

Side Strain—See Edge Strain.

Skin Lamination—Subsurface separation which usually results in surface rupture. (See SAE J810.)

Skin Pass—See Temper Rolling.

Slivers—Surface ruptures somewhat similar in appearance to skin laminations, but usually more prominent. (See SAE J810.)

Smudge (NC)—A dark residue on the surface of sheet steel. (See Smut.)

Smut (NC)—A reaction product sometimes left on the surface of the sheet after pickling or annealing. (See Smudge.)

Snaky Edges (NC)—Carbonaceous deposits in a wavy pattern along the edges of the annealed strip. (See Carbon Edge.)

Spangle (C)—The characteristic crystalline form in which the hot dipped zinc coating solidifies on steel strip. (See SAE J1562.)

Spinning—The shaping of flat circular blanks by forcing the blank against a chuck or form block while it is rotating.

Springback—The tendency of metal to partially return to its original shape after cold forming.

Sticker Breaks (NC)—Arc-shaped breaks usually located near the middle of the sheet. (See SAE J810.)

Stiffness—The ability of a metal or shape to resist deflection.

Strain Hardening—An increase in hardness and strength caused by plastic deformation at temperatures lower than the recrystallization range. (See SAE J877.)

Strain Hardening Exponent—A measure of the rate of strain hardening. The constant 'n' in the expression

$$\sigma = K\varepsilon^n$$

where:

σ = True stress

K = Constant in the equation

ε = True strain

n = Strain hardening exponent

The 'n' value is a good measure of stretch formability. The higher the 'n' value, the better the stretch formability. (See SAE J877.)

Strain Ratio—This expressed as 'r' value. It is the ratio of width to thickness strain determined in uniform elongation portion of a tension test. It is a good measure of the crystallographic directionality of the material. It is also a good measure of deep drawability. The higher the 'r' value, the better the deep drawability. (See SAE J877.)

Stretchability—The ability of a metal to be stretched over a punch without splitting.

Stretch Forming—Shaping of a sheet or part, usually of uniform cross section by applying suitable tension or stretch and forming it around or over a die of the desired shape.

Stretching—The operation where the blank is stretched around the punch with no metal flow over the draw ring. The metal thickness is reduced.

Stretcher Leveling—Leveling where a piece of metal is gripped at each end and subjected to a stress higher than its yield strength to obtain a high degree of flatness. (Sometimes called patent leveling.)

Stretcher Strain (Lüder's Lines)—Irregular surface patterns of ridges and valleys which develop during forming of annealed last or temper rolled, aged steel. (See SAE J810.)

Surface Texture—The finish of the surface of sheet steel presently described by the roughness (peak) height in micro inches and the peaks per inch. (See Matte Finish and SAE J448.)

Synthetic Cold Rolled (NC)—A hot rolled pickled sheet given a sufficient final temper pass to impart a surface approximating that of cold rolled steel.

Temper Rolling—Light cold rolling of sheet steel. This operation is performed to improve flatness, minimize the tendency to stretcher strain and flute, obtain the desired texture and mechanical properties.

Tensile Strength—The unit stress at the highest load reached during the tension test. (See SAE J877.)

Tiger Stripes (C)—Continuous bright lines in the rolling direction.

Total Elongation—Percent elongation measured after fracture in a tension test. (See SAE J877.)

Traverse Lines—Lines closely spaced across the full width of the sheet and running in the direction of rolling.

"U" Finish—This designation indicates that the material is to be used for an unexposed part for which surface finish is unimportant. (See SAE J403.)

Uniform Elongation (Uniform Strain E_u)—The percent elongation at the onset of necking, usually taken as the strain to maximum load in the tension test.

Vacuum Degassing—A process of refining liquid steel in which the liquid is exposed to a vacuum as part of a special refining technique for the purpose of removing impurities or for decarburizing the steel.

Wiped Coat (C)—A hot dipped galvanized coating where virtually all the free zinc is removed by wiping prior to solidification leaving only a thin zinc iron alloy layer.

Work Hardening—Same as Strain Hardening.

Wrinkling—Small buckles which occur in drawing sheet metal as it passes over the drawing ring radius.

Yield Point—The stress beyond which the metal is permanently deformed. (See SAE J877 and J450.)

Yield Point Elongation—Percent elongation at the end of nonhomogeneous yielding in a tension test.

(R) AGING OF CARBON STEEL SHEET AND STRIP—SAE J763 APR91

SAE Information Report

Report of the Iron and Steel Technical Committee, approved May 1961, reaffirmed with editorial change January 1982. Completely revised by the SAE Iron and Steel Technical Committee—Division 32—Sheet and Strip Steel April 1991.

1. Scope—This SAE Information Report briefly covers the aging of hot rolled, cold rolled, and coated carbon steel sheet and strip. Its purpose is to provide general information concerning the phenomenon of aging so that associated problems may be recognized.

2. References

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

1. Kenyon, R.L. and Burns, R.S., "Aging in Iron and Steel," ASM Preprint 40, 1939 Meeting Iron and Steel, 13, April 1940, p. 227; May 1940, p. 260.
2. Epstein, S., "Aging of Iron and Steel," Metals Handbook, 1948, p. 438.
3. Shoenberger, L.R., and Paliwoda, E.J., "Accelerated Strain Aging of Commercial Sheet Steels," Transactions ASM, 45, 1953, p. 344.
4. Leslie, W.C. and Rickett, R.L., "Influence of Aluminum and Silicon Deoxidation on the Strain Aging of Low-Carbon Steels," Transactions AIME, 197, 1953, p. 1021.
5. Morgan, E.R., and Shyne, J.C., "The Strain Aging of Boron-Treated Low-Carbon Steels," Journal Iron and Steel Institute, 185, 1957, p. 156.

6. Morgan, Eric R., "Can an Improved Non-Aging Steel Be Produced Commercially," Metal Progress, 73, June 1958, p. 88.
7. "Strain Aging" and "Stretcher Strains," Metals Handbook, 9th Edition, Vol. 1, 1978, p. 157.
8. "Control of Flatness," Metals Handbook, 9th Edition, Vol. 1, 1978, pp. 157, 160."
9. "Selection of Steel for Forming," "Stretcher Strains," and "Strain Aging," Metals Handbook, 8th Edition, Vol. 4, 1969, pp. 115, 116.

2.2 Terminology

Aging—A term applied to changes in physical and mechanical properties of low-carbon steel that occur with the passage of time. These changes adversely affect formability. Aging accelerates as the temperature is raised.

Strain Aging—A term applied to changes in properties which occur after cold working. Rimmed steel is particularly susceptible to strain aging.

Quench Aging—A term applied to those changes in properties which occur after rapid cooling of the product.

NOTE—Rapid cooling as a process is normally performed by the producer and is not a factor for consideration by the fabricator; therefore, this explanation is for reference purposes only and