1515-HS MAX Material Technical Requirements			MSC-API W5.6-F20
prepared by	reviewed by	approved by	Edition 1.0 Revision 04
编写组	王增华		Effective on September 21,2016

1515-HS MAX Material Technical Requirements

1.0 Scope of application

This specification is made with the objective to provide the requirements for the materials used for the non-magnetic drill collar in the severe bending conditions.

Main properties: high strength and low permanent magnetism, shall be ensured by the supplier through certification.

This material will be used in the drilling mud with alternating stress and corrosion for a long time. It will provide the properties higher than those required in API Spec. 7.

This specification may be applied to the drill collar with the outer diameter less than 10 inch.

2.0 Requirements

This material shall comply with the following requirements,

2.1 Material

This material shall be alloy and comply with the requirements of this specification. It shall be in the form of forged rod, and it shall be roughly machined to the unified mechanical property and the minimum residual stress. The residual stress of appropriate compression for the exposed surface is feasible.

2.1.1 Alloy

Unless otherwise specified in the product drawings or the purchase order regarding the materials, these alloys may be used.

Alloy
15-15HS MAX

2.2 Dimensions

Unless otherwise specified in the drawings of China Oilfield Services Limited (COSL), the tolerance for the forged rod dimensions by rough turning shall be:

Length +1.0/-0 inch

Outer diameter +0.06/-0 inch

Inner diameter +0/-0.06 inch

The radial tolerance run-out tolerance of the forged rod shall be .06".

2.3 Chemistry and machining

This material shall chrome-manganese stainless steel with other alloys specified by the manufacturer. The composition shall be:

Chrome:	18-21%
Manganese	16-19%
Nitrogen	0.5-0.8%
Molybdenum	0.5-3.0%
Nickel	less than 3.4%
And iron	
PRE	report on the certificate

PRE=%Cr+3.3x%Mo+16x%N.

2.4 Mechanical properties

Minimum mechanical property requirements are given below (longitudinal measurement):

Horizontal specimen is acceptable, which shall be decided by the supplier, but shall be marked on the certificate. These properties will be only applicable for the drill collar with the outer diameter less than “10”

Yield strength (0.2% deviation)	140 ksi
Tensile strength	150 ksi
Specific elongation	20%
Reduction of area	50%
Impact ductility at room temperature (V-notch)	60 ft-lb
Hardness	report on the certificate for information（reference range：HBN350—430）
Fatigue strength (push, pull or bending)	10 Million Cycles +/-65ksi Minimum Or 100,000 Cycles +/-80ksi Minimum

Report Elongation in 4D

2.5 Magnetism

Magnetic conductivity shall be determined with the method 1 in ASTM A-342, or with the Severn measuring meter. Residual magnetism shall be determined with Dr Foerster magnetic field model 1.067 (or higher) in company with the field probe 1.009-4502 (or equivalent). The measurement steps shall be recognized by China Oilfield Services Limited (COSL), and shall not be modified without being recognized.

Magnetic conductivity (ASTM A-342)	1.005 maximum
Magnetic field change	50 gammas maximum per API 7-1

1 gamma = 1 nanoTesla = 10 micro-Gauss

2.6 Corrosion resistance

2.6.1 Sensitivity

According to ASTM A-262, Practice “A”, this material shall be treated so that it is not corrosion sensitive. On the grain boundary, the sediment of chrome carbide or nitride is not acceptable, unless this material is provided with the mark of “corrosion resistance performance disclaim” mentioned in 2.1.2. The material mentioned in 2.1.2 cannot meet the standard in Practice “A”, but shall be tested according to Practice “E”, and shall pass the bending test.

2.6.2 Stress corrosion

Critical stress of transcrystalline stress corrosion crack in the chloride solution shall be at least 45 ksi, and it shall be tensioned. This regulation refers to the boiling sodium chloride solution, with the critical cutoff at 1000h.

The protection against stress corrosion cracking will be realized by means of the compression treatment for the surfaces exposed to the drilling mud. The exterior surface of the forged drill collar usually has the residual compression stress from the machining. All other exposed surfaces will be finished after final machining.

2.6.3. Pitting

After the determination with the method ASTM G150, critical pitting temperature shall be at least 35°C in the following environment:

Sodium chloride solution	6 mol	
Electric potential	-100mV	Standard calomel electrode

2.7 Weldability

The overlapping repair welding seams of .125 inch in this material shall not be sensitive to corrosion, and shall pass the test according to ASTM A-262, Practice “E”.

2.8 Discontinuity

This material shall completely avoid internal discontinuity capable of being detected with ultrasonic examination, and no restriction is imposed on the material beyond the regulations in ASTM A745 specification and Class QL-2, or equivalent testing standards, such as ASTM E114 or ASTM E214.

3.0 Quality guarantee

3.1 Tests

3.1.1 Chemical analysis

The materials from every furnace shall receive the chemical analysis.

3.1.2 Tensile test

Tensile test shall be carried out on the sample of every forged billet. The sample shall be taken from the position at least 1.0” below the roughly machined collar surface. The test report shall indicate the yield strength, tensile strength, specific elongation and reduction of area.

3.1.3 Impact test

Impact test is necessary, unless otherwise exempted by China Oilfield Services Limited

(COSL). If the impact energy is more than 100 feet-pound, and there is the data to support the 95% confidence, the exemption will be authorized. This sample shall be taken from the same position in the tensile test sample. If necessary, at least three tests shall be carried out.

3.1.4 Fatigue test

Fatigue test is not mandatory. Data shall be collected from periodic tests by supplier, and information shall be provided by supplier.Or the supplier shall ensure the material provided meets fatigue strength requirement.

3.1.5 Magnetizing test

Magnetic field change for every forged rod shall be inspected with differential magnetometer probe. If the purchase order exempts this item, this test may be omitted.

3.1.6 Corrosion resistance performance

The samples taken from every forged billet shall be tested according to ASTM A-262, Practice “A”. No duct structure shall be observed.

3.1.7 Weldability

The sample in every furnace shall be exposed to 1250F for 30min. The samples shall then be tested according to USA ASTM A-262, Practice “E”, and shall be free from cracking during the bending test.

3.1.8 Cracking inspection

The material shall be free from cracking either from the casting defect or from the forging. Every forged rod shall receive the ultrasonic examination according to the procedures of the supplier approved by China Oilfield Services Limited (COSL), and this is consistent with ASTM A 745, or equivalent testing standards, such as ASTM E114 or ASTM E214. Any change of this procedure shall be approved by China Oilfield Services Limited (COSL). In case that this test is carried out before the drilling, it is very viable to mark the drilling position. In this case, it is required to report it and mark it on the forged billet. Such mark shall be inspected again after the drilling. If necessary, it is required to use the dye penetrant inspection, to ensure no run-through crack in the surface. Any such crack shall be repaired.

3.2 Certification

The supplier of every forged rod shall provide the following certifications:

Chemical analysis (every furnace)

Mechanical properties

Ultrasonic examination

Magnetic field change

Corrosion sensitivity test

4.0 Identification

Materials shall be identified by supplier’s identification procedure which is capable of information required for multiple pieces from billet.

5.0 Applicable documents

Comply with ASTM A - 262 Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels

Comply with ASTM A- 342 Standard Test Methods for Permeability of Feebly Magnetic Materials

Comply with ASTM A- 745 Standard Practice for Ultrasonic Examination of Austenitic Steel Forgings.

Comply with ASTM E114 Standard Practice for Ultrasonic Pulse-Echo Straight-Beam Examination by the Contact Method.

Comply with ASTM E214 Standard Practice for Immersed Ultrasonic Testing by the Reflection Method Using Pulsed Longitudinal Waves.

Comply with ASTM A - 370 Standard Test Methods and Definitions for Mechanical Testing of Steel Products

US ASTM G – 150 Standard Test Method for Electrochemical Critical Pitting Temperature Testing of Stainless Steels

API Spec. 7-1 Specification for Rotary Drill Stem Elements

ISO 10424-1 Article 8.3

THE FOLLOWING IS CHINESE TRANSLATION.

1.0 适用范围

此规范明确了在恶劣弯曲条件下无磁钻铤原材料的相关要求。有资质的供应商应确保该材料的主要特性即高强度和低永磁性是满足要求的。无磁钻铤需长时间工作在腐蚀性的钻井泥浆中并承受交变应力，因此该材料的特性应优于 API 规范 7 的相关要求。

本规范适用于外径小于 10 英寸的钻铤。

2.0 要求

该材料应当符合下列要求：

2.1 材料

该材料应为合金钢且应满足本规范要求。它应经锻造成型，并且为能得到一致的机械性能和最小的残余应力应对该棒材进行粗加工。外表面允许有一定的残余压应力。

2.1.1 材料名称

除特殊说明外所指材料为下表牌号材料。

牌号
15-15HS MAX

2.2 尺寸

除特别说明外，锻棒应进行粗车，其尺寸公差如下：

长度	+1.0/-0 英寸
外径	+0.06/-0 英寸
内径	+0/-0.06 英寸

棒材的径向跳动应小于 0.06 英寸。

2.3 化学成分

该材料为铬锰不锈钢。主要化学成分如下：

铬：	18-21%
锰	16-19%
氮	0.5-0.8%
钼	0.5-3.0%

镍	小于 3.4%
其它为铁	
PRE	材质书中应给出

PRE=%Cr+3.3x%Mo+16x%N.

其他合金元素由生产厂家决定。

2.4 力学性能

最低力学性能要求如下（纵向测量）：

生产厂家可以选择通过横向试样得到试验数据，但必须在材质书上注明。以下要求只适用于外径小于 10 英寸的钻铤材料。

屈服强度（0.2％偏移）	140 ksi
抗拉强度	150 ksi
延伸率（4 倍直径伸长率）	20％
断面收缩率	50％
室温下冲击功（V 型缺口）	60 ft-lb
硬度	HBN350—430 供参考且实测值在材质书上注明
疲劳强度（拉压或弯曲）	1000 万次 + / -65 ksi 最低或 10 万次+ / -80 ksi 最低

2.5 磁性

磁导率应该由 ASTM A-342, 方法 1 确定，或使用 severn 测量计确定。残余磁性应该由 Dr Foerster 磁场模型 1.067（或更高）搭配场探针 1.009-4502（或等同）确定。测量步骤必须由中海油服认可，未经确认不能擅自更改。

磁导率 (ASTM A-342)	1.005 最大
磁场变化	50 gammas 最大（按照 API7-1）

1 gamma = 1 nanoTesla = 10 micro-Gauss

2.6 耐腐蚀性

2.6.1 敏感度

参照 ASTM A-262，试验“A”该材料应被处理应防止腐蚀敏感。在晶界上不应有铬的碳化物或氮化物的沉淀，除非材料具有 2.1.2 提到的“耐腐蚀性能放弃”的标识。2.1.2 提到的材料达不到试验“A”的要求，但应按照试验“E”进行测试，并应通过弯曲试验。

2.6.2 应力腐蚀

该材料在氯化物溶液中的穿晶应力腐蚀开裂的临界拉应力至少为 45 ksi。试验溶液为沸腾的氯化物溶液，临界截止时间为 1000 小时。

与泥浆接触外表面的压应力可以降低应力腐蚀开裂的倾向。锻造成型的钻铤材料在粗加工后通常表面会存在一定的残余压应力。钻铤加工完成后所有其他暴露在外的表面需进行处

理以使这些表面留有残余压应力。

2.6.3. 点蚀

经 ASTM G150 方法的确定，该材料在以下环境中的临界点蚀温度至少为 35℃：

氯化钠溶液	6 摩尔
电位	-100mV 标准甘汞电极

2.7 焊接性

该材料上 0.125 英寸的重叠修复性焊缝不得对腐蚀敏感，且应通过 ASTM A - 262，试验“E”的测试。

2.8 内部缺陷

该材料应通过 2 级超声波探伤，探伤过程中棒材应处于无约束不加载状态下。参照的探伤规范为 ASTM A745、ASTM E114、ASTM E214 中任意一个或其他等同的规范。

3.0 质量保证

3.1 测试

3.1.1 化学成分分析

每个炉次应进行化学成分分析。

3.1.2 拉伸试验

每个锻坯应取样并进行拉伸试验。取样的位置应在粗加工后表面的 1 英寸以下。试验报告应注明屈服强度、抗拉强度、指定标距的伸长率和断面收缩率实测值。

3.1.3 冲击试验

除非中海油服豁免冲击试验，否则该试验必须进行。豁免原则为：能证明该材料 95%的冲击试验值都能大于 100 lb-ft。试样的取样位置和拉伸试样位置相同。需做冲击试验时，应至少取三个试样进行。

3.1.4 疲劳试验

疲劳试验不是必须进行的，厂家疲劳试验数据应通过周期试验获得。并且这些信息应提

供给采购方或者厂家确保该材料是符合疲劳强度要求的。

3.1.5 磁化试验

每一锻棒的磁场变化都应通过差分式磁力计探针进行检查。如果采购方豁免此试验，该试验可以不做。

3.1.6 耐腐蚀性能

每个锻坯应取样并按照 ASTM A - 262，方法 A 进行试验，不得观察到有沟槽出现。

3.1.7 焊接性

每炉进行取样并在 1250F 的条件下暴露 30 分钟，然后按照 ASTM A - 262，方法 E 进行试验，被弯曲的试样不得出现裂纹。

3.1.8 裂纹检测

该材料不允许存在因铸造缺陷或锻造引起的裂纹。每个锻棒必须经过超声波探伤，参照的探伤规程为 ASTM A745、ASTM E114、ASTM E214 或其他等同规范中任意一个被采购方认可的规范。探伤规程的任何变更须得到采购方的同意。如果在钻孔之前进行探伤，那么应注明钻孔位置。一旦决定先探伤应告知并注明孔的位置，在钻孔完成后对标记区域重新探伤。如果有必要应进行着色检查以确保表面没有穿透裂缝。任何此类裂缝都应被修复。

3.2 认证

供应商应的证明文件应包括如下项目：

化学成分分析（按炉次）
力学性能
超声波探伤
磁场变化
腐蚀敏感试验

3.3 资格

在授权期间，按采购方要求，供应商必须提供数据证明材料能满足本规范中所有的要求。需证明的项目包括但不限于 3.2 的要求。

4.0 标识

材料应按供方的标识程序进行标识，该标识应包括子坯、母坯的信息。

5.0 适用的文件

符合 ASTM A – 262	奥氏体不锈钢晶间腐蚀敏感性检测
符合 ASTM A – 342	衰弱磁性材料磁导率的标准检验方法
符合 ASTM A – 745	奥氏体钢锻件超声波检验标准操作规程
符合 ASTM E114	使用接触法的超声波脉冲反射直射束检查规程
符合 ASTM E214	通过使用脉冲纵波的反射法的浸入式超声波测试规程
符合 ASTM A – 370	钢产品力学性能试验
美国 ASTM G – 150	不锈钢临界点蚀温度标准电化学测试方法
API Spec. 7-1	旋转钻柱构件规范
ISO 10424-1	旋转钻杆元件 第 8.3 条