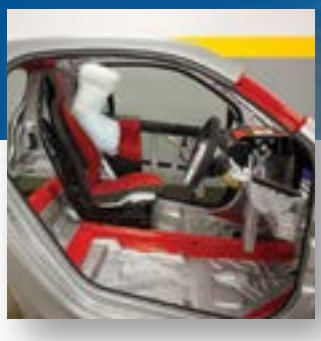
CLIFFS

HOT-DIP GALVANIZED
STEEL



Auto Body Panels
Appliances
HVAC
Agricultural Equipment
Transportation

HOT-DIP GALVANIZED STEEL is continuously coated on both sides with a zinc coating. The hot-dip process, pioneered by our steel business, provides a tight metallurgical bond between the steel and the coating. This process results in a material with the strength and formability of steel, plus the corrosion protection of zinc. Zinc protects the base metal by providing a barrier to corrosive elements and also by the sacrificial nature of the coating.

Hot-Dip Galvanized Steel is available with special surface finishes tailored for specific applications and in a variety of base metal grades and coating weights. Hot-Dip Galvanized Steel is widely used in many applications in automotive, appliance, construction, HVAC and other industries.

Product Features

CORROSION RESISTANCE

The zinc coating protects the base metal by providing a barrier to corrosive elements and also by the sacrificial nature of the coating. Ultimate service life depends on coating thickness and the severity of the environment.

EXCELLENT SURFACE APPEARANCE

Hot-Dip Galvanized Steel is available as EXTRASMOOTH™ or ULTRASMOOTH® for the most demanding surface critical applications.

FORMABILITY

Hot-Dip Galvanized Steel can be used to produce parts containing simple bends to parts with deep drawing requirements.

PAINTABILITY

Hot-Dip Galvanized Steel is readily paintable provided proper pre-treatment is performed.

WELDABILITY

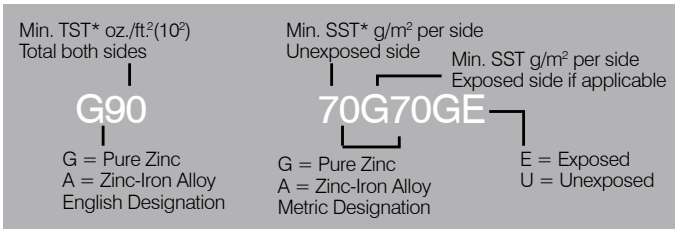
Hot-Dip Galvanized Steel can be joined using a variety of accepted welding practices.

Coating Characteristics

The hot-dip coating process assures a tightly adherent, uniform coating of zinc on both sides of the product. A thin alloy layer readily permits normal fabrication practices without incurring significant coating damage.

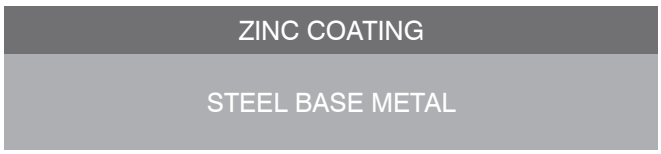
Hot-dip coatings are specified in a wide range of coating weight categories, as shown in Table 1. The differences in designation are explained by the diagram in Figure 1. A schematic of the coating cross section is shown in Figure 2. For coating weights not listed, contact your Cleveland-Cliffs sales representative.

FIGURE 1 – COATING DESIGNATION



**TST/SST = Triple Spot Test/Single Spot Test as defined by ASTM A924.*

FIGURE 2 – COATING CROSS SECTION



Layers not shown to scale.

TABLE 1 – COATING WEIGHT

Coating Designation	Coating Weight Min.	
	oz./ft²	g/m²
Triple Spot Designation (Total Both Sides)		
G01	No Min.	No Min.
G30	0.30	92
G40	0.40	122
G60	0.60	183
G90	0.90	275
G115	1.15	351
G140	1.40	427
G165	1.65	504
G185	1.85	565
G210	2.10	641
G235	2.35	717
Single Spot Designation (Single Side)		
20G/20G	0.07/0.07	20/20
40G/40G	0.13/0.13	40/40
50G/50G	0.16/0.16	50/50
60G/60G	0.20/0.20	60/60
70G/70G	0.23/0.23	70/70
90G/90G	0.29/0.29	90/90
98G/98G	0.32/0.32	98/98

Note: 1 oz./ft² coating weight = 0.0017 in. coating thickness
7.14 g/m² coating mass = 1 µm coating thickness

For other coating weights, please inquire.

Surface Protection and Lubrication

To prevent staining in transit and storage, it is recommended that Hot-Dip Galvanized Steel be supplied with a rust-preventive oil. A chemical passivating treatment can also be supplied. A chemical treatment is not recommended if the product will be painted unless proper surface preparations are taken. Specific chemical treatment requirements (such as RoHS) must be clearly indicated and reviewed.

Hot-Dip Galvanized Steel can be supplied with a zinc-phosphate coating called PAINTGRIP® for applications that require paint pre-treatment.

Surface/Finish

Hot-Dip Galvanized Steel is available in three types of surface appearances.

Minimized Spangle is Hot-Dip Galvanized Steel that, through control of the coating bath chemistry, has no visible spangle. It is available with the full range of coating weights and base metal qualities. It is used in noncritical surface applications and is not guaranteed to be free from stretcher strain, luder lines or fluting.

Hot-Dip Galvanized EXTRASMOOTH Steel is a product that is produced by skin passing the coated sheet to smooth the surface and impart resistance to stretcher strain and fluting. It is suited for applications where appearance is important. EXTRASMOOTH is recommended for coil coated applications.

Hot-Dip Galvanized Steel ULTRASMOOTH Steel is a skin pass product with superior surface appearance, uniformity and consistency. Applications would include more stringent surface quality requirements.

Cleveland-Cliffs utilizes nitrogen finishing to control coating weight and smooth the coating. This technology, along with coating bath chemistry control, combine to produce a superior zinc-coated product.

Regular spangle product is not available from Cleveland-Cliffs.

Formability and Mechanical Properties

The formability of all steel products is a result of the interaction of many variables. These variables include: the mechanical properties of the steel, the forming system (tooling) used to manufacture parts and the lubrication used during forming. Of these three, Cleveland-Cliffs can directly affect the mechanical properties of the steel. Tight control over chemical composition, hot-rolling parameters, the amount of cold reduction, in-line annealing time and temperature, and the amount of additional processing allow the production of high-quality Hot-Dip Galvanized Steel to meet our customers' requirements.

COMMERCIAL STEEL AND FORMING STEEL (FS)

Commercial Steel Type B (CS Type B) and Forming Steel Type B (FS Type B) should be used for moderate forming or bending applications. These products are produced from continuously cast slabs and, unless otherwise specified, have a carbon content of 0.02 – 0.15% C and 0.02 – 0.10% C respectively. To prevent the occurrence of fluting or stretcher strains during forming or processing, both products must be ordered as EXTRASMOOTH. These products are subject to aging and the temper rolling effect is temporary.

DEEP DRAWING STEEL (DDS)

For more stringent forming applications, Deep Drawing Steel should be ordered. Deep Drawing Steel has a controlled carbon content less than 0.06% C. Interstitial-Free (I-F) steel may be supplied at the manufacturer's discretion unless low carbon (non I-F) is specifically requested at the time of purchase.

EXTRA DEEP DRAWING STEEL (DDS)

Extra Deep Drawing Steel or Extra Deep Drawing Steel Plus (EDDS+) should be ordered for the most demanding forming applications. These steels, also known as Interstitial -Free (I-F) steel, are produced from vacuum degassed less than 0.010% C, stabilized grades. EDDS+ has the lowest carbon content available and has been specially formulated to be Cleveland-Cliffs' most ductile product.

For high strength applications, Hot-Dip Galvanized Steel is available as Structural Steel (SS) or High Strength Low Alloy Steel (HSLAS). Bake Hardenable (BH), Dent Resistant (DR) and Dual Phase (DP) Steels are also available.

Typical mechanical properties are shown in Tables 2 – 5.

HOT-DIP GALVANIZED STEEL

SPECIFICATIONS

Hot-Dip Galvanized Steels are produced in conformance to the following specifications:

ASTM A653	Base metal chemistry, grades and coatings
ASTM A755	Hot-dip coil-coated for exposed building products
ASTM A924	General requirements and tolerances
ASTM A929	Corrugated steel pipe
AASHTO M218	Galvanized culvert sheets
SAE J2340	RA 830

For any specifications not listed here, contact your Cleveland-Cliffs sales representative.

OUTSIDE PROCESSING

Tailored blanks, tension leveling, re-squaring, slitting, cut-to-length and coil coating are just some of the services Cleveland-Cliffs can provide through arrangements with outside processors.

TECHNICAL ASSISTANCE

Cleveland-Cliffs' technical representatives can provide you with more detailed information concerning this product. They also are available to assist you in reviewing any welding, forming, painting or other material selection issue.

MILL LIMITS*

Hot-Dip Galvanized Steel is available in thicknesses from 0.018 – 0.134 in. (0.46 – 3.40 mm), and widths up to 80 in. (2032 mm), depending on the dimensions and product quality. For sizes outside these limits, please contact your Cleveland-Cliffs sales representative.

The standard inner diameter of Hot-Dip Galvanized Steel coils is 24 in. (609 mm).

**Please inquire for Hot Rolled substrate capability.*

Tables

TABLE 2 – TYPICAL MECHANICAL PROPERTIES – STANDARD GRADES

Quality Designation	Description	YS		UTS		Min. Elong. %	n-Value	r_m
		ksi.	MPa	ksi.	MPa			
Commercial Steel (CS Type B)	May be moderately formed. A specimen cut in any direction can be bent flat on itself without cracking.	41	283	53	365	36	0.19	—
Forming Steel Type B (FS Type B)		37	255	50	348	37	0.20	—
Deep Drawing Steel (DDS) Low Carbon	May be used in drawing applications.	32	220	48	330	40	0.19	1.3
Deep Drawing Steel (DDS) Ultra-Low Carbon		25	172	42	303	42	0.22	1.5
Extra Deep Drawing Steel (EDDS)	Interstitial Free (I-F) steels are made by adding titanium and/or niobium to the molten steel after vacuum degassing. They offer excellent drawability.	24	165	45	310	44	0.23	1.6
Extra Deep Drawing Steel Plus (EDDS+)		22	148	43	290	46	0.24	1.7

Typical properties produced by Cleveland-Cliffs for these grades.

Commercial Steel, Deep Drawing Steel, and Extra Deep Drawing Steel are designations described in the ASTM specifications for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process A653/A653M. Each of the steel sheet designations is associated with unique requirements for chemical composition and with non-mandatory, typical mechanical properties. All properties are tested per ASTM A370.

TABLE 3 – ASTM-SPECIFIED PROPERTIES – HIGHER STRENGTH GRADE

Quality Designation	Product Details	Min. YS		Min. Tensile Strength		Min. Elong. %
		ksi.	MPa	ksi.	MPa	
Structural Steel (SS)	33 (230)	33	230	45	310	20
	37 (255)	37	255	52	360	18
	40 (275)	40	275	55	380	16
	50 Class 1	50	340	65	450	12
	80 Class 1*	80	530	82	565	—
High Strength Low Alloy Steel (HSLAS)	40	40	275	50	340	22
	50	50	340	60	410	20
	50 (HSLAS-F)	50	340	60	410	22
	55 Class 2	55	380	65	448	18
	60	60	420	70	482	16
	70* (HSLAS-F)	70	480	80	550	14
	80* (HSLAS-F)	80	550	90	620	12

**Cleveland-Cliffs Hot-rolled substrate only.*

Tables

The following qualities are available to various customer or industrial requirements.

Bake Hardenable (BH) grades offer good formability with increased strength from work hardening and subsequent paint/ bake cycle.	Dent Resistant (DR) grades offer good formability with increased strength from a high work hardening rate.	Dual Phase (DP)
BH 180	DR 180	DP 590
BH 210	DR 190	DP 600
BH 220	DR 210	DP 780
BH 240		DP 800
BH 250		DP 980
BH 260		
BH 280		

For strength levels not listed, please inquire.

Multi-Phase (MP) and Complex Phase (CP) Grades	Availability
MP 780	In Development
CP 780	Available
MP 980	In Development
CP 980	Available

TABLE 4 – SAE SPECIFIED PROPERTIES NOT COVERED BY ASTM

Quality Designation	Description	Min. YS		Min. UTS		Min. Elong. %
		ksi.	MPa	ksi.	MPa	
High Strength Low Alloy Steel (HSLAS)	045XLK	45	310	55	380	22
Recovery Annealed 830	SAE J2340 Type 830R	—	830	—	860	2

TABLE 5 – AASHTO SPECIFIED PROPERTIES

Quality Designation	Description	Min. YS		Min. UTS		Min. Elong. %
		ksi.	MPa	ksi.	MPa	
AASHTO M218	CSP	33	230	45	310	20

Tables

TABLE 6 – ENGINEERING PROPERTIES

Young's Modulus of Elasticity	200 x 10^3 MPa at 20 °C	
Density	7.87 g/cm^3 at 20 °C	
Coefficient of Thermal Expansion	Low-Carbon/HSLAS: I-F Steel:	12.4 μm/m/°C in 20 – 100 °C range 12.9 μm/m/°C in 20 – 100 °C range
Thermal Conductivity	Low-Carbon/HSLAS: I-F Steel:	89 W/m°C at 20 °C 93 W/m°C at 20 °C
Specific Heat	481 J/kg/°C in 50 – 100 °C range	
Electrical Resistivity	0.142 $\mu\Omega$•m at 20 °C	

About Cleveland-Cliffs Inc.

Cleveland-Cliffs is the largest flat-rolled steel producer in North America. Founded in 1847 as a mine operator, Cliffs also is the largest manufacturer of iron ore pellets in North America. The Company is vertically integrated from mined raw materials, direct reduced iron, and ferrous scrap to primary steelmaking and downstream finishing, stamping, tooling, and tubing. The Company serves a diverse range of markets due to its comprehensive offering of flat-rolled steel products and is the largest supplier of steel to the automotive industry in North America. The Company is headquartered in Cleveland, Ohio with mining, steel and downstream manufacturing operations located across the United States and in Canada. For more information, visit www.clevelandcliffs.com.

CLIFFS

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September 2024.