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SURFACE VEHICLE RECOMMENDED PRACTICE

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CATEGORIZATION OF LOW CARBON AUTOMOTIVE SHEET STEEL

***Foreword*—**This document has not changed other than to put it into the new SAE Technical Standards Board Format.

More stringent mechanical property and surface quality requirements for automotive sheet steels, coupled with improvements in steel manufacturing and processing techniques, have made traditional procedures for categorizing sheet steel obsolete. In particular, classification of steel quality by deoxidation process is no longer appropriate. Similarly, classification of surface quality needs revision. Uniformity of material properties is a subject that has become of major importance and this issue has not been addressed in previous classification systems. This SAE Recommended Practice furnishes a categorization procedure to aid in selecting low carbon sheet steel for identified parts and fabrication processes.

It is necessary for both the steel user and producer to know both the aim in mechanical properties and the range in these properties. There is a wide variety of parts within the automotive industry, and different levels of specific mechanical properties, e.g., r_m values, n values, yield strength, and total elongation may be required for specific applications. For identified parts it is suggested that the steel user and steel supplier consult to determine specific requirements. For this document, yield strength has been chosen as a major discriminator of the categorization system since this property has meaning to both automotive and steel engineers. Uniformity of mechanical properties may also be considered a categorization factor, since this can affect the ability to make good parts on a consistent basis. Therefore, in this document steel is classified by a nominal yield strength and a range in yield strength. In addition, surface quality and/or aging characteristics are an important consideration. Thus, the categorization system uses a five character designation as follows:

a. The first three digits define the nominal yield strength (in MPa)
b. The fourth letter character defines the yield strength range
c. The fifth letter denotes the steel type with regards to surface quality and/or aging character

1. ***Scope*—**This SAE Recommended Practice establishes a nomenclature for categorizing low carbon automotive hot rolled sheet, cold rolled sheet, and zinc and zinc alloy coated sheets.

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2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J416—Tensile Test Specimens
SAE J1392—Steel, High Strength, Hot Rolled Sheet and Strip, Cold Rolled Sheet, and Coated Sheet
SAE J1562—Selection of Galvanized (Hot Dipped and Electrodeposited) Steel Sheet
SAE J1852—Properties of Galvanized Low Carbon Steel Sheets and their Relation to Formability

2.1.2 ASTM PUBLICATIONS—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM A 370—Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM E 8—Standard Test Methods of Tension of Metallic Materials

2.2 Related Publications—The following publications are provided for information purposes only and are not a required part of this document.

2.2.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J126—Selecting and Specifying Hot and Cold Rolled Steel Sheet and Strip

2.2.2 ASTM PUBLICATIONS—Available from ASTM, 1916 Race Street, Philadelphia, PA 19103.

ASTM A 366/A 366M—Specification for Steel, Sheet, Carbon, Cold-rolled, Commercial Quality
ASTM A 525/A 525M—Specification for General Requirements for Steel Sheet, Zinc-coated (Galvanized) by the Hot-Dip Process

ASTM A 526/A 526M—Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality

ASTM A 528/A 528M—Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Drawing Quality
ASTM A 568/A 568M—Specification for Steel, Sheet, Carbon, and High Strength, Low Alloy, Hot-Rolled and Cold-Rolled, General Requirements for

ASTM A 569/A 569M—Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Steel and Strip, Commercial Quality

ASTM A 569/A 569M—Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Steel and Strip, Commercial Quality

ASTM A 642/A 642M—Specification for Steel Sheet, Zinc-Coated (Galvanized by the Hot-Dip Process, Drawing Quality, Special Killed
ASTM A 619/A 619M—Specification for Steel, Sheet, Carbon Cold-Rolled Drawing Quality
ASTM A 619/A 619M—Specification for Steel, Sheet, Carbon Cold-Rolled Drawing Quality
ASTM A 620/A 620M—Specification for Steel, Sheet, Carbon, Drawing Quality, Special Killed, Cold-Rolled
ASTM A 621/A 621M—Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Drawing Quality
ASTM A 622/A 622M—Specification for Steel, Sheet and Strip, Carbon, Drawing Quality, Special Killed, Hot-Rolled

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2.2.3 OTHER PUBLICATIONS

Steel Products Manual
Sheet Steel
Iron and Steel Society Publication
January 1988

3. ***Classes—***The specific classes are identified by a four character code, consisting of a 3-digit number and an alphabetic character. The three digit number gives the nominal yield strength level in MPa and the fourth character shows the allowable range in product yield strength, i.e., the maximum and minimum yield strengths.

It is recognized that under certain circumstances particular parts may require steel properties that do not conform exactly to the specific classes defined herein. These deviations should be resolved through discussions between the steel user and the steel producer.

3.1 Cold Rolled and Zinc and Zinc Alloy Coated Steel Sheet—For these steels the classes are as follows in Table 1:

TABLE 1—YIELD STRENGTHS AND RANGES OF YIELD STRENGTH

Nominal Yield Strength - MPa (ksi)	Range in Yield Strength - MPa (ksi)
120 (17.4)	A = 40 (5.8)
145 (21.0)	B = 60 (8.7)
175 (25.4)	C = 90 (13.1)
210 (30.4)	D = 120 (17.4)
245 (35.5)	
000 (Not Specified)	V = Not Specified

Practical considerations limit the cold rolled and zinc and zinc alloy coated steel classes to the sixteen listed in Table 2:

TABLE 2—CLASSES OF COLD ROLLED AND ZINC AND ZINC ALLOY COATED STEEL SHEET

Nominal Class	Range in Yield Strength - MPa (ksi)	Yield Strength - MPa (ksi)
120 A	120 (17.4)	100–140 (14.5–20.3)
120 B	120 (17.4)	90–150 (13.1–21.8)
145 A	145 (21.0)	125–165 (18.1–23.9)
145 B	145 (21.0)	115–175 (16.7–25.4)
145 C	145 (21.0)	100–190 (14.5–27.6)
175 A	175 (25.4)	155–195 (22.5–28.3)
175 B	175 (25.4)	145–205 (21.0–29.7)
175 C	175 (25.4)	130–220 (18.9–31.9)
210 A	210 (30.5)	190–230 (27.6–33.4)
210 B	210 (30.5)	180–240 (26.1–34.8)
210 C	210 (30.5)	165–255 (23.9–37.0)
210 D	210 (30.5)	150–270 (21.8–39.2)
245 A	245 (35.5)	225–265 (32.6–38.4)
245 B	245 (35.5)	215–275 (31.2–39.9)
245 C	245 (35.5)	200–290 (29.0–42.1)
000 V	Not Specified	Not Specified

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Cold rolled and zinc and zinc alloy coated steels specified to a 240 MPa (35 ksi) or greater minimum yield strength are considered high strength steels. See SAE J1392, J1562, and J1852.

3.2 Hot Rolled Sheet Steel—Hot rolled steels are not normally made to the same strength levels as cold rolled steels and control of yield strength is also more limited. Hence, the nominal yield strength levels and ranges of yield strength of hot rolled steel are somewhat different as noted in Table 3:

TABLE 3—YIELD STRENGTHS AND RANGES OF YIELD STRENGTH FOR HOT ROLLED STEEL

Nominal Yield Strength - MPa (ksi)	Range in Yield Strength - MPa (ksi)
245 (35.5)	C = 90 (13.1)
280 (40.6)	D = 120 (17.4)
000 Not Specified	V = Not specified

This leads to the five hot rolled classes listed in Table 4:

TABLE 4—CLASSES OF HOT ROLLED STEEL

Class	Nominal Yield Strength - MPa (ksi)	Range in Yield Strength - MPa (ksi)
245 C	245 (35.5)	200–290 (29.0–42.1)
245 D	245 (35.5)	185–305 (26.8–44.2)
280 C	280 (40.6)	235–325 (34.1–47.1)
280 D	280 (40.6)	220–340 (31.9–49.3)
000 V	None	Not specified

Hot rolled steels specified to a 240 MPa (35 ksi) or greater minimum yield strength are considered high strength steels. See SAE J1392.

4. ***Types—***There are several types of cold rolled/coated steels and hot rolled steels that result from differences in steel manufacturing processes and automotive stamping operations. The types of steels are referred to by letter code that follows the class designation.

4.1 Cold Rolled and Zinc and Zinc Alloy Coated Sheet Steel—Three types of these steels are produced. These types are based on surface quality.

4.1.1 Type E is intended for the most critical exposed applications where surface appearance is of primary importance. This type of steel will meet requirements for controlled surface texture, surface quality, and flatness.

4.1.2 Type S is intended for exposed applications where surface condition is important, but is not as critical as Type E. This type of steel will also meet requirements for controlled surface texture, surface quality, and flatness. This type of steel is nonfluting as shipped, but may age harden and require roller leveling immediately prior to fabrication.

4.1.3 Type U is intended for unexposed applications and may also have special use where improved ductility over a temper rolled product is desired. Type U can be produced without temper rolling, but may be lightly rolled in the process of oiling or rewinding. This type of steel can be expected to exhibit coil breaks, fluting, and stretcher straining. Standard tolerances for flatness and surface texture are not applicable. In addition, surface imperfections are more prevalent and severe than with Types E or S.

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4.2 Hot Rolled Sheet Steel—Four types of hot rolled steel are available.

4.2.1 Type R is an as-hot-rolled coiled product. Therefore, it has not been processed in any way; i.e., pickled, oiled, temper rolled, side trimmed, rewound, or cut back to established thickness and width tolerances. Yield strength range classes apply only to material that has been cut back to established thickness and width tolerances.

Processed coils may have had any or all of the processing steps listed in the previous paragraph performed subsequent to hot rolling. Ends of coils are cut back to established width and thickness tolerances.

4.2.2 Type F has been processed and is available in coils or cut lengths. This material is susceptible to coil breaks and aging.

4.2.3 Type N has been processed and is available in coils or cut lengths. This material is nonaging at room temperature but is susceptible to coil breaks.

4.2.4 Type M has been processed and is available in coils or cut lengths. This material is free from coil breaks and does not strain age at room temperature.

Some of the product characteristics available for each type of hot rolled steel are listed in Table 5.

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TABLE 5—PRODUCT CHARACTERISTICS OF HOT ROLLED STEEL

Type	Freedom From Coil Breaks	Non Aging	Pickle and Oil	Cut Edge	Special Surface
R	No	No	n	n	n
F	No	No	a	a	n
N	No	Yes	a	a	n
M	Yes	Yes	a	a	a

a = available but not required
n = not available

5. Examples—As previously discussed, categorization is made by commodity, class, and type. A typical automotive sheet could be categorized as cold rolled 175 BE. This would denote a cold rolled steel with a 175 MPa (25.4 ksi) nominal yield strength with a range in yield strength from 145 MPa to 205 MPa (21.0 ksi to 29.7 ksi) and of critical exposed surface quality. Similarly, a steel categorized as hot rolled 245 CM would be a processed steel with a 245 MPa (35.5 ksi) nominal yield strength, a range in yield strength from 200 MPa to 290 MPa (29.0 ksi to 42.1 ksi), and would be nonaging and free of coil breaks.

6. Sampling Procedure—Yield strength ranges do not apply to coil extremities not meeting thickness tolerances. When questions arise as to steel meeting the minimum or maximum yield strength criteria, the following procedure applies. Two longitudinal test specimens shall be taken from the lift of blanks, cut lengths, or coil in question, except that no portion of the specimens may be closer than 25 mm to the edge of the as-received steel. When tested as outlined in the following section, both tests must fall within the yield strength range for the class specified: otherwise the lift of blanks, cut lengths, or coil can be considered unacceptable.

7. Yield Strength Determination—The procedures given in SAE J416, ASTM E 8, and ASTM A 370 shall be followed in determining tensile properties. However, within these specifications latitude exists in determining yield strength/yield point. For this document the following procedures apply.

7.1 Specimen Geometry—The 12.5 mm (1/2 in) wide sheet type specimen will be used. The width of the grip section will be 20 mm (3/4 in).