1. Scope

This specification is to provide material requirements of non-magnetic steel DWNM101 for non-magnetic drill collars.

2. Applicable Documents

ASTM A-262 Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels
ASTM A-342 Standard methods of Test for permeability of Feebly Magnetic Materials
ASTM A-745 Standard Practice for ultrasonic examination of Austenitic Steel Forgings
ASTM A-370 Mechanical testing of Steel Products
API Specification 7, Section 6 Drill Collars

3. Requirements

The material shall meet the following requirements:

3.1 Material

The material shall be the non-magnetic steel DWNM101 of Shanxi Yujiaheng Industrial Co., Ltd. as qualified in this specification.

3.2 Dimensional Tolerance

The dimensional tolerance of forged bar shall be as follows:

Length +2.0/-0 inch (+5/-0 mm)
Outside Diameter +0.12/-0 inch (+3/-0 mm)

3.3 Chemical Composition

The chemical composition of material shall be as Table 1.

Table 1 unit：%

C	Si	Mn	P	S	Cr	Ni
≤0.03	0.40 ~0.60	18.00 ~21.00	≤0.03	≤0.005	13.00 ~14.00	0.40 ~1.20

Mo	N	Al	Cu	Nb	B	-
0.40 ~0.60	0.30 ~0.40	≤0.025	≤0.70	≤0.10	0.0005 ~0.0025	-

3.4 Mechanical properties

Mechanical properties of material shall conform to the requirements of table 2.

Table 2

OD of Collar	Yield Strength R_{eL}		Tensile Strength R_m		Elongation A	Reduction of Area Z
in	Ksi	Mpa	Ksi	Mpa	(%)	(%)
up to 6 7/8	≥110	≥759	≥120	≥828	≥25	≥50
7 and larger	≥100	≥690	≥120	≥828	≥25	≥50

Charpy V notch energy 75 ft • lb (100 J) minimum at 25°C or below
Hardness 285-360 BHN
Fatigue Strength (Push-Pull or rotating bend)
at 100,000 cycles +/-65 ksi (450 MPa) minimum

3.5 Magnetic Properties

The following non-magnetic properties are required:

Magnetic Permeability 1.005 max.
Magnetic Field Variation 0.04 μT max.

3.6 Corrosion Resistance

The material shall be processed according to ASTM A-262, practice "A" and practice "E", shall not to be sensitised to corrosion, as indicated by ASTM A-262, practice "A" practice "E".

3.7 Low Magnification Examination

The cross section specimen after Acid leaching shall not have visible shrinkage, bubble, bubble under surface, inclusion, subcutaneous, crack formation, hierarchical, white spots and other defects.
The macrostructure rating shall conform to table 3.

Table 3

common porosity	center porosity	ingot segregation	spot segregation
≤1.5	≤1.5	≤1.5	≤1.5

3.8 Metallographic Examination

3.8.1 Non-metallic inclusions

The Non metallic inclusions rating shall conform to table 4.

Table 4

inclusion type	type A	type B	type C	type D
thin	≤1.0	≤1.0	≤1.0	≤1.0
heavy	≤1.0	≤1.0	≤1.0	≤1.0

3.8.2 Grain size

Grain size shall be greater than grade 4.

3.9 Discontinuities

The material shall be free of internal discontinuities detectable by ultrasonic inspection and exceeding the rejection limits of ASTM Specification A745, level QL-1.

4. Testing

4.1 Chemical analysis

A chemical analysis shall be made for each heat of material.

4.2 Tensile Testing

A tensile test shall be performed on the sample from each bar. Longitudinal tensile specimens shall be taken at least 1.0" (25 mm) below the outside surface. The test report shall show yield strength, tensile strength, elongation and reduction of area.

4.3 Impact Testing

Longitudinal sample shall be taken at one inch (25mm) below the outside surface. Impact value shall be tested in accordance with ASTM A370 type A, Charpy V Notch. The test shall be carried out at 25 ℃ or below.

4.4 Fatigue Testing

A fatigue test shall be performed on two samples from each heat, to guarantee

+/-65 ksi, (450 MPa) at 100,000 cycles.

4.5 Magnetic Testing

Magnetic Field variation shall be surveyed along every bar using a differential magnetometer probe.

4.6 Corrosion Resistance

A sample from every forged bar shall be tested by ASTM A-262, Practice "A". No ditch structure shall be detectable.

And a sample and shall be tested per Practice “E” and no cracking shall be observed in the bend test.

4.7 Low Magnification Examination

A cross section specimen of low magnification examination shall be taken from each bar.

4.8 Metallographic Examination

Longitudinal specimens shall be taken at least 1.0" (25 mm) below the outside surface for metallographic examination

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4.9 Ultrasonic Testing

Each bar shall be ultrasonically inspected over its entire length according to ASTM A 745.

5 Certification

The following certifications shall be furnished by the vendor for each bar:

-Diamention
-Order number
-Heat number
-Chemical Analysis (per heat)
-Mechanical Properties (Tensile, Impact, Hardness, Fatigue Test)
-Magnetic Permeability
-Magnetic Field Variation
-Ultrasonic Examination
-Corrosion Sensitisation Test
- Low Magnification Examination
- Metallographic Examination (grain size, Non-metallic inclusions)

6. Identification

A unique bar number shall be stamped on both ends of the bar, or at the edge of an identification flat.