Thank you for choosing VAM EIS®

Valourec Drilling Products is committed to provide its customers with high quality products following demanding internal procedures aimed to reach our main goals: customer satisfaction and high performance drilling product supply.

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<th>Date</th>
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<td>2018-01-23</td>
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Created by: Sebastien VILLERT, VRCC R&D Project Leader
Verified by: Eric VERGER, VRCC I, R&D General Manager
Approved by: Marta LAFUENTE, VDP Product Champion

VRCC is the Vallourec Research Center Connections department & VDP is the Vallourec Drilling Products division
Disclaimer

This procedure defines the preparation and precautions to take when running drill pipe with VAM EIS® connections. It is divided into 3 sections: Product Description, Rig Site Procedures & Inspection and Repair Procedures.

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For more information on VAM® connections and Vallourec tubes steel grades, please visit www.vallourec.com.

VAM® Field Service and Vallourec Drilling Products Engineers are available worldwide to assist with handling and running supervision at the rig site. For details of your nearest VAM® Field Service Centre, please contact your Vallourec Drilling Products regional sale office (cf. section 8).

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- Scotch-Brite™ is registered trademark of 3M.
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1 Safety and Environment

1.1 Lifting, Stepping and Handling the pipe

People in charge of lifting, stepping or handling operations have to follow basic safety rules by using personal protective equipment and not standing under heavy loads.

1.2 Thread Compound Recommendations

Vallourec Drilling Products is concerned about the use of its products on the field and their environmental impact. Please follow Vallourec Drilling Products recommendations regarding quantities and application procedures for thread compounds. Use of the thread compounds on Vallourec Drilling Products is required to guarantee safe operations and good product performances.

2 Product Description

VAM EIS® (External Internal Shoulder) is a double shoulder high torque drill pipe connection. It is ideal for high torque drilling applications. The addition of an internal shoulder allows more torque to be applied to the connection. It is a connection compatible with API threads. All references to VAM EIS® connections will be preceded by the name of the compatible API connector. For example, '5 1/2" FH VAM EIS®' is the VAM EIS® size compatible with '5-1/2 FH API'.

VAM EIS® tool joints are available in range of materials including Sour Service resistance grades. VAM EIS® is specially adapted for challenging environments since it outperforms API connections even when manufactured with a lower strength steel.

Figure 1. VAM EIS® tool joints amongst
Figure 2. Torsional strength comparison between API vs VAM EIS® tool joints

Figure 3. Tensile strength comparison between API vs VAM EIS® tool joints
The nomenclature used in this procedure are shown on the following sketch:

![Drill pipe description](image)

Note: Primary shoulder is also called external shoulder; secondary shoulder is also called internal shoulder.

The following scheme presents a VAM EIS® connector:

![VAM EIS® connector](image)
The following table presents compatibility between VAM EIS® and standard API rotary shouldered connections:

For compatibility with other types of connections please contact Vallourec Drilling for details.

<table>
<thead>
<tr>
<th>VAM EIS® Compatibility with API Shouldered Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 7/8 PAC</td>
</tr>
<tr>
<td>NC26</td>
</tr>
<tr>
<td>NC31</td>
</tr>
<tr>
<td>NC38</td>
</tr>
<tr>
<td>NC40</td>
</tr>
<tr>
<td>NC46</td>
</tr>
<tr>
<td>NC50</td>
</tr>
<tr>
<td>5 1/2 FH</td>
</tr>
<tr>
<td>6 5/8 FH</td>
</tr>
</tbody>
</table>

Table 1. VAM EIS® with API compatibility charts
3 Rig site Procedures

3.1 Inspection on arrival at rig site of new drill pipe

When the drill pipe arrives at the rig site, the first thing to do is to verify that the delivered pipe is the expected quantity and type. This can be done by counting the pipe and by checking the pipe and the tool joint ODs. This verification process can be done using Vallourec Drilling Products certification package. In case the pipe is not the correct type or quantity, please contact the personnel at the pipe yard immediately.

Next check that all the protectors are in place and have not been damaged or lost during transportation. In case of lost or damaged protectors, please check the connections as described hereafter. If protectors are found to be missing or damaged, the replacement ones should be sought from the supplier. If the pipe is not going to be used immediately, then check that the storage compound is in good condition in order to prevent corrosion of the connections.

It is recommended to check that the Performance Data Sheet [PDS] for the product that you have at the rig site rather than wait until you are about to use it. Indeed, it lists the critical dimensions, performances and make-up torque values. The PDS is delivered to the customer: for any needs, please contact Vallourec Drilling Products regional sale office (cf. section 8).

Figure 6. Inspection on arrival at rig site of new pipe
3.2 Handling of drill pipe on location

Like most pipe used at a rig site, care must be taken when handling to avoid any damage. The risk of damage is reduced by handling pipe at all times with thread protectors fitted. Only remove the thread protectors on the drill floor immediately prior to make-up the connections.

VAM EIS® tool joints are designed to be used with conventional 18° bottleneck elevators.

3.3 Application of thread compound (running dope)

Before applying the thread compound on the connectors, ensure that the threads and the shoulders are clean and free of dirt or other foreign material. Drilling fluids and/or additives may affect the frictional properties of the thread compound or increase the chance of corrosion within the connector, thus it is important to rinse all foreign material off the connection prior applying the thread compound.

In order to ease the application of thread compound in cold climate it may be necessary to heat the compound before application. Never add solvents to thin the thread compound.

Apply a uniform layer of thread compound, step by step:

- on the PIN threads,
- on the PIN shoulders.

It is not necessary to apply thread compound to the BOX end. If thread compound is used on BOX end, separate thread compound buckets should be used for BOX and PIN to reduce mud contamination to one set of doped threads.
The thread compound should be applied evenly but sparingly so that the thread profile is still visible as shown in the following pictures:

![Figure 7. The correct application of thread compound](image)

![Figure 8. Too little thread compound](image)

![Figure 9. Too much thread compound](image)

It is important that the proper amount of thread compound is applied on connections. Vallourec Drilling Products is concerned about the use of its products on the field and their environmental impact. Please follow Vallourec Drilling Products recommendations regarding application procedures for thread compounds.

After application of the thread compound, the lid must be set over the bucket in order to prevent foreign material or water from entering the bucket and contaminating the compound.

### 3.4 Make-Up & Break-Out

Proper make-up of connections by engaging both external and internal shoulders with sufficient preloading is the most important factor in prevention of fatigue failure. As with any drill pipe connector, making-up tool joints with rig tongs can put high bending loads in the pipe, so it is necessary to ensure that the connection is the correct height above the rotary table.

It is important to ensure good alignment between PIN and BOX connectors during make-up to avoid galling of threads and other damage that can occur during stabbing and spinning in.
A stand of drill pipe can weigh more than 2,500 lbs. If poorly stabbed the entire weight of the stand could be supported by the sharp edge of just one thread. This can cause high contact stresses or damage to the threads and inadvertently remove the phosphate coating or the thread compound. The whipping action of spinning pipe can also cause high loads on threads when running in stands. As a result care must be taken during stabbing.

The tong capacity should be 140% to 150% of the recommended make-up torque to allow trouble-free break-out even after drilling operations.

Avoid banging the PIN threads or PIN nose surface while disengaging the connection.

Slip and tong dies can cause damage to the tool joint, so every possible effort should be made to keep such damage to a minimum by using low marking die insert if available.

It is recommended to place the tong dies as far from the external shoulder as possible (minimum 2") while staying above the hardbanding. For PIN side it is recommended to place the tong 1" minimum from the shoulder.

The Make-Up Torque [MUT] values are available on Performance Data Sheets [PDS] that are supplied with the product. If needed, please contact your Vallourec Drilling Products regional sale office (cf. section 8).

When two products presenting different grades are assembled together, the recommended Make-Up Torque of the one with the lowest grade has to be used.

Published Make-Up Torque values must be corrected by multiplying them by the thread compound Friction Factor* [FF].

Example:

Published recommended Make-Up Torque = 20,000 ft.lbs
Thread compound Friction Factor* = 1.12

Final Make-Up Torque = 20,000 \times 1.12 = 22,400 ft.lbs

(*) Vallourec Drilling Products declines any responsibility if thread compound does not meet supplier specifications.
A typical torque graph should show the following characteristics as shown in the following graph:

![Torque graph](image)

Figure 10. Typical make-up torque graph

### 3.5 Marking after Make-Up

After having made-up the connection, apply a mark on PIN and BOX face to face to evaluate a possible overtorque during operations:

![Reference mark](image)

Figure 11. Reference mark after connector make-up

### 3.6 Accessories

Only use VAM EIS® connections on accessories made-up for VAM EIS® drill pipe.
3.7 MAX. Break-Out Torque value

The Break-Out Torque (BOT) value should be between 80% and 100% of the Recommended Make-Up Torque (MUT) presented in the connector Performance Data Sheet (PDS).

Monitor the Break-Out Torque (BOT) value. If this torque is higher than the specified MUT, the connection should be inspected for mechanical damage such as BOX swelling and PIN stretching from over torque caused by down hole make-up. In this case, use inspection program presented in section 4.

Figure 12. MAX. Break-Out Torque value

3.8 Standing pipe back

If threaded protectors are used, it is not recommended to use pressed steel protectors as they may allow the weight of the stand to be supported by the primary make-up shoulder of the connection on the sharp edge of the thread protector.

When racking the pipe back in the derrick, it is important to apply oil, grease or thread compound to the connections to avoid the risk of corrosion.
4 Inspection of used pipe

VAM EIS® tool joint shall be inspected in accordance with common drill pipe inspection procedures, such as API RP 7G, and takes into account points presented here-after.

People performing inspection shall be familiar with their inspection practices and have all necessary certification prior to the inspection.

4.1 Cleaning of the connections

Prior to inspection, remove thread protectors and thoroughly clean connections by using a non-metallic brush or steam cleaner. All thread and shoulder sections shall be cleaned to allow visual inspection and dimensional checks.

4.2 Visual inspection

The same rules as in section 3.1 have to be used.

In addition, visually inspect the internal surfaces of the tool joint as well as the PIN and BOX threads and torque shoulders in accordance with common drill pipe inspection procedures, such as recommended practice API RP 7G.

All connectors and tool joint bodies shall be free of visible cracks. Hairline cracks in the hardbanding are acceptable if they do not extend into base metal. Specialized companies can check this and repair the hardbanding as required.
4.2.1 Shoulder damage acceptance

The PIN and BOX shoulders shall be free from nicks, fins, galls and other damage in accordance with recommended practice API RP 7G.

External shoulder damage (pitting or interruptions) that does not exceed 0.8 mm (1/32") in depth and crosses less than 30% of the radial width of the shoulder area is acceptable (cf. following scheme). If the damage exceeds these limits, re-facing is required to repair the shoulder surface, see section 5.

All rejects shall be documented on an inspection report.

![Diagram of shoulder damage acceptance](image)

If \( \frac{x}{\text{width}} > 30\% \), the connection must be rejected.

The internal shoulder is not a seal, it is a mechanical shoulder. No raised, metal or imperfections that could prevent proper make-up are permitted. This shoulder, if damaged can be hand filed.

Figure 13. External shoulder damage acceptance
4.2.2 Control of refacing

Drill pipe machined with VAM EIS® design have benchmark on PIN and BOX external shoulders to check whether the connector can be re-faced or not.

PIN benchmark is a groove cut inside the external shoulder that has the same depth as allowed re-facing depth (1/16”). When the PIN benchmark is no longer visible, it means that the connection cannot be re-faced anymore.

On the BOX end, the benchmark is a recess on the counter-bore diameter of the external shoulder. This benchmark has twice the depth of allowed re-facing depth. When BOX benchmark depth is equal to or smaller than 1/16” (1.59 mm), it means that the connector cannot be re-faced anymore.

Measurement of BOX benchmark depth is also an indicator of how much re-facing was already carried out on the BOX part.

Figure 14. PIN end benchmark

Figure 15. BOX end benchmark
4.2.3  Threads

Check that the threads have not been damaged or galled during handling or make-up. Thread surface shall be free of pits or other imperfections that appear to exceed 1.6 mm (1/16") in depth or 3.2 mm (1/8") in diameter, that penetrate below the thread root, or that occupy more than 40 mm (1-1/2") in length along the thread helix.

A profile thread gage can be used along the full length in two locations at least 90° apart. Both flanks should have normal contact. This means that thread profile should mesh evenly in the threads. If there is a doubt about this topic, lead measurement shall be taken.

If damage is found the connection must be re-cut by a VAM® Licensee.

4.2.4  Pin nose chamfer

VAM EIS® new design includes a 1.50mm PIN nose chamfer. This chamfer must be machined while re-facing or re-cutting PIN connection.

![PIN nose chamfer](image)

Figure 16. PIN nose chamfer

4.2.5  BOX counter-bore

Make sure that the BOX counter-bore radius is free from "rag" or other sharp edged defects caused by poor handling or stabbing. Such defects must be removed by grinding prior to re-using the connector.

4.2.6  Phosphate coating

VAM EIS® should always have a phosphate coating (Mn or Zn) on both the PIN and BOX thread and shoulder areas. If this coating is slightly worn in some areas it is acceptable, however if the coating is removed completely or if re-facing has been carried out, the connector requires re-coating with phosphate or with a Molybdenum Disulfide (MoS₂) repair kit (like Molykote® spray products).

4.3  Dimensional checks

The drawings here-after show the dimensions that are specific to VAM EIS® connectors. Ensure that all equipment has a valid calibration prior to the inspection.
4.3.1 PIN & BOX connection length field tolerances

The following table lists the common Make-Up Loss [MUL] and field tolerances for VAM EIS® connectors:

### Table 2. Shoulder-to-shoulder field tolerances for grades 120ksi and above

<table>
<thead>
<tr>
<th>Connection Type for grades above 120ksi</th>
<th>Distance between Shoulders (MUL)</th>
<th>Box shoulder to shoulder length (MUL) tolerance (mm)</th>
<th>Pin shoulder to shoulder length (MUL) tolerance (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>in.</td>
<td>mm</td>
<td>max</td>
<td>min</td>
</tr>
<tr>
<td>2 7/8 PAC VAM EIS®</td>
<td>3</td>
<td>76,2</td>
<td>76,35</td>
</tr>
<tr>
<td>NC26 VAM EIS®</td>
<td>3,626</td>
<td>92,1</td>
<td>92,19</td>
</tr>
<tr>
<td>NC31 VAM EIS®</td>
<td>4,126</td>
<td>104,8</td>
<td>104,80</td>
</tr>
<tr>
<td>NC38 VAM EIS®</td>
<td>4,626</td>
<td>117,5</td>
<td>117,50</td>
</tr>
<tr>
<td>NC40 VAM EIS®</td>
<td>5,126</td>
<td>130,2</td>
<td>130,20</td>
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<tr>
<td>NC46 VAM EIS®</td>
<td>5,126</td>
<td>130,2</td>
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<tr>
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<td>5,126</td>
<td>130,2</td>
<td>130,20</td>
</tr>
<tr>
<td>5 1/2 RH VAM EIS®</td>
<td>5,626</td>
<td>142,9</td>
<td>142,90</td>
</tr>
<tr>
<td>6 5/8 RH VAM EIS®</td>
<td>5,626</td>
<td>142,9</td>
<td>142,90</td>
</tr>
</tbody>
</table>

### Table 3. Shoulder-to-shoulder field tolerances for grades 95 to 120ksi

<table>
<thead>
<tr>
<th>Connection Type for grades 95 to 120ksi</th>
<th>Distance between Shoulders (MUL)</th>
<th>Box shoulder to shoulder length (MUL) tolerance (mm)</th>
<th>Pin shoulder to shoulder length (MUL) tolerance (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>in.</td>
<td>mm</td>
<td>max</td>
<td>min</td>
</tr>
<tr>
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<td>76,29</td>
</tr>
<tr>
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<td>92,10</td>
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<td>5,126</td>
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<td>142,90</td>
</tr>
<tr>
<td>6 5/8 RH VAM EIS®</td>
<td>5,626</td>
<td>142,9</td>
<td>142,90</td>
</tr>
</tbody>
</table>

*Please note that in this table, a comma is used as the decimal separator.*
4.3.2 BOX connection length

The distance between the 2 make-up shoulders shall be verified at 2 x locations 90° apart. This distance shall be compared to the requirements for the connector being inspected (cf. Table 1.) to determine acceptance or rejection. The diagram below shows two methods of measuring this dimension.

![Figure 18. BOX connection length inspection](image)

If the connector length of the BOX exceeds the dimension specified, then repair must be made by re-facing the external shoulder of the BOX end and vice versa. Re-facing limits are the same as for repair of damaged shoulders.

4.3.3 PIN connection length

The distance between the 2 make-up shoulders shall be verified at locations 90° apart. This distance shall be compared to the requirements for the connectors being inspected (cf. Table 1.) to determine acceptance or rejection. The diagram below shows 2 methods of measuring this dimension.

![Figure 19. PIN connection length inspection](image)

If the connector length of the PIN exceeds the dimension specified in the table above, then repair may be made by re-facing the internal shoulder of the PIN end and vice versa. Re-facing limits are the same as for repair of damaged shoulders.
4.3.4 Protection of the connection for further handling and storage

After inspection, connectors shall have storage thread compound applied to avoid corrosion unless the drill pipe is run immediately.

Only protectors specially designed for VAM EIS® connectors may be used. These shall cover the whole thread section and BOX counter-bore. Thread compound should be applied to prevent the ingress of water into the connection.

Figure 20. VAM® approved protector for VAM EIS® BOX end

5 Repair Procedures

After inspection program described here-before, some connectors could be repaired if damages are within defined limits.

Any connection requiring major repair shall NOT be used.

If re-threading is necessary, it should be carried out by a VAM® Licensee using gauges to confirm that the connection is acceptable for re-use. For a location of your local VAM® Licensee please refer to the VAM® Services website at www.vamservices.com.

5.1 Corrosion / Minor damages

Minor damage to internal shoulder can be hand dressed by file or hand grinder in order to remove any protrusion interfering with mating surfaces. Do not file on external shoulders.

Any build-up of corrosion should be removed using a scoring pad (like Scotch-brite® or 400 grit emery paper).

5.2 Shoulder re-facing

This operation must be performed in a machine repair shop.

5.3 Phosphate coating

Connections have a phosphate layer to reduce the chance of galling during make-up. If there is phosphate missing from some areas such as after a repair or high usage, spray Molybdenum Disulfide (MoS₂) onto the affected area (like Molykote® products).

This procedure could be applied after re-facing shoulders. In case of re-cut by a licensee, a complete phosphate coating is mandatory.
6 Glossary*

*(Glossary per API RP7G)

Bevel ► Conical surface machined 45° from the axis at the juncture of the tool joint make-up shoulder and OD,

Break-Out ► Loosening a rotary shouldered connection,

BOX end ► cf. tool joint BOX,

Corrosion ► Deterioration of a material by chemical or electrochemical reaction with its environment,

Double-shouldered connection ► Connections with torque shoulders at each end of the threaded section,

Drill pipe ► Upset seamless steel pipe with weld-on tool joints,

Drill string ► Drilling assembly from the swivel to the bit,

Hardbanding ► Sacrificial or wear resistance material applied to component's surface to prevent wears of the component,

Inspection ► Process of measuring, examining, testing, gauging or otherwise comparing the unit of product with the applicable requirements,

Lead ► Distance the PIN will advance in the BOX in one complete turn,

Make-Up Torque ► Torque applied to tighten rotary-shouldered connection,

PIN end ► cf. tool joint PIN,

Protector ► Cap (for PIN) or plug (for BOXes) placed on rotary-shouldered connections to protect the threads and shoulders while moving or during pick-up and lay-down operations,

Rotary-shouldered connection ► Two-member threaded connection with sealing shoulders,

Tensile yield strength ► Stress at which a material exhibits a specified deviation from proportionality of stress and grain,

Thread compound ► Lubricant used on rotary-shouldered connections to add lubricity and protect the mating surface from galls during make-up,

Tolerance ► Permissible variation,

Tong space ► Cylindrical, outside, surface of a tool joint or other threaded drill string member,

Tool joint BOX ► Tool joint with internal threads,

Tool joint PIN ► Tool joint with external threads,

Tool joint ►Threaded connection, welded the drill pipe body, for coupling lengths of drill pipe,

Torsional strength ► Torsional load a string member can withstand without permanent deformation,

Upset ► Forged end of a drill pipe tube used to increase wall thickness,
7 References

- API Recommended Practice 7G
  - "Recommended Practice for Drill Stem design & Operating Limits",

- API Specification 7
  - "Specification for Rotary Drill Stem Elements",

- API Recommended Practice 7A1
  - "Testing of Thread Compound for Rotary-Shouldered Connections", 
8 Vallourec Drilling Products Contacts

HEADQUARTERS

Vallourec Drilling Products France
27, avenue du Général Leclerc
92660 Boulogne-Billancourt
France
Phone: +33 1 49 09 35 61
Fax: +33 1 49 09 37 15

MANUFACTURING FACILITIES

> FRANCE

Vallourec Drilling Products France
Aulnoye Plant
62, rue de Leval
59620 Aulnoye-Aymeries
France

Vallourec Drilling Products France
Cosne & Villechaud Plants
7, rue des Frères Lumière
58200 Cosne-sur-Loire
France

Vallourec Drilling Products France
Tarbes Plant
10, boulevard Renaudet
65000 Tarbes
France

>BRAZIL

Vallourec Tubos do Brasil S.A.
Belo Horizonte Plant
Avenida Olinto Moireses, 65, Barreiro
30640-010 Belo Horizonte
MG - Brazil

> USA

Vallourec Drilling Products USA
Houston Plant
6300 Navigation Blvd
Houston, Texas 77011
USA

> EUROPE

Vallourec Oil & Gas Nederland B.V.
Heerhugowaard Plant
Kelvinstraat 8-16-1704 RS
Heerhugowaard
The Netherlands

> UNITED ARAB EMIRATES

Vallourec Drilling Products Middle East FZE
Jebel Ali Free Zone Plant
P.O. BOX 261108
UAE

Vallourec Drilling Oil Equipment Manufacturing LLC
Mussafah Industrial Area Plant
P.O. BOX 9709
Abu Dhabi
UAE

> REGIONAL SALES OFFICES

>NORTH AMERICA

Vallourec Drilling Products USA
Client Support Center
4424 W. Sam Houston Parkway North, Suite 150
Houston, Texas 77041
USA
Phone: +1 713 479 3200
Fax: +1 713 479 3201
Email: OSC.drilling-products@vallourec.com

Vallourec Drilling Products USA
6300 Navigation Blvd
Houston, Texas 77011
USA
Phone: +1 713 844 3700
Fax: +1 713 926 7103
Email: sales.drilling-products.NA@vallourec.com

Vallourec Drilling Products USA
Oklahoma Office
1015 Waterwood Pkwy, Suite G, #G-2
Edmond, OK 73034
USA
Phone: +1 405 340 0545
Email: sales.drilling-products.NA@vallourec.com

Vallourec Canada Inc.
2107 9th Street
Nisku, Alberta T9E 7Z7
Canada
Phone: +1 780 955 9850
Fax: +1 780 955 9850
Email: sales.drilling-products.NA@vallourec.com

> LATIN AMERICA

Vallourec Tubos do Brasil S.A.
Av. República do Chile, 230, 14° andar,
Edificio Castelo Branco
Centro, Rio de Janeiro, RJ, CEP: 20031-170
Phone: +55 21 3873 83 00
Fax: +55 21 3351 72 61
Email: sales.drilling-products.LA@vallourec.com

> NORTHERN EUROPE

Vallourec Oil & Gas UK Ltd.
Prospect Place, Westhill Industrial Estate
Westhill, Aberdeen AB32 6SY
UK
Phone: +44 1224 279 392
Fax: +44 1224 279 384
Email: sales.drilling-products.UK@vallourec.com

Vallourec Drilling Products France
27, avenue du Général Leclerc
92660 Boulogne-Billancourt
France
Phone: +33 1 41 03 77 77
Fax: +33 1 49 09 37 15
Email: sales.drilling-products.EU@vallourec.com

> MIDDLE EAST

Vallourec Drilling Products Middle East FZE
P.O. Box 261108, Jebel Ali Free Zone
Dubai, United Arab Emirates
UAE
Phone: +971 4 815 0000
Fax: +971 4 883 9967
Email: sales.drilling-products.ME@vallourec.com

> AFRICA

Vallourec Drilling Products France - South Africa Branch
Fairway Office Park, Sable B2, Ground floor
52, Grosvenor Road, Bryanston, Johannesburg,
South Africa
Phone: +27(0)11 267 58 26
Email: sales.drilling-products.Africa@vallourec.com

> EASTERN EUROPE

Vallourec Deutschland GmbH
Theodorstrasse 90
40472 Düsseldorf
Germany
Phone: +49 211 980 2352
Fax: +49 211 980 6924
Email: sales.drilling-products.EU@vallourec.com

> RUSSIA

Vallourec RUS LLC
Office E02-305, Business - centre "Dobrynka"
4th Dobrynkinskaya Pervulok 8
Moscow, 119049
Russia
Phone: +7 495 787 49 30
Fax: +7 495 787 49 31
Email: sales.drilling-products.RU@vallourec.com

> CHINA

Vallourec (Beijing) Co., Ltd.
Room 301, East Ocean Center
24A Jianguomenwai Avenue
Beijing 100022
China
Phone: +86 10 8593 49 30
Fax: +86 10 8593 49 31
Email: sales.drilling-products-CN@vallourec.com

> FAR EAST

Vallourec Asia Pacific Corp. Pte Ltd.
238A Thomson Road, #10-07/10
Novena Square Tower A
Singapore 307684
Phone: +65 6933 9100
Fax: +65 6738 9175
Email: sales.drilling-products.Asia@vallourec.com

www.vallourec.com/drilling-products