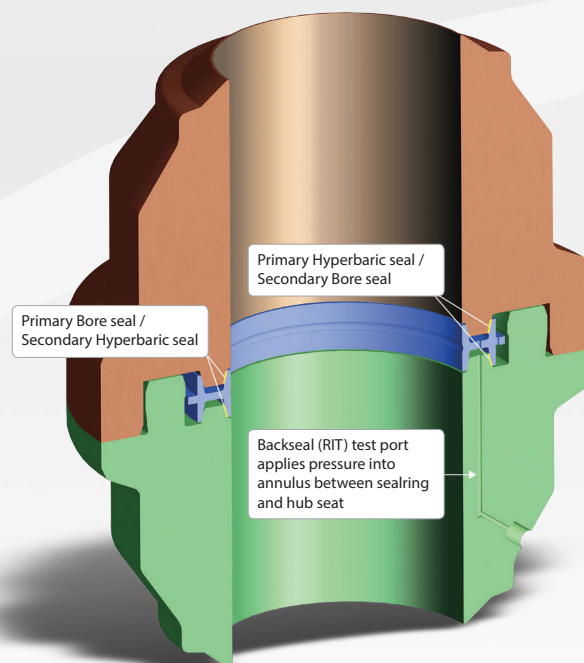


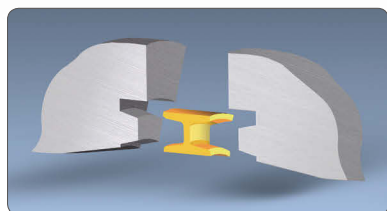
Bi-directional pressure energized dual seal for subsea applications

The only dual acting metal-to-metal seal in the subsea connector world

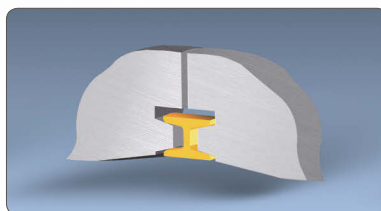
The Vector Duoseal™ is an API qualified metal-to-metal seal that prevents both internal and external leakage of fluids and gases. The joints may be Optima® subsea connectors, special or compact flanges, Techlok® clamp connectors, valve bonnets or any other joint where two seals are preferred. The bore seal capability has been PR2 qualified to 15,000 PSI. The hyperbaric seal acts to give a level of back up bore seal capability. The unique design of Vector Duoseal™ has independent internal and external seals with the capacity to carry out a reverse integrity (RIT) test on the seals.



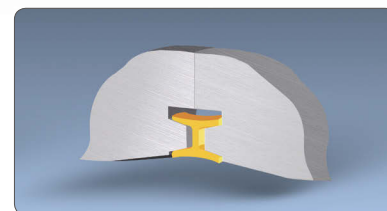
Energization : making the perfect seal



Fully open : The Vector Duoseal™ is shown as being separate from both joint faces. It is most likely that the sealing would be sitting or located in one of the seat pockets.

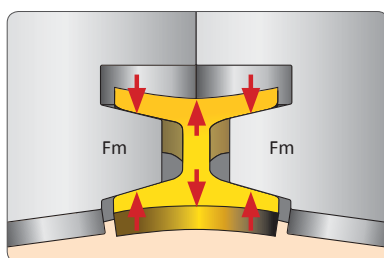
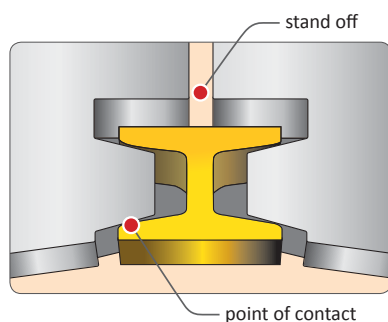


Point of stand off: Once the two faces have been pulled together, all four sealing surfaces are in contact. The stand off between the two faces can be seen.



Fully Energized : The Vector Duoseal™ is self energizing from the point of standoff to fully closed. Once the joint is face to face, the sealing has gone to its maximum point of deflection. This creates the self-energization loads required for the seal to function.

It is the self-energization force " F_m " between the Vector Duoseal™ and seat that creates the initial seal of the joint. The rib between the inner and outer seals ensures energization occurs by reacting against this force.



NOTES : The self energization force is a fraction of seal geometry and is never sufficient to indent the hub faces.

Vector Duoseal™ Sealing

Operating principles and characteristics

Pressurization

Once the joint is pressurized, the Vector Duoseal™ becomes pressure energized. This of course could be due to either internal or external pressure.

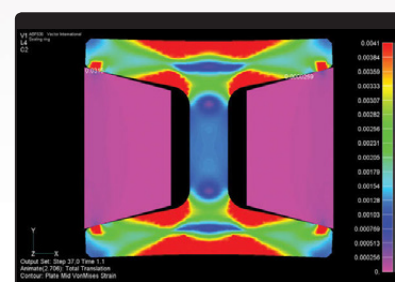
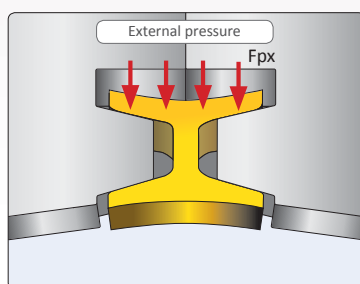
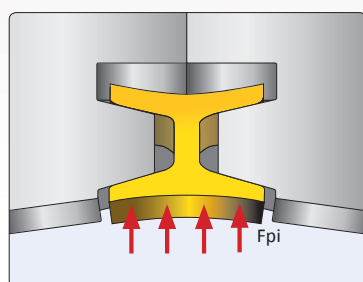
The pressure creates a seating force which further energizes either or both the inner and outer seals. In simple terms the radial sealing force for the inner and outer seals is as follows :

Internal sealing force = $F_m + F_{pi}$

External sealing force = $F_m + F_{px}$

Therefore the greater the pressure the more sealing force exists. There is of course a maximum internal/external pressure that both the Duoseal™ and the joint can withstand; however this is much greater than normal operating pressures.

With the pressure differential between the internal and external values, the central rib will have a tendency to move towards the low pressure side. Finite Element Analysis and testing has shown that within the working limits of the Vector Duoseal™ the resulting deformations will not de-seat the outer pressure seal.



Characteristics

- Field proven up to NPS 36" and qualified at pressures up to 20,000psi
- For use in depths up to and exceeding 13,125ft (4,000m)
- Subsea, bidirectional, pressure energized sealing system provides internal and external pressure integrity
- Re-usable seal which can be used as an integral part of the Vector Optima® connector, Vector Techlok® clamp connector or other licensed manufacturer products
- Spring retention : Sealing can be removed/replaced by ROV using dedicated Vector tooling ^(*)



Type Approval by
Bureau Veritas

Vector Duoseal™ with retention fingers

The retention fingers on the Vector Duoseal™ are designed to locate in a special groove on the inside profile of the male Optima® hub. The profile of the fingers and the special groove give a positive location for the Vector Duoseal™ to prevent accidental release due to impact or shock loads, whilst allowing the Seal Removal Tool to be inserted and reliably remove the sealing when required. The number of fingers depends on the size of the sealing.



Designed for
VECTOR
Optima® subsea connector



(*1)
Also available :
• Seal Face cleaning tool
• Seal Removal tool

Downloadable version of flyer can be found online.

Material selection & functionality

The Vector Duoseal™ can be manufactured from various materials, however most Duoseal™ sealings installed subsea are made from Alloy 725 or similar. These materials are selected to utilize the higher strength and flexibility of the material. The seal face is inlaid with Alloy 625.

Standard gaskets (such as API 6A BX gaskets) are crushed into place when the connection is made, requiring the seal faces to be harder than the sealings. The Duoseal™ does not operate in this fashion. It is energized predominantly in the elastic range of the material, so there is no need to have the seal face harder than the sealing.

| Application | Hub/seat material | Recommended Duoseal™ Material | Comments |
|---------------------------|--|---|---|
| Subsea | Alloy 625 overlay | Alloy 725 Alloy 716 | Standard supply for all subsea applications |
| | | High strength Low alloy steel | For hydrotest and FAT only - at clients request |
| Topside piping and valves | Alloy 625 overlay Carbon Steel | Alloy 725 Alloy 716 High strength Low alloy steel | |
| Pressure Vessels | Various: dependant on vessel construction. | Suitable compatible high strength material | Seal selection on a "case by case" basis |

NOTE : Standard DUOSEALS are supplied with a MoS2/Graphite coating for low friction during assembly. For subsea service, silver coated sealings are also available.

Annulus test and dimensional data

Annulus Test

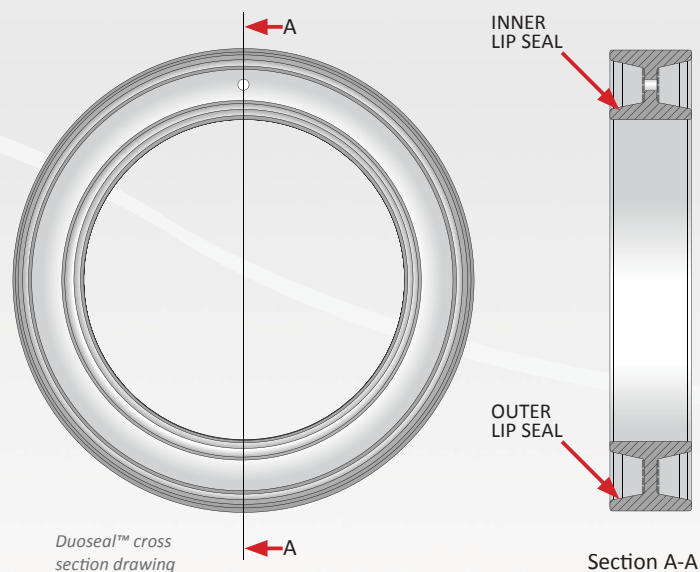
The void between the inner and outer seals is ideal for carrying out a Reverse Integrity Test (RIT). This test will prove that the joint has been correctly assembled and that the seals are intact. The selected pressure for the RIT test is independent of either internal or external pressures and purely tests the seals pressure integrity in-situ. The RIT pressure is attempting to lift the sealing off the seat. If the force on the sealing lips is "Frit" in simple terms the following is true:

Internal sealing force = $F_m - F_{rit}$

External sealing force = $F_m - F_{rit}$

This means as the RIT pressure increases it will get closer to the make-up force. At the point where $F_m = F_{rit}$ the seal would no longer be in contact with the seat. The test is therefore set to be conservative in nature.

The Vector Duoseal™ is proven in sizes from 2" to 34" in water depths up to 13,125ft (4,000m) at temperatures ranging from



-50°C to 150°C, and at pressures up to 15,000psi, making it suitable for most known subsea applications, and as an alternative to RIT rings for Topside joint integrity.

Dimensional Data

| Ring Size | Outside Diameter | | Inside Diameter | | Ring Overall Length | | Ring Weight | |
|-----------|------------------|------|-----------------|------|---------------------|------|-------------|-----|
| | inch | mm | inch | mm | inch | mm | lbs | kg |
| 20 | 3,38 | 85,7 | 2,00 | 50,8 | 0,83 | 21,0 | 0,68 | 0,3 |
| 24 | 3,88 | 98,4 | 2,50 | 64 | 0,83 | 21,0 | 0,81 | 0,4 |
| 30 | 4,38 | 111 | 3,00 | 76 | 0,83 | 21,0 | 0,93 | 0,4 |
| 34 | 4,88 | 124 | 3,50 | 89 | 0,83 | 21,0 | 1,06 | 0,5 |
| 40 | 5,63 | 143 | 4,00 | 102 | 1,00 | 25 | 1,63 | 0,7 |
| 44 | 6,13 | 156 | 4,50 | 114 | 1,00 | 25 | 1,78 | 0,8 |
| 50 | 6,63 | 168 | 5,00 | 127 | 1,00 | 25 | 1,95 | 0,9 |
| 54 | 7,13 | 181 | 5,50 | 140 | 1,00 | 25 | 2,12 | 1,0 |
| 60 | 7,75 | 197 | 6,00 | 152 | 1,13 | 29 | 3,10 | 1,4 |
| 64 | 8,25 | 210 | 6,50 | 165 | 1,13 | 29 | 3,32 | 1,5 |
| 70 | 8,75 | 222 | 7,00 | 178 | 1,13 | 29 | 3,55 | 1,6 |
| 74 | 9,25 | 235 | 7,50 | 191 | 1,13 | 29 | 3,77 | 1,7 |
| 80 | 9,75 | 248 | 8,00 | 203 | 1,13 | 29 | 4,00 | 1,8 |
| 82 | 10,00 | 254 | 8,25 | 210 | 1,13 | 29 | 4,11 | 1,9 |
| 84 | 10,25 | 260 | 8,50 | 216 | 1,13 | 29 | 4,23 | 1,9 |
| 86 | 10,50 | 267 | 8,75 | 222 | 1,13 | 29 | 4,34 | 2,0 |
| 90 | 10,88 | 276 | 9,00 | 229 | 1,19 | 30 | 5,13 | 2,3 |
| 94 | 11,38 | 289 | 9,50 | 241 | 1,19 | 30 | 5,39 | 2,4 |
| 100 | 11,88 | 302 | 10,00 | 254 | 1,19 | 30 | 5,64 | 2,6 |
| 104 | 12,38 | 314 | 10,50 | 267 | 1,19 | 30 | 5,90 | 2,7 |
| 110 | 12,88 | 327 | 11,00 | 279 | 1,19 | 30 | 6,16 | 2,8 |
| 114 | 13,38 | 340 | 11,50 | 292 | 1,19 | 30 | 6,42 | 2,9 |
| 120 | 13,88 | 352 | 12,00 | 305 | 1,19 | 30 | 6,52 | 3,0 |
| 124 | 14,38 | 365 | 12,50 | 318 | 1,19 | 30 | 6,93 | 3,1 |
| 130 | 14,88 | 378 | 13,00 | 330 | 1,19 | 30 | 7,19 | 3,3 |
| 134 | 15,38 | 391 | 13,50 | 343 | 1,19 | 30 | 7,45 | 3,4 |
| 140 | 16,00 | 406 | 14,00 | 356 | 1,25 | 32 | 8,61 | 3,9 |
| 144 | 16,50 | 419 | 14,50 | 368 | 1,25 | 32 | 9,10 | 4,1 |

NOTES : 1) Materials for subsea use Alloy 725 or equivalent
2) Hydrotest rings available in AISI 4140

| Ring Size | Outside Diameter | | Inside Diameter | | Ring Overall Length | | Ring Weight | |
|-----------|------------------|-----|-----------------|-----|---------------------|----|-------------|------|
| | inch | mm | inch | mm | inch | mm | lbs | kg |
| 150 | 17,00 | 432 | 15,00 | 381 | 1,25 | 32 | 9,39 | 4,3 |
| 154 | 17,50 | 445 | 15,50 | 394 | 1,25 | 32 | 9,69 | 4,4 |
| 160 | 18,00 | 457 | 16,00 | 406 | 1,25 | 32 | 9,98 | 4,5 |
| 164 | 18,50 | 470 | 16,50 | 419 | 1,25 | 32 | 10,27 | 4,7 |
| 170 | 19,00 | 483 | 17,00 | 432 | 1,25 | 32 | 10,57 | 4,8 |
| 174 | 19,50 | 495 | 17,50 | 445 | 1,25 | 32 | 10,86 | 4,9 |
| 180 | 20,00 | 508 | 18,00 | 457 | 1,25 | 32 | 10,90 | 4,9 |
| 184 | 20,50 | 521 | 18,50 | 470 | 1,25 | 32 | 11,45 | 5,2 |
| 190 | 21,00 | 533 | 19,00 | 483 | 1,25 | 32 | 11,74 | 5,3 |
| 194 | 21,50 | 546 | 19,50 | 495 | 1,25 | 32 | 12,04 | 5,5 |
| 200 | 22,00 | 559 | 20,00 | 508 | 1,25 | 32 | 12,33 | 5,6 |
| 204 | 23,00 | 584 | 20,50 | 521 | 1,50 | 38 | 17,32 | 7,9 |
| 210 | 23,50 | 597 | 21,00 | 533 | 1,50 | 38 | 17,72 | 8,0 |
| 214 | 24,00 | 610 | 21,50 | 546 | 1,50 | 38 | 18,12 | 8,2 |
| 220 | 24,50 | 622 | 22,00 | 559 | 1,50 | 38 | 18,52 | 8,4 |
| 224 | 25,00 | 635 | 22,50 | 572 | 1,50 | 38 | 18,91 | 8,6 |
| 230 | 25,50 | 648 | 23,00 | 584 | 1,50 | 38 | 19,31 | 8,8 |
| 234 | 26,00 | 660 | 23,50 | 597 | 1,50 | 38 | 19,71 | 8,9 |
| 240 | 26,50 | 673 | 24,00 | 610 | 1,50 | 38 | 20,11 | 9,1 |
| 244 | 27,00 | 686 | 24,50 | 622 | 1,50 | 38 | 20,51 | 9,3 |
| 250 | 27,50 | 699 | 25,00 | 635 | 1,50 | 38 | 20,90 | 9,5 |
| 254 | 28,00 | 711 | 25,50 | 648 | 1,50 | 38 | 21,30 | 9,7 |
| 260 | 28,50 | 724 | 26,00 | 660 | 1,50 | 38 | 21,70 | 9,8 |
| 264 | 28,96 | 736 | 26,46 | 672 | 1,50 | 38 | 21,25 | 9,6 |
| 270 | 30,00 | 762 | 27,00 | 686 | 1,75 | 44 | 32,18 | 14,6 |
| 280 | 31,00 | 787 | 28,00 | 711 | 1,75 | 44 | 33,30 | 15,1 |
| 290 | 32,00 | 813 | 29,00 | 737 | 1,75 | 44 | 34,43 | 15,6 |
| 300 | 33,00 | 838 | 30,00 | 762 | 1,75 | 44 | 35,82 | 16,2 |

3) Intermediate and larger sizes available upon request.
4) Contingency seals available for all sizes