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SAE J351 DEC88

Oil Tempered Carbon Steel Valve Spring Quality Wire and Springs

SAE Recommended Practice
Reaffirmed December 1988

Submitted for Recognition as an American National Standard

SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®

400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

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MATERIALS PRACTICE

SAE J351

Issued July 1968
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Reaffirming J351 JUL68

OIL TEMPERED CARBON STEEL VALVE SPRING QUALITY WIRE AND SPRINGS

1. SCOPE:

This specification covers the physical and chemical requirements of oil tempered carbon steel valve spring quality wire used for the manufacture of engine valve springs and other springs requiring high-fatigue properties. This specification also covers the basic material and processing requirements of springs fabricated from this wire.

2. MANUFACTURE AND WORKMANSHIP:

The steel shall be made by the electric furnace, open hearth, or basic oxygen process. Sufficient discard must be made to insure freedom from all pipe and undue segregation. The wire shall be properly drawn, austenitized, oil quenched, and tempered to produce the specified mechanical properties.

The wire shall be uniform in quality and in temper and shall not be wavy or crooked. It shall be homogeneous and free from injurious imperfections caused in its manufacture, whether such imperfections are apparent at the time of receiving inspection or while the wire is being processed by the user. Each coil shall be one continuous length of wire properly coiled and firmly tied. Welds in coils are not permitted.

3. CHEMICAL COMPOSITION:

The steel shall conform to the chemical composition[1] as follows:

Carbon	0.60–0.75%[2]
Manganese	0.60–0.90%[2]
Phosphorus	0.025% max
Sulfur	0.030% max
Silicon	0.15–0.30%

4. MECHANICAL PROPERTIES:

The tensile properties of the wire shall conform to the requirements in Table 1 for the various sizes. Hardness ranges indicated in Table 1 apply to finished springs and are subject to normal variations found in standard hardness testing procedure.

TABLE 1

Wire Diameter, in	Tensile Strength, 10^2 psi		Hardness		Reduction of Area,[a] min, %
	Min	Max	Min	Max	
			R45N		
0.062 to 0.092 incl	240	260	52	57	N/A[b]
Over 0.092 to 0.128 incl	235	255	51	56	45
			RC		
Over 0.128 to 0.162 incl	230	250	46	51	45
Over 0.162 to 0.192 incl	225	245	45	50	45
Over 0.192 to 0.225 incl	220	240	44	49	45
Over 0.225 to 0.250 incl	215	235	44	49	45

Note: Examination of the tensile fracture shall not show a coarse or cuppy condition.

[a]The 45% minimum value is for as-received wire. A 40% minimum value is acceptable for wire produced at the mill when tested immediately after tempering.

[b]N/A--Reduction of area does not apply to 0.092 and below.

[1]For permissible variations from specified chemical ranges and limits for steel, refer to SAE J409.

[2]Carbon and manganese may be varied from the specified ranges by agreement between the manufacturer and the purchaser, provided the mechanical properties specified are maintained.

5. PERMISSIBLE VARIATIONS IN DIMENSIONS:

The diameter of the wire shall not vary from that specified by more than that shown in Table 2.

TABLE 2

Diameter, in	Permissible Variations, ± in	Permissible Out of Round, in
0.062 to 0.092 incl	0.0008	0.0008
Over 0.092 to 0.148 incl	0.0010	0.0010
Over 0.148 to 0.177 incl	0.0015	0.0015
Over 0.177 to 0.250 incl	0.0020	0.0020

6. WRAP TEST:

Wire 0.162 in and smaller in diameter shall wind on itself without breaking or checking the surface. Larger diameter wire up to and including 0.250 in shall wind without breaking or checking on a mandrel twice the diameter of the wire.

7. MICROSTRUCTURE:

A longitudinal section shall show a fine homogeneous tempered martensitic structure. Decarburization shall be determined by etching a polished transverse section of the tempered wire in nital and examining the entire periphery at 100X magnification, measuring the worst area present. Inspection at 100X magnification shall show no completely decarburized (carbon free) areas and partial decarburization shall not exceed a depth of 0.001 in on wire 0.192 in and smaller or 0.0015 in on wire larger than 0.192 in.

8. SURFACE CONDITIONS:

The surface of the wire specimens shall be examined after etching in a solution of equal parts of hydrochloric acid and water at a temperature of 165-175°F for a sufficient time to remove approximately 1% of the wire diameter. This examination shall be made using a binocular microscope at a magnification not to exceed 10X. The surface of the wire shall be free from imperfections such as seams, pits, die marks, scratches, and other defects tending to impair the fatigue value of the springs.

9. TWIST TEST:

A 10 in specimen of wire slowly twisted four revolutions in one direction and then twisted in the opposite direction until failure shall show a square break normal to the axis of the wire without splits or cracks.

10. ELECTROMAGNETIC INSPECTION:

When specified, the entire length of every coil used by engine valve spring manufacturers must be inspected for surface imperfections with a magnetic and/or eddy current defect analyzer. Springs made from wire containing surface defects 0.002 in deep and greater must be rejected.

11. FINISHED PARTS:

1. There shall be no excessive coiling marks, nicks, or gouges which would affect the specified wire diameter by more than 1% or would impair the serviceability of the parts.

2. Springs coiled from this wire shall be stress relieved for a minimum of 30 min at heat. Normally the temperature used will be the maximum which will leave the original hardness of the wire essentially unchanged. Typical temperatures are 650-750°F.

3. Hardness of springs shall be measured on suitably ground flats. Hardness values shall conform to Table 1.

4. Engine valve springs shall be shot peened to a minimum of 90% coverage on the ID of the spring (reference: HS 84, Manual on Shot Peening). After shot peening, the springs shall be stress relieved at 400-450°F.

RATIONALE:

Not applicable.

RELATIONSHIP OF SAE STANDARD TO ISO STANDARD:

Not applicable.

REFERENCE SECTION:

SAE J409 JUN84, Product Analysis-Permissible Variations from Specified Chemical Analysis of a Heat or Cast of Steel

HS 84, Manual on Shop Peening

APPLICATION:

This specification covers the physical and chemical requirements of oil tempered carbon steel valve spring quality wire used for the manufacture of engine valve springs and other springs requiring high-fatigue properties. This specification also covers the basic material and processing requirements of springs fabricated from this wire.

COMMITTEE COMPOSITION:

DEVELOPED BY THE SAE DIVISION 17 - SPRING WIRE:

E. H. Judd, Associated Spring Co., Livonia, MI, Chairman

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