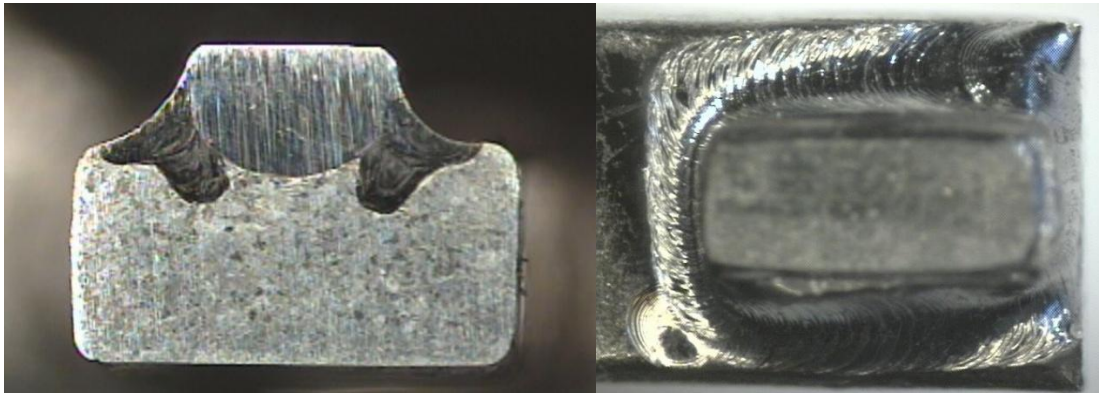
Hot Lock vs. Sillment Shell Seal Comparisons – Shell Torque Strength



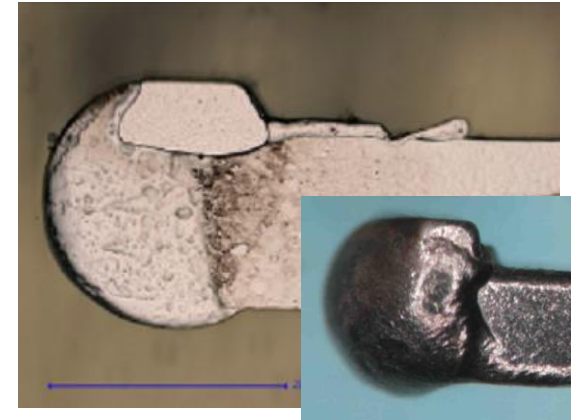
- Shell torque strength testing displayed the hot-lock design to be 25% stronger than the Sillment shell seal design at the smallest cross section. This improvement gives a more robust shell/assembly design allowing for a higher 'margin of error' over torque conditions during engine assembly/disassembly process.

FB M-18 Weld Process Enhancements

Advanced Laser Welding Process



FB M-18 Ground Electrode – Cross Section and A Top View



Current RB77WPCC

- Modulated Continuous Wave (SMCW) Laser Benefits
 - Consistent/uniform weld penetration and coverage
 - Improved bi-metal alloying through improved heat/energy control
 - Multi-configuration compatible (precious metal)
 - Fully automated
 - Weld parameter/input flexibility

FB M-18 Longer Run Life

FB M-18 Service Life Advantage

FB M-18 service life advantage is made possible through the key product improvement areas including;

- IFISS Core Technology
- Electrode Enhancements
- Hot Lock Shell Seal

Product validation via field testing has been completed on multiple OEM applications across the world running on various fuels including CNG, Bio, and Landfill.

