



**ASTM DESIGNATIONS FOR STEEL PROPERTIES OF HOT-DIP GALVANIZED AND GALVALUME® -COATED STEEL SHEET**

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**BACKGROUND**

In 1996, 2003 and 2004 ASTM made significant changes to the substrate specifications for hot-dip coated steels. The basic changes were:

- Changing the designation names, as shown in Table 1.
- Tightening some steel chemical composition requirements.
- Combining designations and splitting designations.
- Listing **non-mandatory** mechanical properties.

ASTM changed these specifications to conform more closely to the reality of modern steel making. Tables 2 and 3 show the chemical composition requirements for the current designations and Tables 4a, 4b, 5a and 5b show the mechanical properties. ASTM did not change the coating weight and adhesion requirements. The abbreviation HDG applies to both hot-dip galvanized and galvanized steel sheets, while AZ is used for GALVALUME®<sup>1</sup> Coated Sheet Steel.

**Table 1: Current Steel Designation Names and Their Prior Equivalent**

<b>Current Designation</b>	<b>Coating Types for these Steels</b>	<b>Traditional Designation, Used Prior to 1996</b>
Commercial Steel ( <b>CS</b> ) Types A, B, C	HDG and AZ	Commercial Quality ( <b>CQ</b> ), Lock-Forming Quality ( <b>LFQ</b> )
Forming Steel ( <b>FS</b> ) ----- Forming Steel ( <b>FS</b> ) Types A, B	HDG and AZ ----- HDG Only	Some <b>LFQ</b> Applications
Drawing Steel ( <b>DS</b> )	AZ only	No Prior Designation
Deep Drawing Steel ( <b>DDS</b> )	HDG only	Drawing Quality ( <b>DQ</b> )
Extra Deep Drawing Steel ( <b>EDDS</b> )	HDG only	Drawing Quality Special Killed ( <b>DQSK</b> )
Structural Steel ( <b>SS</b> )	HDG and AZ	Structural Quality ( <b>SQ</b> )
High Strength Low Alloy Steel ( <b>HSLAS</b> ) Types A, B	HDG Only	High Strength Low Alloy ( <b>HSLA</b> )
Solution Hardened Steel ( <b>SHS</b> )	HDG Only	No Prior Designation
High Temperature Steel ( <b>HTS</b> )	AZ only	No Prior Designation

<sup>1</sup> GALVALUME® is an internationally registered trademark of BIEC International, Inc. and some of its licensed producers for 55% Aluminum-Zinc Alloy-Coated Steel Sheet

## STEEL CHEMICAL COMPOSITION REQUIREMENTS

ASTM A 653-04a applies to HDG-coated steel sheets. ASTM A 792-02 applies to GALVALUME® Coated Sheet Steels. Table 2 details requirements for the chemical composition for the heat analysis of all steel designations in A 653 and A 792. For example, Commercial Steel (CS) Type A is specified when CQ or LFQ steel had been used; Type B is used to avoid very low carbon steels [designate Type A when the use of ultra-low carbon, degassed or stabilized steel is allowed]; and Type C for higher phosphorus steel. A 0.02% C minimum prevents the use of ultra-low carbon, stabilized or degassed steel for some steel types. Table 3 lists chemical requirements for “residual” or unspecified elements that are not specified for each steel designation.

**Table 2. A 653 and A 792 Chemical Requirements for Specified Elements in HDG and AZ-Coated Sheet Steel (Heat Analysis, Maximum Weight %)**

Steel Designation	Carbon		Manganese		Phosphorous	Sulfur	
<b>CS</b> (HDG and AZ)							
Type A <sup>B</sup>	0.10		0.60		0.030	0.035	
Type B	0.02-0.15		0.60		0.030	0.035	
Type C <sup>B</sup>	0.08		0.60		0.100	0.035	
<b>FS</b>							
Type A (HDG) <sup>C</sup>	0.10		0.50		0.020	0.035	
Type B, (HDG and AZ)	0.02-0.10		0.50		0.020	0.030	
<b>DS</b> (AZ) <sup>F</sup>	0.06		0.50		0.020	0.025	
<b>DDS</b> (HDG) <sup>B, F</sup>	0.06		0.50		0.020	0.025	
<b>HTS</b> (AZ) <sup>F</sup>	0.02-0.15		0.60		0.040, min.	0.035	
<b>EDDS</b> (HDG) <sup>D, F</sup>	0.02		0.40		0.020	0.020	
<b>SS</b> (HDG and AZ)			HDG	AZ		HDG	AZ
Grade 33	0.20		... <sup>A</sup>	1.15	0.04	0.04	0.040
Grade 37	0.20		...	1.15	0.10	0.04	0.040
Grade 40	0.25		...	1.15	0.10	0.04	0.040
Grade 50, Class 1	0.25		...	1.15	0.20	0.04	0.040
Grade 50, Class 2	0.25		...	1.15	0.20	0.04	0.040
Grade 50, Class 3	0.25		...	-- <sup>E</sup>	0.04	0.04	-- <sup>E</sup>
Grade 80	0.20		...	1.15	0.04	0.04	0.040
<b>HSLAS</b> (HDG)	Type A	Type B	Type A	Type B			
40	0.20	0.15	1.20	1.20	... <sup>A</sup>	0.035	
50	0.20	0.15	1.20	1.20	...	0.035	
60	0.20	0.15	1.35	1.20	...	0.035	
70	0.20	0.15	1.65	1.65	...	0.035	
80	0.20	0.15	1.65	1.65	...	0.035	
<b>SHS</b> (HDG)							
All Grades	0.12		1.50		0.12	0.030	

<sup>A</sup> Where an ellipsis (...) appears in this table there is no requirement, but the analysis shall be reported. A blank entry indicates no requirement.

<sup>B</sup> Steel is permitted to be furnished as a vacuum degassed or chemically stabilized steel, or both, at the producer's option.

<sup>C</sup> Shall not be furnished as a stabilized steel.

<sup>D</sup> Shall be furnished as a stabilized steel.

<sup>E</sup> There is no Grade 50, Class 3 for AZ-coated steel sheet

<sup>F</sup> There is a minimum requirement of 0.01% aluminum for these steels

Maximums have been set for the levels of several unspecified or residual elements, as shown in Table 3. If the manufacturer specifies an element, the limit does not apply.

**Table 3. Chemical Requirements for Unspecified Elements  
In HDG and AZ-Coated Sheet Steel (Maximum Heat Analysis Weight %)**

Steel Designation	Cu	Ni	Cr	Mo <sup>A</sup>	V <sup>C</sup>	Cb/Nb <sup>C</sup>	Ti <sup>C</sup>
CS <sup>C</sup> , FS, DS, DDS <sup>C</sup> , SS, SHS, HTS	0.20	0.20	0.15	0.06	0.008	0.008 (HDG and AZ) 0.015 (Grade 80) <sup>A</sup>	0.025 <sup>D</sup>
EDDS	0.20	0.20	0.15	0.06	0.10	0.10	0.15
HSLAS 40 <sup>E, F</sup>	... <sup>B</sup>	0.20	0.15	0.06	0.01 min	0.005 min	0.01 min
HSLAS <sup>E, F</sup>	0.20	0.20	0.15	0.06	0.01 min	0.005 min	0.01 min

<sup>A</sup> A higher maximum amount of Cb (0.015% versus 0.008%) is allowed for HDG and AZ-coated SS Grade 80.

<sup>B</sup> Where an ellipsis (...) appears in this table there is no requirement, but the analysis shall be reported.

<sup>C</sup> For carbon levels  $\leq 0.02\%$ , V, Cb or Ti, or combinations thereof are permitted to be used as stabilizing elements at the producer's option. In such cases, the applicable limit for V and Cb shall be 0.10% maximum and the limit for Ti shall be 0.15% maximum.

<sup>D</sup> For steels containing more than 0.02% carbon, and for SS steels, Ti is permitted up to 0.025% provided that the ratio of % Ti to % N does not exceed 3.4

<sup>E</sup> HSLAS and HSLAS-F steels commonly contain the strengthening elements V, Cb and Ti added singly or in combination. The minimum requirements only apply to the microalloying elements selected for strengthening of the steel.

<sup>F</sup> The producer has the option to treat HSLAS Type B steels by means of small alloy additions to effect sulfide inclusion control.

ASTM A 924-04 applies to all steel sheets that are metallic-coated by the hot-dip process. Refer to this ASTM specification for the under/over allowed tolerances for product check analyses of steel chemical composition, as compared to reported heat analyses.

## **GALVALUME<sup>®</sup> COATED SHEET STEEL MECHANICAL PROPERTIES**

ASTM A 792-02 applies to AZ-coated sheet steel and divides Commercial Steel into 3 types: Type A is the new designation for applications when CQ or LFQ steel had been formerly used; Type B is used when very low carbon steel needs to be avoided; and Type C is for higher phosphorus steel. ASTM did not previously specify Drawing Steel or Forming Steel for GALVALUME. The mechanical property ranges for Commercial, Forming, Drawing and High Temperature Steels are not mandatory.

**Table 4a. A 792 Specifications for Typical Ranges of Mechanical Properties<sup>A</sup>  
(Non-mandatory)**

Steel Designation	Yield Strength <sup>B</sup> (ksi)	Elongation in 2 inches minimum %	$r_m$ Value	$n$ Value
CS				
Type A	30-60	$\geq 20$	c	c
Type B	35-60	$\geq 20$	c	c
Type C	30-65	$\geq 15$	c	c
FS	25-40	$\geq 24$	1.0 / 1.4	0.16 / 0.20
DS	20-35	$\geq 30$	1.3 / 1.7	0.18 / 0.22
HTS	30-65	$\geq 15$	c	c

<sup>A</sup> These typical properties apply to the full range of steel sheet thickness. The yield strength tends to increase and some of the formability values tend to decrease as the sheet thickness decreases.

<sup>B</sup> Typical ranges have not been established for tensile strength.

<sup>C</sup> No typical properties have been established

**Table 4b. A 792 Mechanical Property Requirements, Structural Steel Base Metal**  
(Longitudinal)

Steel Designation	Yield Strength min., ksi	Tensile Strength min., ksi	Elongation in 2 inches minimum %
<b>Structural Steel (SS)</b>			
Grade 33	33	45	20
Grade 37	37	52	18
Grade 40	40	55	16
Grade 50, Class 1	50	65	12
Grade 50, Class 2	50	... <sup>A</sup>	12
Grade 80 <sup>B</sup>	80 <sup>C</sup>	82	... <sup>A</sup>

<sup>A</sup> Where an ellipsis (...) appears in this table there is no requirement.

<sup>B</sup> For sheet thickness of 0.028-inch and thinner, no tension test is required if the hardness result is Rockwell B 85 or higher.

<sup>C</sup> As there is no discontinuous yield curve, the yield strength should be taken as the stress at 0.5% elongation under load or 0.2% offset.

## HOT DIP GALVANIZED MECHANICAL PROPERTIES

ASTM A 653-04a applies to HDG and divides Commercial Steel into types: Type A is the new designation for when CQ or LFQ steel had been formerly used; Type B is used to avoid very low carbon steels [designate Type A when using ultra-low carbon or degassed steel]; and Type C for higher phosphorus steels. HDG FS type A may use ultra-low carbon or degassed steel but not type B. The mechanical property ranges shown in Table 5a for Commercial, Forming, Deep Drawing and Extra Deep Drawing Steels are not mandatory. Values outside these ranges may occur unless specific other arrangements are made with the manufacturer. The mechanical property ranges shown in Table 5b are specified for Structural Steels, High Strength Low Alloy Steels and Solution Hardened Steels.

**Table 5a. A 653 for HDG Typical Ranges of Mechanical Properties**  
(Non-mandatory)<sup>A</sup>

Steel Designation	Yield Strength <sup>C</sup> (ksi)	Elongation in 2 in. min. %	$r_m$ Value	$n$ Value
CS				
Type A	25-55	≥ 20	... <sup>A</sup>	...
Type B	30-55	≥ 20	...	...
Type C	25-60	≥ 15	...	...
FS				
Type A	25-45	≥ 26	2.0 / 1.4	0.17 / 0.21
Type B	25-45	≥ 26	1.0 / 1.4	0.17 / 0.21
DDS	20-35	≥ 32	1.4 / 1.8	0.19 / 0.24
EDDS <sup>B</sup>	15-25	≥ 40	1.6 / 2.1	0.22 / 0.27

<sup>A</sup> Where an ellipsis (...) appears in this table there is no requirement.

<sup>B</sup> EDDS sheet will be free from changes in mechanical properties over time, that is, non-aging.

<sup>C</sup> Typical ranges have not been established for tensile strength.

**Table 5b. A 653 HDG Mechanical Property Requirements, Base Metal  
(Longitudinal)<sup>A</sup>**

Steel Designation	Yield Strength min., ksi	Tensile Strength min., ksi	Elongation in 2 in. minimum %	
SS <sup>B</sup>				
Grade 33	33	45	20	
Grade 37	37	52	18	
Grade 40	40	55	16	
Grade 50, Class 1	50	65	12	
Grade 50, Class 2	50	...	12	
Grade 50, Class 3	50	70	12	
Grade 80 <sup>C</sup>	80 <sup>D</sup>	82	...	
HSLAS			Type A	Type B
40	40	50 <sup>E</sup>	22	24
50	50	60 <sup>E</sup>	20	22
60	60	70 <sup>E</sup>	16	18
70	70	80 <sup>E</sup>	12	14
80	80	90 <sup>E</sup>	10	12
SHS <sup>B</sup>				
Grade 26	26	...	32	
Grade 31	31	...	30	
Grade 35	35	...	26	
Grade 41	41	...	24	
Grade 44	44	...	22	

<sup>A</sup> Where an ellipsis (...) appears in this table there is no requirement.

<sup>B</sup> No type identification is applicable to the SS, SHS, or BHS designations.

<sup>C</sup> For sheet thickness of 0.028-inch and thinner, no tension test is required if the hardness result is Rockwell B 85 or higher.

<sup>D</sup> As there is no discontinuous yield curve, the yield strength should be taken as the stress at 0.5% elongation under load or 0.2% offset.

<sup>E</sup> If a higher tensile strength is required, the user should consult the producer.

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