

# HPHT Seal Design Options

## High Pressure, High Temperature

### ELASTOMERS & THERMOPLASTICS

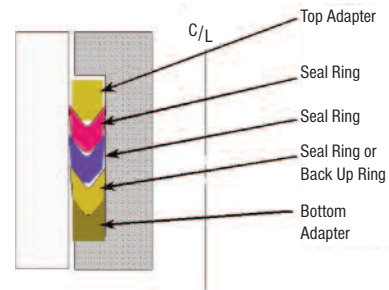
When using elastomers and thermoplastics in critical service applications, there are a number of options in terms of seal configuration and material choice that effectively seal and provide maximum product reliability. These combinations vary based on the sealing conditions faced. Greene, Tweed design engineers pick the best matched material characteristics for optimum seal performance. The table below focuses on designs of multiple redundant seal stack combinations for both uni- and bi-directional HPHT (High Pressure High Temperature) and LPLT (Low Pressure Low Temperature) applications.



### SPECIFICATIONS

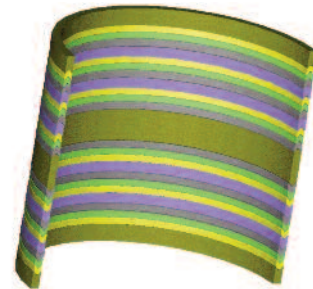
#### Unidirectional

Vee stacks were introduced from a redundancy perspective but used the same compound across the stack. Greene, Tweed introduced the composite stack that combines different elastomers, thermoplastics and metals to cover all service conditions. The following design geometries incorporate materials developed specifically for downhole environment.



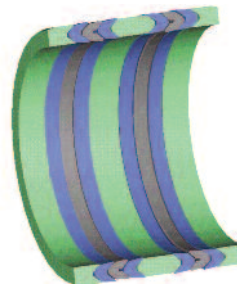
#### Bi-directional

This design incorporates end adapters, center adapters and combinations of steel, elastomeric, Ryton (PPS) and filled PTFE (Avalon®) Vee Rings. In this specific example Arlon® 1000, Fluoraz® 799 and Avalon 16 are used. The combination of elastomer, steel and thermoplastic will seal at both HPHT and LPLT.



#### Bi-directional—Nonelastomeric MSE®

This design incorporates end adapters, center adapters and combinations of thermoplastic and filled PTFE (Avalon) Vee rings. In this specific example Arlon 1000, Fluoraz 799 and Avalon 16 are used. The combination of elastomer and thermoplastic will seal at both HPHT and LPLT. The multiple redundancy concept ensures reliable sealing.



**MSE® with Back-up Ring MSE Stack Assemblies**

Unidirectional MSE assembly on a choke valve featuring an MSE with appropriate Avalon® jacket with a Elgiloy double-coil spring and Arlon® 1000 back-up ring. The Avalon jacket was chosen to pass a 200 psi (1.38 Mpa) nitrogen gas test at ambient temperature. In addition, it also had to hold 15,000 psi (103.42 Mpa) at a higher temperature (350°F, 177°C). It has a cam-activated Arlon 1000 back-up ring to prevent creep and extrusion of the jacket. For static applications the cam-activated back-up ring is preferred because it encourages the backup to close any extrusion gap.



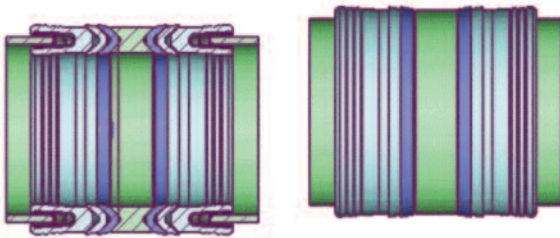
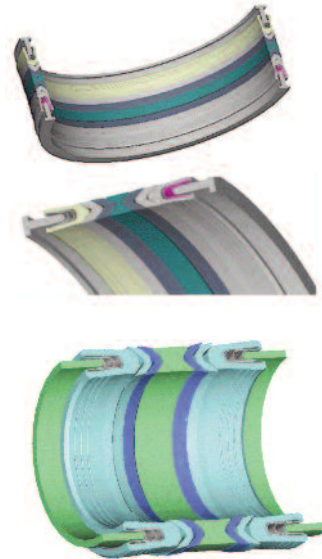
**MSE–Bi-directional with Hat Rings**

Typically two separate grooves are used to handle bi-directional pressure. Greene, Tweed looked at this and developed a single seal assembly capable of handling pressure from both sides, reducing machining cost, simplifying hardware design and installation. The hat ring stabilizes and supports the stack while eliminating damage to the seal. This, in effect, is a modified end adapter. The center adapter prevents twisting and ensures the seal stack remains stable in the gland. This is an effective seal at 350°F (177°C) and 15,000 psi (103.42 Mpa).



**MSE–Combination Stack Assembly**

The next evolutionary step is the MSE stack assembly. This incorporates primary and secondary sealing to ensure multiple redundancy. The MSE is the primary seal, the inclusion of Vee-style seals allows the design to feature combinations of thermoplastics capable of resisting various hostile conditions. This seal is capable of holding 20,000 psi at 350°F (177°C) and passing ports at shifting pressures of 1,500. Our proprietary Avalon material is a high-wear material suited for erosive conditions.



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