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

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SAE J316 DEC88

Oil Tempered Carbon Steel Spring 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 J316

Issued Nov. 1967
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Reaffirming J316 NOV67

OIL TEMPERED CARBON STEEL SPRING WIRE AND SPRINGS

1. SCOPE:

This specification covers the mechanical, chemical, and dimensional requirements of oil tempered carbon steel spring wire used in the automotive and related industries. It is especially intended for the manufacture of mechanical springs and wire forms which are not subjected to a large number of high stress cycles. Class I wire is intended for moderate stress and Class II for higher stress level applications. This specification also covers the basic material and heat treat requirements for springs fabricated from this wire.

2. MANUFACTURE:

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

3. CHEMICAL COMPOSITION:

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

	Grade A	Grade B
Carbon	0.60 - 0.85%	0.60 - 0.75%
Manganese	0.90 - 1.20%	0.60 - 0.90%
Phosphorus	0.040% max	0.040% max
Sulfur	0.050% max	0.050% max
Silicon	0.15 - 0.30%	0.15 - 0.30%

Unless otherwise specified by the purchaser, Grade A shall be supplied for all wire 0.192 in diameter and larger, and Grade B shall be supplied for all wire less than 0.192 in diameter.

4. MECHANICAL PROPERTIES:

The tensile strength 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 procedures.

5. WRAP TEST:

Wire 0.162 in and smaller in diameter shall wind on itself as an arbor without breaking or checking of the surface. Larger diameter wire, up to and including 0.312 in, shall wind without breaking or checking the surface on a mandrel twice the wire diameter. Wrap test on wires over 0.312 in diameter is not applicable.

6. MICROSTRUCTURE:

A longitudinal section shall show a fine homogeneous tempered martensitic structure. Decarburization shall be determined by etching a polished transverse section of the wire in nital and examining the entire periphery at 100X magnification, measuring the worst area present, but not measuring decarburization which is directly associated with a seam or other surface defect. Carbon free depth of decarburization shall not exceed 0.5% of the wire diameter. Combined depth of carbon free and partial decarburization shall not exceed 2% of the wire diameter on sizes less than 0.250 in or 0.005 in on sizes 0.250 in or larger.

[1]Subject to limits shown for check analysis in SAE J409.

TABLE 1

Decimal Size, in	Class I Wire				Class II Wire				Decimal Size, in	Class I Wire				Class II Wire			
	Tensile Strength,[a] 10^3 psi		Hardness		Tensile Strength,[a] 10^3 psi		Hardness			Tensile Strength,[a] 10^3 psi		Hardness		Tensile Strength,[a] 10^3 psi		Hardness	
	Min	Max	Min	Max	Min	Max	Min	Max		Min	Max	Min	Max	Min	Max	Min	Max
			R15N				R15N					RC				RC	
0.020	293	323	88.0	90.0	324	354	90.0	92.0	0.135	215	240	45	50	241	266	50	55
0.023	289	319	88.0	90.0	320	350	90.0	92.0	0.148	210	235	44	49	236	261	49	54
0.026	286	316	88.0	90.0	317	347	89.0	91.0	0.162	205	230	43	48	231	256	48	53
0.029	283	313	87.5	89.5	314	344	89.0	91.0	0.177	200	225	42	48	226	251	48	53
0.032	280	310	87.5	89.5	311	341	88.5	90.5	0.192	195	220	41	47	221	246	47	52
0.035	274	304	87.0	89.0	305	335	88.0	90.0	0.207	190	215	40	46	216	241	46	51
0.041	266	296	86.5	88.5	297	327	87.5	89.5	0.225	188	213	40	45	214	239	45	50
0.047	259	289	86.0	88.0	290	320	87.0	89.0	0.244	187	212	40	45	213	238	45	50
0.054	253	283	86.0	88.0	284	314	87.0	89.0	0.250	185	210	40	45	211	236	45	50
			R45N				R45N		0.312	183	208	39	44	209	234	44	49
0.062	247	277	55.0	60.0	278	308	58.0	63.0	0.375	180	205	39	44	206	231	44	49
0.072	241	271	54.0	59.0	272	302	57.0	62.0	0.437	175	200	37	43	201	226	43	48
0.080	235	265	53.0	58.0	266	296	56.0	61.0	0.500	170	195	36	42	196	221	42	47
0.091	230	260	52.0	57.0	261	291	55.5	60.5	0.562	165	190	35	41	191	216	41	46
0.105	225	255	51.5	56.5	256	286	55.0	60.0	0.625	165	190	35	41	191	216	41	46
0.120	220	250	50.5	55.5	251	281	54.5	59.5									

[a]Examination of the tensile fracture shall not show a coarse or cuppy condition.
NOTE: Tensile strength values for intermediate diameters may be interpolated.

7. SURFACE CONDITION:

The surface of the wire shall be smooth and free from rust, scale, die marks, deep scratches, slivers, seams, laps, pits, or cracks which would affect the fabrication of the finished parts or their serviceability. Unless otherwise specified by the purchaser, seams shall not exceed 3.5% of the wire diameter or 0.010 in, whichever is the smaller as measured on a transverse section.

8. WORKMANSHIP:

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 processed by the manufacturer. Each coil shall be one continuous length of wire, properly coiled and firmly tied.

9. PERMISSIBLE VARIATIONS IN DIMENSIONS:

The diameter of the wire shall not vary from the specified by more than the following:

Diameter, in	Permissible Variations, ± in	Permissible Out-Of-Round, in
0.020 to 0.027	0.0008	0.0008
Over 0.027 to 0.072	0.0010	0.0010
Over 0.072 to 0.375	0.0020	0.0020
Over 0.375 to 0.625	0.0030	0.0030

10. FINISHED PARTS:

10.1 Heat Treatment: Springs coiled from this wire shall be stress relieved for a minimum of 30 minutes at temperature. Normally, the temperature used will be the maximum which will leave the original hardness of the wire essentially unchanged. Typical temperatures are:

450 F - small diameter (0.020 to 0.054 in)
550 F - medium diameter (over 0.054 to 0.120 in)
650 F - large diameter (over 0.120 in)

It should be recognized that in certain applications, such as extension springs with initial tension requirements, lower than the typical stress relieving temperature may be used. This is also true for thin flexible spring designs to minimize distortion. Springs requiring maximum resistance to relaxation at moderately elevated temperatures may be stress relieved at higher than the typical temperatures with some loss of hardness.

10.2 Hardness: Hardness of springs shall be measured on suitably ground flats on wire sizes of 0.062 in and larger, or on ground mounted sections for wire sizes of less than 0.062 in.

10.3 Surface Condition: The surface condition of the finished parts shall be as described for the wire except in certain instances where shot peening might be used. In addition, there shall be no excessive coiling marks, nicks, or gouges which would impair the serviceability of the parts.

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

APPLICATION:

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COMMITTEE COMPOSITION:

DEVELOPED BY THE SAE DIVISION 17 - SPRING WIRE:

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

SPONSORED BY THE SAE IRON AND STEEL TECHNICAL COMMITTEE:

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