4½-in HSD High Shot Density Perforating Gun System

High shot density with optimal phasing and featuring PowerJet family of deep penetrating shaped charges

The 4½-in HSD* high shot density perforating gun system is for operations in 7-in casing but has applications in larger completions where downhole restrictions limit gun size.

Where deep penetration is critical—for natural completions, penetrating beyond formation damage, or in hard formations—PowerJet Omega* deep penetrating and PowerJet Nova* extradeep penetrating shaped charges are used. PowerJet Omega charges increase penetration depth on average by 20% compared with the performance of previous-generation shaped charges. The extradeep perforations produced by PowerJet Nova charges deliver 50% more formation contact for more effective stimulation treatments and increased drainage contact for greater productivity.

For sand prevention, the combination of optimized phasing with high shot density and deep penetrating charges prevents failure of the sand around the perforation cavity and minimizes perforation-to-perforation collapse. The 4½-in HSD gun has a 12-spf option with 135°/45° phasing using PowerJet* 4512 deep penetrating charges.

Sand control requires high shot density, optimized phasing, and big hole charges to maximize the area open to flow. The 4½-in HSD gun is used with PowerFlow* slug-free big hole shaped charges for this application.

The 4½-in HSD guns can be conveyed using wireline, slickline, tubing, or coiled tubing. Multiple guns are easily aligned with alignment intercarriers.

### Mechanical Specifications

- **Outside diameter, in**: 4½; With fin standoffs: 5.75
- **Shots per foot (spf), phasing, °**: 4, 0/180; 5, 72; 6, 120; 12, 135/45
- **Shot spacing, in**: 4 spf: 3; 5 spf: 2.4; 6 spf: 2; 12 spf: 1
- **Temperature rating, degF [degC]**: 400 [204]†
- **Pressure rating, psi**: 11,000
- **Min. casing size, in**: 7
- **Nominal lengths, ft**: 5, 10, 20
- **Interval missed between guns, in**: 12
- **Max. outside diameter including burrs, in**: Shot in liquid: 4.74 to 4.91
  Shot in gas: Not rated for gas
- **Loaded 20-ft gun weight in air, lbm**: 5 spf: 510‡; 21 spf: 597‡
- **Tensile load, lbf**: Recommended: 185,000§

† With high-temperature explosives and seals
‡ Depends on gun configuration and charge type
§ Based on worst-case material and machining tolerances
4½-in HSD High Shot Density Perforating Gun System

Shot patterns for the 4½-in HSD gun system for 7-in casing.

API Statistics

API RP 19B shot in 7-in 32.0-lbm/ft casing

<table>
<thead>
<tr>
<th>Charge</th>
<th>Explosive Type, Max. Weight, g</th>
<th>Shots per Foot, Phasing,°</th>
<th>Entrance Hole, in</th>
<th>Burr Avg./Max., in</th>
<th>Area Open to Flow, in²/ft</th>
<th>Penetration, in</th>
<th>Temperature, degF</th>
<th>Target Strength, psi</th>
<th>Test Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>PowerJet Omega 4505‡</td>
<td>HMX, 38.8</td>
<td>5, 72</td>
<td>0.45</td>
<td>0.08/0.13</td>
<td>—</td>
<td>65.2</td>
<td>1 h: 400</td>
<td>5,965</td>
<td>06/2012</td>
</tr>
<tr>
<td>PowerJet 4505‡</td>
<td>HMX, 38.6</td>
<td>5, 72</td>
<td>0.47</td>
<td>0.08/0.15</td>
<td>—</td>
<td>46.4</td>
<td>1 h: 400</td>
<td>6,583</td>
<td>12/2004</td>
</tr>
<tr>
<td>PowerJet 4512‡</td>
<td>HMX, 22.0</td>
<td>12, 135/45</td>
<td>0.34</td>
<td>0.07/0.12</td>
<td>—</td>
<td>30.2</td>
<td>1 h: 400</td>
<td>6,802</td>
<td>11/2002</td>
</tr>
<tr>
<td>PowerJet Omega 4512‡</td>
<td>HMX, 22.0</td>
<td>12, 135/45</td>
<td>0.35</td>
<td>0.07/0.12</td>
<td>—</td>
<td>34.0</td>
<td>1 h: 400</td>
<td>5,789</td>
<td>09/2005</td>
</tr>
<tr>
<td>UltraJet* 4505†</td>
<td>HMX, 38.6</td>
<td>5, 72</td>
<td>0.46</td>
<td>0.08/0.13</td>
<td>—</td>
<td>42.6</td>
<td>1 h: 400</td>
<td>7,308</td>
<td>01/2002</td>
</tr>
<tr>
<td>PowerFlow 5008‡</td>
<td>RDX, 30.0</td>
<td>6, 120</td>
<td>0.93</td>
<td>0.12/0.18</td>
<td>4.08</td>
<td>6.0</td>
<td>1 h: 340</td>
<td>5,992</td>
<td>03/2006</td>
</tr>
</tbody>
</table>

1 Entrance hole, penetration, temperature
2 API 19B Registered Perforation Systems

www.slb.com/perforating