1.0 SCOPE

This specification covers the application of steel processing techniques for improvement of steel cleanliness. This is a multiple variation specification with different cleanliness levels. See Article 2.0 - Drawing Designations.

2.0 DRAWING DESIGNATIONS

2.1 This specification is intended to further qualify wrought steel specifications used in applications requiring improved internal cleanliness, see Figure 1. Different levels of cleanliness may be specified by the following designations:

Designation	Application
1E2661A	Bearing quality steel, per Articles 5, 6, and 7 requirements.
1E2661B	Special cleanliness steel, per Articles 5, 6, and 7 requirements.
1E2661C	Steel produced to approved premium air melt processes.
1E2661D	Air Melt plus Vacuum Arc Remelt (VAR) Quality.
1E2661E	Vacuum Induction Melt plus Vacuum Arc Remelt (VIMVAR) Quality.

Figure 1

3.0 QUALIFYING SPECIFICATIONS

1E0024 Wrought Steel - General Requirements
1E1861 Wrought Steel - Approved Suppliers
1E2700 Strand Cast Steel - Application and Quality

4.0 APPROVED STEEL MILLS

Steel mills approved to make steel are indicated in 1E1861.

5.0 STEEL MAKING PRACTICE (1E2661A, 1E2661B, 1E2661C)

5.1 Small additions of Calcium may be added for castability purposes. Calcium residuals shall not exceed 20 ppm and shall be reported on test certificates.

5.2 Steel shall be ladle refined and vacuum degassed.

5.3 Air melted steel shall be protected from reoxidation during teeming or casting. A Class 1 (1E2700) casting practice is required to produce steel grades qualified by this specification.

6.0 OXYGEN CONTENT

6.1 Oxygen content measured and reported for A and Z product samples is a requirement per 1E0024A chemical analysis requirements. Reporting oxygen levels measured in the ladle or tundish does not fulfill the requirements of the A and Z product samples but can be submitted for review when product levels are not available. Maximum total oxygen content as determined by inert gas fusion method shall be as follows:

1E2661A	20 Parts Per Million
1E2661B	12 Parts Per Million
1E2661C, 1E2661D, 1E2661E	10 Parts Per Million

7.0 INCLUSION CONTENT

7.1 Micro-Inclusion Content

7.1.1 For **1E2661 A and 1E2661B:**

ASTM E45 Method A or ISO 4967 Method A test for microcleanliness shall be performed according to the sampling plan of ASTM A534. This sampling plan identifies six specimen locations that will represent the entire heat. The values obtained from two-thirds of all specimens and at least one from each ingot or strand tested, as well as the average of all specimens, shall not exceed the ratings specified in Figure 2. The average of the six specimens shall be reported to the dispositioning Caterpillar Facility.

	A		B		C		D	
	Thin	**Heavy**	**Thin**	**Heavy**	**Thin**	**Heavy**	**Thin**	**Heavy**
1E2661A	2.5	1.5	2	1	0.5	0.5	1.0	1.0
1E2661B	2.5	1.5	1.5	0.5	0	0	0.5	0.5

Figure 2 - Micro-Inclusion Ratings

Note: When a minimum of 0.01% sulfur or greater is specified for machinability, Type A sulfide rating in Figure 2 shall be 3.0 Thin and 2.0 Heavy.

7.1.2 For **1E2661C, 1E2661D**, and **1E2661E** the microcleanliness acceptance levels and rating methods are specified in MQ1000-501.

7.1.3 For reference only, micro-inclusion types, per ASTM, are defined below. Stringers are inclusions which have been elongated in the direction of rolling.

Type A - Sulfide	MnS Stringers – Light Gray in Bright Field Optical
Type B - Alumina	Strings of oxide particles broken by rolling. May consist of alumina or complex oxides of aluminum, magnesium, calcium and silicon.
Type C - Silicate	Silicon Oxide Stringers – Black in Bright Field Optical
Type D – Globular Oxide	Isolated, non-deformed oxide inclusions with aspect ratio less than 2:1.

Figure 3

7.2 Macro-Inclusion Content - Periodic SAE AMS 2301K or SAE J420 magnetic particle inspection may be required by the Metallurgical Division of the user Caterpillar Facility.

8.0 REFERENCES

Abbreviations	1E0011
Caterpillar	MQ1000-501
ASTM	E45, A534
ISO	4967
SAE	J420, AMS 2301K

Note: And other applicable national standards governing bearing quality.