MODULAR FLEXIBLE PERFORATING SYSTEM.
PERFORATING-EXPLOSIVE OPERATIONS RISK MITIGATION AND EFFICIENCY IMPROVEMENT

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1. Introduction: General information

Modular flexible perforating system «Snake BVT» (hereinafter «MPS») resolves the following issues in the areas below:

- Technological hazards – flexible perforating system (PS) design allows successful performance of perforating-explosive operations in well bores of any curvature and reduces the possibility of problems related to the discharged perforator recovery;
- Potential human error risk – ease of assembly of the MPS decreases the human error factor on the work results;
- Decrease of span time and material costs for perforating-explosive operations – MPS system is able to shorten substantially the duration of blasting-perforation (perforating-explosive) operations, especially, when the work is performed on the cable with perforating intervals more than 7 meters.
2. Design features and possibilities of applying

**Key elements:**

1. Perforation system standard cases;
2. Commonly used coupling and detonation transferring unit UU-AT:
   - Consists of transferring and intake devices.
   - Quick release flexible coupling adopted for different PS sizes (Ø 50÷114 mm);
   - Saves integrity after shoot-off that allows to form PS assemblies with length up to 500 m.
Due to flexibility, the system eliminates restrictions on drift angle build-up (when short sections of 0.5 – 1 m are used, the bend between the sections can reach of 8-10°, therefore it is possible to launch MPS by 75-85° on the interval of approx. 10-15 m).
## 3. MPS technical specifications

<table>
<thead>
<tr>
<th>No.</th>
<th>Technical specifications</th>
<th>Parameter value for the size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Jet perforator 50-AT</td>
</tr>
<tr>
<td>1</td>
<td>Outer diameter of multi-section perforator, mm</td>
<td>without centralizers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>with centralizers</td>
</tr>
<tr>
<td>2</td>
<td>Density of perforation, shots/m</td>
<td>*</td>
</tr>
<tr>
<td>3</td>
<td>Charge phasing, °</td>
<td>**</td>
</tr>
<tr>
<td>4</td>
<td>Section conditional length, m</td>
<td>***</td>
</tr>
<tr>
<td>5</td>
<td>Maximum allowable hydrostatic pressure, MPa</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Maximum length of multi-section perforator assembly per one run, no more than, m</td>
<td></td>
</tr>
</tbody>
</table>

* - density of perforations can be changed upon customer request; ** - phasing 0°, 45°, 90°, 180° is possible upon customer request; *** - different lengths of section are available upon customer request; **** - purpose-made HP with the supply of high-temperature charge for hollow-carrier multiple action jet perforator
### 4. Experience in application: MPS using in complicated geology-technical condition of Western Siberia field

<table>
<thead>
<tr>
<th>Task</th>
<th>Blasting-perforation works on production tubing under complicated geology-technical condition (with high intensity of drift angle buildup in the completion interval).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conditions</td>
<td></td>
</tr>
</tbody>
</table>
- perforation interval depth 2950-3140 m;  
- current total depth 3144 m;  
- inclination maximum angle 91 grad. 19 min. at the depth of 3060 m;  
- drift angle buildup maximum intensity 4.24 grad. per 10 m (depth 2820 m). |
| Solution | Perforation is made in the interval of 3046-3140 m. (93.66 m) using 73-AT SNAKE BVT jet perforator system with 73-AT-M-01 (1680 pcs.) charges for hollow-carrier multiple action jet perforator and second operational run in the interval of 2950-3046.34 m (1720 charges). |
| Results | All the works are performed during routine operation, multi-section assembly perforators have activated completely, equipment faults are not registered. |
4. Experience in application: MPS industrial application

**PROGRESS ACHIEVED:**

- easy rigging up and assembly compared with standard perforating systems;
- significant reduction of perforating-explosive operations duration.
- design continuous improvement in the process of the industrial application for different unconventional geotechnical tasks solving.

<table>
<thead>
<tr>
<th>Region</th>
<th>Well hole number, pcs.</th>
<th>Total interval, m.</th>
<th>Average interval per one well hole, m.</th>
<th>Total time save, h.</th>
<th>Average time save per 1 well hole, h.</th>
<th>Average time save, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Siberia</td>
<td>732</td>
<td>2961.6</td>
<td>28.64</td>
<td>6017.04</td>
<td>8.22</td>
<td>34.57</td>
</tr>
<tr>
<td>Volga federal district</td>
<td>89</td>
<td>1280.5</td>
<td>14.39</td>
<td>463.69</td>
<td>5.21</td>
<td>20.72</td>
</tr>
<tr>
<td>Other regions</td>
<td>53</td>
<td>1436.3</td>
<td>27.1</td>
<td>422.41</td>
<td>7.97</td>
<td>32.65</td>
</tr>
</tbody>
</table>

Well hole downtime decrease

- Total duration of perforation standard performing, h.: 23549.49
- Total duration of SNAKE BVT perforation, h.: 16646.35
5. Results assessment

- Advanced reliability and safety – the faults and emergencies do not occur;
- Sealing and thread damage are eliminated during the installation on well head;
- Time save is confirmed for perforating-explosive operations performing on the intervals more than 7 m;
- MPS capabilities in the well holes with high intensity of drift angle build-up are confirmed;
6. Development: self-aligning MPS

**PURPOSE:**
for blasting-perforation works performing in slanted and lateral oil and gas well holes.

**PROVIDES:**
- completing in the direction set;
- ability to select the jet charge phasing for V-version.

**FEATURES AND ADVANTAGES:**
- Easy and quick assembly due to flexible coupling;
- Time save at elongated intervals perforation;
- Versatility (ability to use universal coupling unit UU-AT);
- Ability to perform the combined perforation using deeply extending and large hole charges;
- Additional operations for perforating system alignment in the perforating interval are not required.
6. Development: MPS with reusable UU-AT

**PURPOSE:**

- perforating-explosive operations performing in the well holes of large curvature up to 8 grad/10 m;
- Reduced time for installation at well head;
- Increased detonation transmission device in-use life up to 5 shots due to replacement parts.
Thank you!
Questions?

BVT JSC
Modular flexible perforating system. Perforating-explosive operations risk mitigation and efficiency improvement