



Spring Materials – Valve Spring Quality

1 Scope

This specification covers three grades of special quality round and multi-arc steel wire intended for the manufacture of valve springs requiring resistance to set when used at moderately elevated temperatures and high stress levels. This wire shall be in either the quenched and tempered condition or annealed and cold drawn condition as specified by the purchaser.

- Type A wire has the lowest tensile strength.
- Type B wire is an intermediate tensile strength grade
- Type C wire is a high tensile strength grade.

1.1 Material Description. This steel shall be made by a GM approved steel making practice, such as the electric arc furnace or the basic oxygen process. This steel shall be continuously cast. The subsequent refining processes must include the use of secondary ladle refining and the use of silicon for deoxidation purposes. The resulting inclusions shall be predominantly of a deformable nature. This material is considered super clean steel.

1.2 Symbols. Not applicable.

1.3 Applicability. Engine valve springs.

2 References

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

2.1 External Standards/Specifications.

ASTM A751 ISO 6892

2.2 GM Standards/Specifications.

GMW3059

3 Requirements

3.1 Requirements on Delivery.

3.1.1 Chemical Requirements. The steel furnished to this specification shall conform to the composition listed in Table 1. Each heat of steel shall be analyzed by the steel mill to determine the percentage of elements using ASTM A751. Analysis may also be done by the purchaser on the finished wire. Conformance to the chemical composition is required.

Table 1: Chemical Requirements

	Type A	Type B		Type C	
	CrSi	CrSiV	CrSiNiV	CrSiNiV	CrSiMoV
Element	(Weight %)	(Weight %)	(Weight %)	(Weight %)	(Weight %)
Carbon	0.50 to 0.60	0.55 to 0.70	0.57 to 0.62	0.50 to 0.70	0.50 to 0.70
Silicon	1.20 to 1.60	1.20 to 1.60	1.30 to 1.60	1.80 to 2.20	1.80 to 2.20
Manganese	0.50 to 0.80	0.50 to 0.80	0.50 to 0.80	0.70 to 1.00	0.30 to 0.60
Phosphorous	0.025 maximum	0.020 maximum	0.020 maximum	0.020 maximum	0.020 maximum
Sulfur	0.025 maximum	0.020 maximum	0.020 maximum	0.020 maximum	0.020 maximum
Copper	---	0.15 maximum	0.15 maximum	0.15 maximum	---
Nickel	---	---	0.20 to 0.50	0.20 to 0.40	---
Chromium	0.50 to 0.80	0.50 to 0.70	0.80 to 1.0	0.80 – 1.05	0.80 to 1.00
Vanadium	---	0.08 to 0.18	0.05 to 0.10	0.05 to 0.15	0.05 to 0.15
Molybdenum	---	---	---	---	0.05 – 0.15

3.1.2 Mechanical Property Requirements for Quenched and Tempered Wire.

3.1.2.1 Unless otherwise specified by the purchaser, wire shall be shaved, drawn, austenitized, quenched and tempered. The tensile strength of the wire shall conform to the limits shown in Table 2 for the various sizes shown (for non-round wires, use the equivalent round wire diameter). The initial cross sectional area for round and non-round wires can be calculated per the procedure in ISO 6892, Annex C; or by measuring a sample's minimum and maximum diameters (width and thickness) and multiplying by a shape factor.

3.1.2.1.1 The shape factor can be either derived from the nominal shape of the cross section, or it can be determined by dividing the area calculated per ISO 6892, Annex C by the measured width times the thickness. The reduction of area for sizes listed in Table 2 shall be 40% minimum. Final cross sectional area for non-round shapes can be calculated by multiplying the shape factor by the measured width times the thickness in the necked cross section.

3.1.2.2 One (1) tensile test specimen shall be taken from each end of a coil. Tensile strength within one coil shall not vary by more than 70 MPa for Types A and B and not more than 50 MPa for Type C. Each coil shall be tested. The tensile test shall follow the test procedure in ISO 6892.

3.1.2.3 Wrap Test. All wire materials, round wire or multi-arc wire cross sections through 4.0 mm diameter shall wind (as a close wound helix) on itself as an arbor (or an arbor of equivalent round wire diameter) for at least two (2) turns without breaking or checking the surface. All wire diameters over 4.0 mm shall wind on an arbor twice its diameter for at least two (2) turns without breaking or checking the surface. The wrap test is not applicable for multi-arc or round wire diameters > 8.0 mm.

Table 2: Tensile Strength Requirements for Quenched and Tempered Wire

Wire Diameter, mm	Tensile Strength MPa		
	Type A	Type B	Type C
2.50 to 3.20	1920 to 2080	2060 to 2160	2110 to 2210
3.21 to 4.00	1900 to 2040	2010 to 2110	2060 to 2160
4.01 to 5.00	1820 to 1980	1960 to 2060	2010 to 2110
5.01 to 6.00	1780 to 1920	1910 to 2010	1960 to 2060

3.1.3 Mechanical Property Requirements for Annealed and Cold Drawn Wire.

3.1.3.1 Unless otherwise specified by the purchaser, wire shall be shaved, annealed and cold drawn. The tensile strength of the wire shall conform to the limits shown in Table 3 for the various sizes shown (for non-round wires, use the equivalent round wire diameter). The initial cross sectional area for round and non-round wires can be calculated per the procedure in ISO 6892, Annex C; or by measuring a sample's minimum and maximum diameters (width and thickness) and multiplying by a shape factor.

3.1.3.1.1 The shape factor can be either derived from the nominal shape of the cross section, or it can be determined by dividing the area calculated per ISO 6892, Annex C by the measured width times the thickness. The reduction of area for sizes listed in Table 3 shall be 40% minimum. Final cross sectional area for non-round shapes can be calculated by multiplying the shape factor by the measured width times the thickness in the necked cross section.

3.1.3.2 One (1) tensile test specimen shall be taken from each end of a coil. Tensile strength within one coil shall not vary by more than 70 MPa for Types A and B and not more than 50 MPa for Type C. Each coil shall be tested. The tensile test shall follow the test procedure in ISO 6892.

3.1.3.3 Wrap Test. All wire materials, round wire or multi-arc wire cross sections through 4.0 mm diameter shall wind (as a close wound helix) on itself as an arbor (or an arbor of equivalent round wire diameter) for at least five (5) turns without breaking or checking the surface. All wire diameters over 4.0 mm shall wind on an arbor twice its diameter for at least five (5) turns without breaking or checking the surface. The wrap test is not applicable for multi-arc or round wire diameters > 8.0 mm.

Table 3: Tensile Strength Requirements for Annealed and Cold Drawn Wire

Wire Diameter, mm	Tensile Strength MPa		
	Type A	Type B	Type C
2.50 to 3.20	1400 to 1650	1500 to 1750	1550 to 1800
3.21 to 4.00	1300 to 1550	1400 to 1650	1400 to 1650
4.01 to 5.00	1300 to 1550	1400 to 1650	1400 to 1650
5.01 to 6.00	1300 to 1550	1400 to 1650	1400 to 1650

3.1.4 Metallurgical Requirements.

3.1.4.1 Shaving Requirements. The original rod wire surface shall be shaved to remove 150 µm of material per side.

3.1.4.2 Surface Conditions. The final wire surface shall be smooth and free from rust, scale, die marks, deep scratches, seams, cracks, and other surface defects 40 µm in size and larger, which are detectable using eddy current testing via stationary and rotary probe testers. 100% of the outer wire surface must be eddy current tested. All wire sections with an indicated defect shall be painted by the wire processor, so that these sections can be discarded during the spring manufacturing process. The number of painted defects per coil shall be tracked and submitted to the valve spring supplier to ensure that all defects are accounted for during the spring