



## Wire-Rope Pull Test Procedure for Stator Winding Wire Welds of Electric Motors

### 1 Introduction

**Note:** Nothing in this standard supercedes applicable laws and regulations.

**Note:** In the event of conflict between the English and domestic language, the English language shall take precedence.

**1.1 Purpose.** For evaluation of fracture strength of electric motor stator winding wire welds and documentation of comparative test data.

**1.2 Applicability.** Applies to rectangular copper wire with cross sectional area less than 13 mm<sup>2</sup> and Width-to-Depth (WxD) aspect ratio less than 1.2.

**1.3 Remarks.** This test method covers the tension testing of stator winding wire welds at room temperature with a stainless steel rope at room temperature which shall be 10 °C to 38 °C.

### 2 References

**Note:** Only the latest approved standards are applicable unless otherwise specified.

#### 2.1 External Standards/Specifications.

|             |            |
|-------------|------------|
| ASTM E4     | ISO 6892   |
| ASTM E8/E8M | ISO 7500-1 |

#### 2.2 GM Standards/Specifications.

None

### 3 Resources

**3.1 Facilities.** Figure 1 shows the tension testing of stator winding wire welds with a stainless steel rope. Tensile testing machines and load cells used for rope-pull testing shall conform to the requirements of ASTM E4 or ISO 6892. A load cell less than 10 kN shall be used. Alternative load cells shall be approved by GM Materials Engineering. Method of gripping shall meet the requirement of ASTM E8/E8M or ISO 7500-1. Wedge Grips are recommended for this test. Breaking strengths of 7x7 strand 304 stainless steel wire ropes (Figure 2) shall be greater than 2138 N for 1.59 mm diameter rope and greater than 1203 N for 1.29 mm diameter rope, respectively.

**3.1.1 Calibration.** The test facilities and equipment shall be in good working order and shall have a valid calibration label.

**3.1.2 Alternatives.** Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

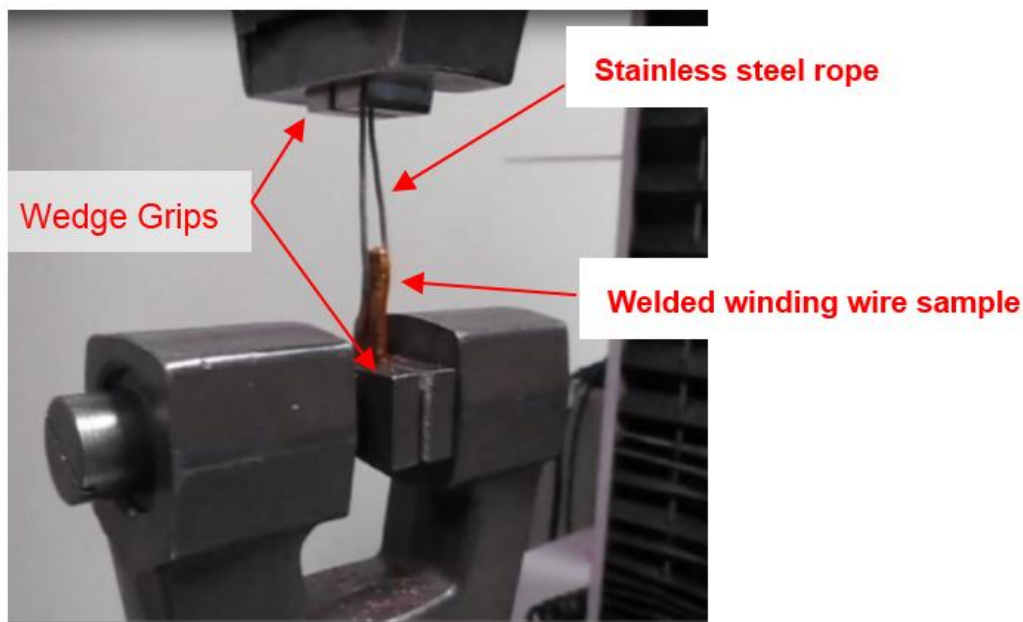


Figure 1: Rope Pull Test



Figure 2: A Representative 7x7 Strand 304 Stainless Steel Wire Rope

**3.2 Equipment.** Machines used for tension testing shall conform to the requirements of Practices of ASTM E4 or ISO 6892. The forces used in determining tensile strength and yield strength shall be within the verified force application range of the testing machine as defined in Practices of ASTM E4 or ISO 6892.

**3.3 Test Vehicle/Test Piece.** Not applicable.

**3.4 Test Time.** Not applicable.

**3.5 Test Required Information.**

**3.5.1 Test Sample Requirement.** A representative stator winding wire weld test sample is shown in Figure 3. Three dimensional requirements shall be met:

- Total sample length (A): 50 mm minimum (see Figure 3).
- Distance (B) between the weld tip and the location where C shall be measured: 9 mm to 11 mm (see Figure 3).
- Spacing (C) between two copper wires: 1.4 mm to 1.9 mm for 1.29 mm diameter ropes; 1.8 mm to 2.3 mm for 1.59 mm diameter ropes (see Figure 3).

Relative flatness between the two copper wires shall be less than 3 mm (see Figure 3). If test samples are obtained from a stator, the detailed instruction in Appendix A shall be followed for cutting and straightening the samples. A minimum five samples shall be tested.

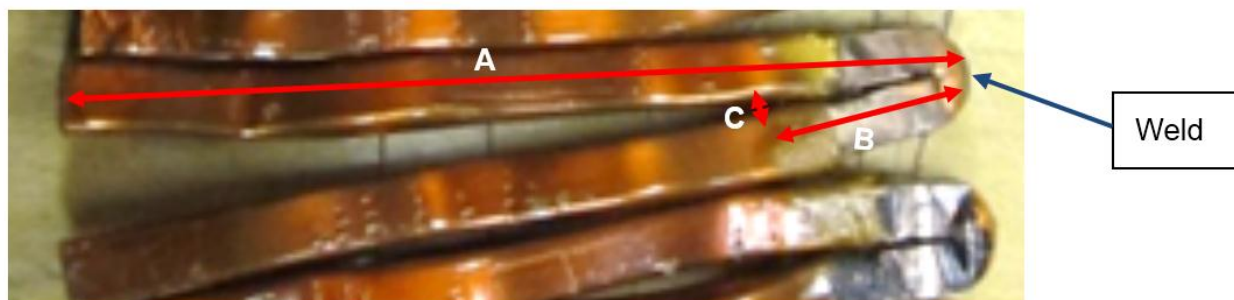


Figure 3: Test Sample Requirement

**3.5.2 Pull Test Metal Rope Requirement.** For rectangular copper wire with cross-sectional area 6 mm<sup>2</sup> to 13 mm<sup>2</sup> and aspect ratio less than 1.2 (see Figure 4), use 1.59 mm diameter 7x7 strand 304 stainless steel wire ropes (Figure 4) which breaking strength is greater than 2138 N. See Table 1.

For rectangular copper wire with cross-sectional area less than 6 mm<sup>2</sup> and aspect ratio less than 1.2 (see Figure 3), use 1.29 mm diameter 7x7 strand 304 stainless steel wire ropes which breaking strength is greater than 1203 N. See Table 1.

Table 1: Pull Test Metal Rope Requirement

| Wire Rope     |         |                   | Copper Wire Dimension                   |                    |
|---------------|---------|-------------------|-----------------------------------------|--------------------|
| Diameter (mm) | Strands | Load Capacity (N) | Cross Sectional Area (mm <sup>2</sup> ) | Aspect Ratio (WxD) |
| 1.59          | 7x7     | 2138              | 6 to 13                                 | ≤ 1.2              |
| 1.29          | 7x7     | 1203              | ≤ 6                                     | ≤ 1.2              |

Alternative ropes shall be approved by GM Materials Engineering.

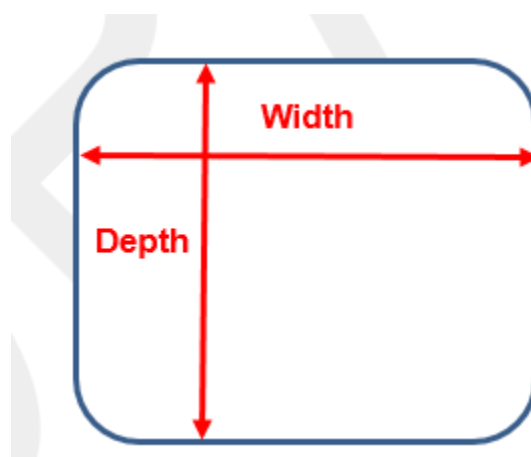


Figure 4: A Representative Rectangular Copper Wire Cross-Section

**3.6 Personnel/Skills.** Not applicable.

## 4 Procedure

**4.1 Preparation.** Not applicable.

### 4.2 Conditions.

#### 4.2.1 Environmental Conditions.

**4.2.2 Test Conditions.** Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

### 4.3 Instructions.

#### 4.3.1 Test Procedure of Specimen Mounting.

**4.3.1.1** Mount the copper winding wire weld sample in lower wedge grip (Figures 5 and 6) as follows:

- Gripped length: greater than 27 mm.
- Ungripped length: 23 mm to 27 mm.

**4.3.1.2** Pass the stainless steel rope between the two copper wires and mount the two rope ends to the upper grip (Figure 6) as follows:

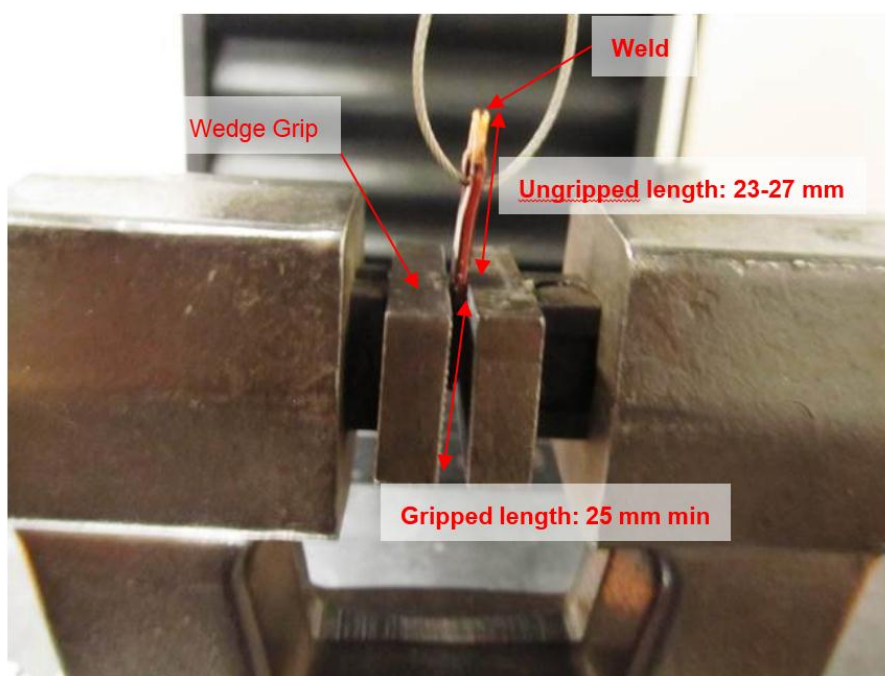
- Gripped length: greater than 30 mm.
- Ungripped length: 20 mm to 25 mm.
- Spacing of gripped ends: 18 mm to 22 mm.

#### 4.3.2 Test Procedure.

**4.3.2.1** Run test machine in stroke control with displacement rate 40 mm/minute to 55 mm/minute.

**4.3.2.2** Record load-displacement or load-time graphs (Figure 7). Data collection rate or number of points shall be able to record the peak load within a maximum 5 N force range.

**4.3.2.3** Report the peak load for each sample (Figure 7).



**Note:** min = minimum.

**Figure 5: Winding Wire Weld Sample Setup Requirement**