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SAE J940 DEC88

Glossary of Carbon Steel Sheet and Strip Terms

SAE Information Report
Revised December 1988

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The Engineering Society For Advancing Mobility Land Sea Air and Space ®
400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

MATERIALS REPORT

SAE J940

Issued November 1965
Revised December 1988

Superseding J940 JAN82

GLOSSARY OF CARBON STEEL SHEET AND STRIP TERMS

1. SCOPE:

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This glossary is intended to provide engineers, metallurgists, and production personnel with uniform definitions of commonly used carbon sheet and strip terms. The glossary serves to supplement information and photographs reported in SAE J810, J763, J877, J863, J403, and J1562.

Many of the terms listed apply only to hot-dipped zinc-coated products or to uncoated products. The letter C following the term identifies a term applying to coated materials, while the letters NC identify a term applying to uncoated materials. Where no identification is provided, the term is common to both.

2. GLOSSARY:

Aging: A term applied to changes in physical and mechanical properties of low carbon steel that occur with the passage of time. (See SAE J763.)

Annealing Border (NC): See Oxidized Surface. (See also SAE J810.)

Annealing Stain (NC): A discoloration on annealed material which may occur anywhere on the sheet (usually lighter than annealing border). It results from residue, or oxidation, during annealing.

Arc (C): A narrow curved pencil-like line in the coating running transversely approximately 2 in from each edge of the strip.

Band Mark: An indentation caused by the packaging band resulting from external pressure on cut lengths or coils and may occur in handling, transit, and storing.

Ø Batch Annealing: See Box Annealing.

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2. GLOSSARY: (Continued)

Beads (C): Small lumps in the coating surface. Particles of dross picked up in the coating or iron oxide particles imbedded in the strip surface from the furnace hearth rolls.

Black Spots (NC): Carbonaceous deposits caused by tightly wound areas in a coil not being exposed to the circulating gases during open coil type annealing. This condition is aggravated by poor strip shape.

Blank: A flat piece of sheet steel produced in blanking dies or by shearing for an identified part. The blank is usually subjected to further press operations.

Blanking: Cutting desired shapes out of flat sheet.

Blister: A small raised area on the surface resulting from the expansion of gas concentrated at a subsurface inclusion. May occur as isolated spots, but often found in longitudinal streaks.

Ø Box Annealing: The process of softening steel by heating coils or stacks of sheets slowly in a closed container, through which, in most cases, a controlled atmosphere is circulated to prevent oxidation during the heating and cooling cycle. The time required may vary from one to several days. (See SAE J415.)

Breaks: Creases or ridges usually in "untempered" or in aged material where the yield point has been exceeded. Depending on the origin of the break, it might be termed a crossbreak, a coil break, an edge break, a sticker break, etc. (See SAE J810.)

Bright Annealing (NC): Annealing in a protective atmosphere to prevent discoloration of the surface.

Bright Finish (NC): A high quality finish produced on sheets by rolls which have been ground and polished. Suitable for electroplating.

Buckles: A series of waves in sheets which are ordinarily transverse to the direction of rolling. (See SAE J810.) In formed panels, "excess metal" in the form of wrinkles, kinks, or folds.

Buildup (C): Localized lineal areas showing a difference in cross-sectional contour during coiling. Usually occurs on the edges of the strip.

Camber: Deviation from a straight edge, usually referring to the greatest deviation of the concave side edge of a sheet or strip from a straight line.

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2. GLOSSARY: (Continued)

Capped Steel: This is a type of steel with characteristics similar to those of rimmed steels, but to a degree intermediate between those of rimmed and semikilled steels. It can be either mechanically capped or chemically capped when the ingot is cast, but in either case the full rimming action is stopped, resulting in a more uniform composition than rimmed steel.

Carbon Edge (NC): Carbonaceous deposits in a wavy pattern along the edges of the sheet or coil. (See also Snaky Edges.)

Chatter: A series of lines uniformly spaced appearing transverse to the rolling direction usually resulting from material being rolled on units having loose bearings. Results in a slight thickness variation where lines appear.

Checked Edges: Sawtooth edges seen after hot rolling and/or cold rolling. (See also Ragged Edge in SAE J810 and Sawtooth Edge in this report.)

Coil Breaks: Creases or ridges which appear as parallel lines across the direction of rolling and which generally extend across the width of the sheet. (See SAE J810.)

Coil Weld: A joint between two lengths of metal within a coil. (See SAE J810.)

Cold Rolled Sheets (NC): A product produced from a hot rolled pickled coil which has been given substantial cold reduction at room temperature. The resulting product usually requires further processing to make it suitable for most common applications. The usual end product is characterized by improved surface, greater uniformity in thickness and improved mechanical properties compared to hot rolled sheet.

Continuous Annealing: The process of passing a strand or sheet through a controlled atmosphere furnace that has both heating and cooling zones. Temperatures, line speeds, and cooling rates are varied to obtain the desired properties for the type of steel being heat treated. The time required for continuous annealing does not usually exceed a few minutes.

Continuous Casting: This is a casting technique in which a cast shape is continuously withdrawn from a mold as it solidifies so that the length is independent of mold dimensions. The rapid solidification inherent in this process minimizes chemical segregation of the product.

Corrugations: Transverse ripples caused by a variation in strip shape during hot or cold reduction.

Cross Breaks: See Coil Breaks.

Curtains (C): An uneven pattern of the coating resulting from run-back of the applied material.

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2. GLOSSARY: (Continued)

Cut Edge: A mechanically sheared edge obtained by slitting, shearing, or blanking.

Deep Drawing: An extreme condition of drawing. The term "deep drawing" is commonly used to describe metal stamping operations which are a combination of drawing and severe stretching.

Developed Blank: See Finished Blank.

Differential Coating (C): A coated product that has different coating masses and/or different coating compositions on the two surfaces of the steel substrate.

Dimple: A defect resulting from foreign matter being mechanically impressed into the sheet surface.

Dings: Accidental impact damage, similar in appearance to dimples.

Drawability: The ability of the sheet steel to be formed or drawn into the intended end product without fracturing.

Drawing: The shaping of a flat blank into the desired contour by causing the metal to flow over a draw ring and round a punch. The flow of metal is restrained by sufficient blank holder pressure to prevent buckling.

Drawing Compound:
Drawing Lubricant: A substance applied to minimize metal-to-metal contact between the sheet metal and the die. Proper application of the proper lubricant can improve flow characteristics of the metal and prevent scoring, galling, and pickup on the dies or part.

Ductility: The ability of a metal to be deformed plastically without fracturing. (See Formability.)

"E" Finish: This designation indicates that the material is to be used for an exposed part requiring a good painted surface. (See SAE J403.)

Earing (Scalloping): The formation of scallops (ears or marked unevenness) around the top edge of a drawn cup caused by differences in the directional properties of the sheet metal used.

Edge Break (Side Strain): See Edge Strain. (See also SAE J810.)

Edge Strain: Transverse strain lines of Lüder's Lines ranging from 1 to 12 inch in from the edges of the sheet. (See SAE J810.)

Elastic Ratio: The yield point divided by the tensile strength.

Ø Electrogalvanizing (C): The electroplating of zinc or zinc alloys upon iron or steel.

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2. GLOSSARY: (Continued)

End Mark: A roll mark caused by the end of a sheet marking the roll during hot or cold rolling.

Entry Mark (Exit Mark): A slight corrugation caused by the entry or exit rolls of a roller leveling unit.

Finished Blank (Developed Blank): A blank that requires little or no trimming after being formed.

Flex Roll: The movable jump roll designed to push up against the sheet as it passes through the roller leveler. The roll can be adjusted to produce varying amounts of deflection of the sheet up to the diameter of the roll.

Flex Rolling: Passing sheets through a flex roll unit to minimize yield point elongation so as to reduce the tendency for stretcher strains to appear in forming.

Floppers: Lines or ridges which are transverse to the direction of rolling and generally confined to the section midway between the edges of the coil as rolled. They are somewhat irregular and tend toward a flat arc shape. (See SAE J810.)

Fluting: A series of sharp parallel kinks or creases occurring in the arc when sheet steel is rolled formed into a cylindrical shape. (See SAE J810.)

Formability: The degree to which a metal can be shaped through plastic deformation. (See Ductility.)

Forming: The shaping of sheet metal by bending, uniaxial stretching, biaxial stretching, compression, or by a combination thereof.

Friction Gouges or Scratches: A series of relatively short scratches variable in form or severity. (See SAE J810.)

Full Center: A "fullness" in the center portion of the sheet or strip.

Galling: Scratches caused by localized cold welding of particles to the tool during the forming operation.

Galvannealed Coating (C): Galvannealed sheets are hot dipped zinc-coated sheets which have been processed to produce a zinc-iron alloy coating. This product does not have a spangle and is suitable for painting after cleaning. The alloy produced lacks ductility and powdering of the coating can occur during forming.

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2. GLOSSARY: (Continued)

Ghost Lines (NC) (Ghost Welt Lines): Lines running parallel to the rolling direction that appear in a panel when it is stretched. These lines may not be evident unless panel has been sanded or painted. (Not to be confused with leveler lines.)

Handling Breaks: Irregular breaks caused by improper handling of sheets during processing. These breaks result from the bending or sagging of the sheets while being handled.

Healed Over Scratch (NC): A scratch that occurred in an earlier mill operation and was partially masked in subsequent rolling. It may open up during forming. (See SAE J810.)

Hot Rolled: Hot rolled sheets are those that are reduced to required thickness at temperatures at which scale is formed and, therefore, carry hot mill oxide.

Hot Rolled, Pickled: The hot rolled product which has been pickled to remove the hot mill oxide.

Impact or Recoil Line: The line on a drawn panel where a change in thickness occurs. Caused by: (1) the transfer of the panel from the die to the punch; (2) the reaction from the blank being pulled sharply through the draw ring (recoil); (3) the impact of the punch contacting the blank.

Inclusions: Nonmetallic materials in a solid metallic matrix.

Ironing: Thinning the walls of deep drawn articles by reducing the clearance between punch and die.

Killed Steel: Steel deoxidized with certain deoxidizing elements, such as aluminum, silicon, etc. The term "killed" is used because such additions cause the steel to lie quietly in the mold during solidification. (See SAE J877.)

Laminations: Defects aligned parallel to the worked surface of the sheet resulting from the presence of inclusions. (See SAE J810.)

Loose Metal: Refers to an area in a formed panel that is not stiff enough to hold its shape, may be confused with Oil Canning.

Lüder's Lines: See Stretcher Strains.

Luster Finish (NC): A finish produced on ground rolls suitable for decorative painting and plating with additional surface preparation after forming.

Matte Finish: The texture produced on sheets by rolls which have been blasted to various degrees of roughness depending upon the end use.

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2. GLOSSARY: (Continued)

Mechanical Properties: The properties of a material that reveal its elastic and plastic behavior when force is applied, for example, yield strength, ultimate strength, elongation, hardness, etc.

Mill Edge: The normal edge produced in hot rolling. This edge is customarily removed when hot rolled sheets are further processed into cold rolled sheets.

Minimized Spangle (C): Minimized spangle galvanized sheet has very small spangles which are obtained by treating the galvanized sheet during the solidification of the zinc to restrict the normal zinc spangle formation.

Necking: Reducing the thickness of a sheet in a localized area by stretching.

Normalizing: Heating steel to a suitable temperature above the transformation range and then cooling in air to a temperature substantially below the transformation range. (See SAE J415.)

Offal: The material trimmed from blanks or formed panels.

Oil Can (Oil Canning): Refers to an area in a formed panel that when depressed slightly will recover its original contour after the depressing force is removed.

Orange Peel: A course textured or pebbly surface condition which becomes evident during forming. (See SAE J810.)

Oxide Border (NC): See Oxidized Surface.

Oxidized Surface (NC): Surface having a thin, tightly adhering, (discolored from straw to blue) oxidized skin extending in from the edge of the coil or sheet. Sometimes called "Annealing Border." (See SAE J810.)

Physical Properties: The properties other than mechanical properties, that pertain to the physics of a material; for example, density, electrical conductivity, thermal expansion, etc. Often improperly used to express mechanical properties.

Pickle Patch (NC): A tightly adhering oxide or scale not removed during the pickling process. (See SAE J810.)

Pickle Stain (NC): Discoloration present after pickling.

Pickling: The removal of surface oxides from sheets by chemical or electrochemical reaction.

Pickup: Metal particles adhering to a work roll or tool which cause a series of dents, scratches, or pits on a sheet or part.

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2. GLOSSARY: (Continued)

Pinchers: Fernlike ripples or creases usually diagonal to the rolling direction. (See SAE J810.)

Pipe: In sheets it appears as a separation midway between the surfaces containing oxide inclusions. (See SAE J810.)

Pits: Small cavities in the surface of the sheet. (See SAE J810.)

Reel Breaks (Reel Kinks): Transverse breaks or ridges on successive inner laps of a coil which are the result of crimping the lead end of the coil into a gripping segmented mandrel.

Ridge: A longitudinal line where the thickness of the metal is slightly greater than the thickness adjacent.

Rimmed Steel: A type of steel characterized by a gaseous effervescence when cooling in the mold. This results in a relatively pure iron outer rim. Rimmed steel is subject to aging. (See SAE J877.)

Roller Leveler: A series of small diameter staggered rolls used primarily to improve flatness and/or to remove yield point elongation.

Roller Leveler Breaks: Obvious transverse breaks usually 1/8 to 1/4 in apart caused by the sheet fluting during roller leveling. These will not be removed by stretching.

Roller Leveler Lines: Lines running transverse to the direction of leveling. These may be seen upon stoning or light sanding after leveling and before drawing. Moderate stretching will usually remove them.

Rosebuds (C): Noted only on minimized spangle. Concentric rings of distorted coating, giving the effect of an opened rosebud.

Rough Developed Blank: A blank that will require trimming after being formed.

Saw Tooth Edge: See Checked Edges.

Scabs: Elongated patches of loosened metal which have been rolled into the surface of the sheet or strip.

Scale: Oxides of iron which form on the surface of hot steel.

Scoring: Marring or scratching of a formed part by metal pickup on the punch or die. (Also see Galling.)

Scratches: Lines caused by the abrasion of one surface against another during rolling, processing, or shipping.

Scribed Square Test: A method to determine the percent increase in unit area of selected regions of a formed panel. (See SAE J863.)

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2. GLOSSARY: (Continued)

Seam Lines (C): A continuous line of small beads.

Seams: Open, broken surface running in straight longitudinal lines caused by the presence of oxides near the surface of the sheet.

Segregation: The variation in chemical composition resulting from natural phenomena in the solidification of a steel ingot. The various elements of the steel having lowest freezing points are concentrated in parts of the ingot last to solidify.

Semikilled Steel: Steel that is partially deoxidized so that there is greater degree of gas evolution than in killed steel, but less than in capped or rimmed steel. The uniformity in composition lies between that of killed steel and rimmed steel.

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.

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2. GLOSSARY: (Continued)

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.)

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2. GLOSSARY: (Continued)

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.

Ø 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.

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