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FIAT CHRYSLER AUTOMOBILES

SHEET STEEL FOR AUTOMOTIVE APPLICATION

MS.50002

MATERIAL STANDARD

Date: 11-MAR-2019

GLOBALLY HARMONIZED DOCUMENT

Change level	Date	Description of change
-	2012-12-18	Initial release.
A	14-MAY-2013	Revised grades CR03, CR04, CR05 to CR04, CR05, CR06 respectively.
B	02-OCT-2013	Revised coating drawing call outs in Annex C and Annex D
C	24-APR-2014	Editorial changes (No technical updates)
D	06-MAY-2014	New steel grades: Fine Grain (FG), Quenching & Partitioning (QP), Structural Steels (ST), Multiphase Cold Rolled (MPC) New steels: BHC280Y380T (BH300), DPC420Y780T HF (DP800 High Formability), DPC700Y980T (DP1000 High Yield), DPC950Y1180T (DP1200). New coating type: Zinc-Magnesium-Aluminum coating (ZM)
E	18-JUL-2014	Introduced 10.5 Corrosion Resistance. Introduced ZM150 coating class. Revised test direction for MPH and MPC (from T to L)
F	18-MAY-2015	Discontinue Grade TRIP590 (TRC360Y590T) and moved to Section 8.2, Added new steel Grade'TBC700Y1050T'. Revised chemical composition limits and property range for several steel grades.
G	10-AUG-2015	Corrections made to Grade Designations in ANNEX A & B.
H	22-DEC-2015	Added New Grades: TBC340Y590T, TBC700Y980T, TBC600Y980T HF, TBC850Y1180T, MPH660Y760T, Revised grade TBC700Y1050T to TBC700Y980T, and DPC420Y780T HF to TBC420Y780T. Discontinued Grade LAC830Y860T. Revised Section 10.2.
J	21-MAR-2016	Discontinue Grade LAC830Y860T (HSLA 830MPa min yield recovery annealed product). Added coating type EGA. Adjusted property range and revised grade MPH620Y780T to MPH660Y760T, revised grade name from TBC600Y980T HF to TBC600Y980T.
K	04-AUG-2016	Added discontinued steel grades DPC340Y590T, MPH620Y780T& MPH680Y800T to Section 8.2, to support carry over parts.
L	28-MAR-2017	Minor Technical changes. Added welding NOTE for steels bearing retained austenite (TRC, TBC, and Q&P), Added grade MTC700Y900T. Updated Limitations of usage.
M	15-NOV-2017	Added the A elongation for hot rolled materials. Added reference to MS.50027. Added Jet Vapor Deposition zinc coating. Changed the yield strength range for MPH660Y760T.
N	05-SEP-2018	Added new sheet steel type Ferrite + Nano-precipitates (FN). Added new Section 8.2 for new AHSS steel grades that are still under engineering development.
P	13-DEC-2018	Revised Hole Expansion Index requirement for FBH440Y580T to 65%. Added requirements for bumper quality appearance and surface finish.
Q	11-MAR-2019	Added surface roughness for LATAM. Added NOTE 1 to Table 28.

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SHEET STEEL FOR AUTOMOTIVE APPLICATION

TABLE OF CONTENTS

1 GENERAL

1.1 Purpose

This standard specifies the classification and requirements for various types and grades of sheet steel used for automotive applications.

1.2 Coverage of this Standard

This standard applies to uncoated and coated, cold rolled and hot rolled sheet steel materials for cold formed parts. These products shall be supplied as coils or sheet with thicknesses typically from 0.5 mm to 8.0 mm. Additionally this standard covers the substrate, coating mass, coating type, and surface finish.

For coated steels sheet refer to appropriate coating standard for additional requirements:

PS.50026 – Hot Dip Aluminized, Cold Rolled Steel Sheet, Strip and Seamless or Welded Drawn Tubing.

PS.50027 - Hot Dip Galvanized Steel Sheet and Strip (GI and GA).

PS.50028 – Electrogalvanized Steel Sheet and Strip (EG).

Products covered under this standard are to be procured only from mill sources that are qualified by FCA Group Materials Engineering (See Document SD.00013).

1.3 Limitations on Usage

For applications where hot stamping / press hardening processes are used, refer to MS.50001. Sheet steel products included in this standard are not intended for secondary bulk hardening (Quench & tempering, Q&T) or surface hardening processes such as carburizing, carbonitriding or nitriding.

All products supplied to this specification must be free of hydrogen embrittlement sensitivity. These materials may require baking treatments after electroplating to eliminate hydrogen embrittlement.

Parts stamped with DP, TRIP, TWIP, and MT steels shall not be electroplated with zinc or any other corrosion prevention coatings after stamping.

2 REFERENCES

Table 1 - References	
Document Number	**Document Title**
ASTM standards	Available from: http://www.astm.org
ASTM A 370	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A513/A513M	Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
ASTM A 512	Standard Specification for Cold-Drawn Buttweld Carbon Steel Mechanical Tubing
ISO standards	Available from: http://www.iso.org
ISO 1460	Hot Dip Galvanized Coatings on Ferrous Materials
ISO 10113	Metallic Materials - Sheet and Strip - Determination of Plastic Strain Ratio
ISO 10275	Metallic Materials - Sheet and Strip - Determination of Tensile Strain Hardening Exponent
European Standards	Available from: http://www.cen.eu/cen/
EN 10325	Steel – Determination of yield strength increase by the effect of heat treatment (Bake-Hardening-Index)
Harmonized Standards	Available from: http://bestandard.fcagroup.com
LP.7M001	Tension test for sheet metal products and calculation of parameters “n” and “r”
MS.50001	Press-Hardened Steel for Body Parts
MS.50003	Stainless and Heat-Resisting Steel Sheet, Strip, Plate, Bar, Wire and Tubing for Automotive Application
MS.50005	Aluminum Sheet for Body and Closure Panel Applications
MS.50014	Carbon and Alloy Steel Specifications for Sheet and Strip
PS.50009	Sheet Metal in Coils and Cut Lengths
PS.50026	Hot Dip Aluminized, Cold Rolled Steel Sheet, Strip and Seamless or Welded Drawn Tubing
PS.50027	Hot Dip Galvanized Steel Sheet and Strip
PS.50028	Electrogalvanized Steel Sheet and Strip
SD.00013	Engineering Approved Source List for Sheet Metal Products
CS-9003	Supplier Requirements For Vehicle And Service Parts: Material Content Reporting, Marking, And Recyclability
MS.50014	Hot and Cold – Rolled Steel Sheet, Strip and Welded Mechanical Tubing (Superseded by MS.50014)
MS-66<S>	Low Carbon Hot Rolled Steel – Sheet and Strip (Superseded by MS.50002)
MS-67<S>	Low Carbon Cold Rolled Steel – Sheet and Strip (Superseded by MS.50002)
MS-264<S>	High Strength And Structural Quality Steels – Sheet, Strip, Plate, Flat Bar And Welded Mechanical Tubing (Superseded by MS.50002)

Table 1 - References	
Document Number	**Document Title**
MS-6000<D>	Zinc And Zinc-Iron Alloy Coated Sheet Steel (Superseded by MS.50002)
MS-9680	Body In White Fluids Sheet Metal Lubricants and Rust preventatives.
PS-508	Chemical Surface Treatment of Automotive Parts in General Industry
MS.90103	Full Immersion Zinc Phosphate Standard for Steel, Galvanized Steel, Galvanneal and Aluminum Passenger Bodies
9.50240	Sheet Steel and Strip Technical Supply Requirements
FG52806	Low carbon steel sheet and strip(Superseded by MS.50002)
52811	Steel Sheets and Strips Standard Microalloyed, Cold Rolled, with High Yield Strength(Superseded by MS.50002)
MS.50027	Approximate Equivalence Between Hardness Numbers
52814	High- Resistance Steel Sheets Standard and Strips With Yield Point of 180 to 300 MPa(Superseded by MS.50002)
52815	Multiphase And Ultra-High Standard Resistance Hot--- And Cold---Rolled Steel Sheets And Strips (Superseded by MS.50002)
52891	Hot rolled or drawn steels. General-purpose constructional sheet, strip, wire, bar, shapes and sections
9.55842	Various Metallic Part Painting
5.00604	Three-coat automotive body shell paint cycle
5.00606	Two-coat paint cycle for car body shell

3 DEFINITIONS/ABBREVIATIONS/ACRONYMS/SYMBOLS

AHSS: Advanced High Strength Steels
BH: Bake Hardening Steel
CR: Cold Rolled
DP: Dual Phase Steel
FB: Ferritic-Bainitic Steel
FN: Ferritic Steel with Nano-precipitates Strengthening
FG: Fine Grain
H.E.I.: Hole Expansion Index
HF: High Formability
HR: Hot Rolled
HSS: High Strength Steels
ISO: International Organization of Standardization
Max: maximum
Min: minimum
MPa: Mega Pascal
MPH: Multiphase Steel Hot Rolled
MPC: Multiphase Steel Cold Rolled
MS: Mild Steel
MT: Martensitic Steel
QP: Quenching & Partitioning Steel
ST: Structural Steel
TB: TRIP with Bainite Matrix
TR: TRIP with Ferrite Matrix

TRIP: Transformation Induced Plasticity
TWIP: Twinning Induced Plasticity
UTS: Ultimate Tensile Strength
VDA: German Association of the Automotive Industry (Verband der Automobilindustrie)
UHSS: Ultra High Strength Steels
WH: Work Hardening
YS: Yield Strength

4 CORRELATION TO OTHER STANDARDS

Comparison between new nomenclature and old FCA Italy and FCA US nomenclature is in Annex A.

5 REGULATED SUBSTANCES & RECYCLABILITY

Provisions must be made to prevent the addition of such elements from scrap or other materials used in the manufacturing process which would impair the recyclability of the finished components. Material must meet requirements of FCA US standard CS-9003.

6 MATERIAL CHARACTERISTICS

6.1 Steel Types - bare and substrate for coated products

6.1.1 Mild Steels

Mild steels are characterized by low yield strength and high ductility and are especially suited for the production of complex parts. They are produced as aluminum killed non-IF grades or as IF grades. Soft IF grades have an excellent formability, show very low carbon and nitrogen contents, and are stabilized by the addition of titanium and/or niobium.

6.1.2 High Strength IF-Steels (IF)

High Strength IF-steels have very low contents of carbon and nitrogen and are stabilized by the addition of titanium and/or niobium. As a consequence, these steels show a nearly unlimited suitability for storage. Their higher strength is achieved by solid solution hardening with adding manganese, phosphorus and/or silicon. A higher work-hardening, no pronounced yield point, high elongations and r values result in an excellent formability.

6.1.3 Bake Hardenable Steels (BH)

The higher strength of bake hardenable steels is achieved by solid solution hardening adding manganese, phosphorus and silicon. The dissolved carbon in the lattice results in a defined increase in yield strength after heat cycles that usually occur in automotive paint processes (e.g. 170 °C, 20 minutes).

Bake hardening index should be determined per EN 10325.

Bake hardening effect improves the dent resistance for exposed outer panels. Since this shift in the mechanical properties (yield strength, elongation, n-value) is a time and temperature driven process, the suitability for storage of this steels is limited.

6.1.4 High Strength Low Alloy Steels (HSLA)

Micro-alloyed Steels achieve their high strength through alloy additions of niobium, titanium, and vanadium. Those alloying elements can be added either alone or in combination. Alternatively, carbon-manganese alloying concepts in combination with grain refinement can be used. Structure shall be ferritic with evenly distributed fine grains. The grains shall not have preferential orientation. The size of the grains, determined as per Standard UNI EN ISO 643, is to be 10 or finer. Size 9 grains are allowed only in percentages less than 10 %. Type A inclusions are not to exceed grade 3 of the JK scale (ASTM E45 method A).

6.1.5 Fine Grain Low Alloy Steels (MC)

The fine grain microstructure of these micro-alloyed steels is achieved by finely dispersed precipitations (mostly carbides and/or nitrides) in combination with final rolling at a certain temperature range, the thermo-mechanical rolling. Due to their fine grained structure, small grain size low alloyed steels show high fatigue strength.

6.1.6 Dual Phase Steels (DP)

The microstructure of dual phase steels consists of a soft ferrite matrix with a dispersed mainly martensitic phase. At a given high tensile strength dual phase steels show a low yield ratio (YS/UTS) and a strong work hardening capacity. Therefore, dual phase steels are especially suited for forming operations with high stretching portions.

6.1.7 TRIP Steels (TR & TB)

TRIP (Transformation Induced Plasticity) or retained austenite steels have a fine-grained ferritic-bainitic microstructure with embedded retained austenite. Small portions of martensite can also be present.

During plastic deformation retained austenite transforms to martensite and leads to a strong work hardening (TRIP effect). High tensile strengths with high values of the uniform elongation can be achieved. The combination of work and bake hardening results in high component strengths. TRIP steels are suited for stretch forming and deep drawing where high press and blank-holder forces and a strong springback effect have to be considered.

TRIP steel are also available with fine bainitic matrix in place of ferrite, and are termed as TRIP assisted Bainitic (TB) steels. These steels show better performance with respect to regular TRIP, a higher YS and UTS due to bainitic-ferritic matrix and higher ductility due to stable retained austenite. This microstructure also provides better stretch flangeability and bending behaviour.

The TRIP-Bainitic cold rolled steel grades, included in Tables 12, 25, 35, & 36 contain significant amounts of austenite in their microstructure. These steel grades when supplied with a zinc coating (GI, EG, GA) will require additional development for arc, laser and spot welding processes. Application engineers must receive approval from Materials Engineering when specifying an arc or laser welding process for joints using a combination of these materials and coatings.

6.1.8 Ferritic-Bainitic Steels (FB)

Ferritic-bainitic steels are characterized by a matrix of ferrite or strengthened ferrite containing bainite or strengthened bainite. The high strength of the matrix is caused by grain refinement, precipitation of micro-alloying elements and a high dislocation density.

6.1.9 Multiphase Steel (MP)

Complex phase steels are characterized by a multiphase microstructure containing mostly a ferritic-bainitic matrix whereas martensite, tempered martensite, retained austenite and pearlite can be present as additional phases. The extremely fine-grained microstructure is generated by retarded recrystallization or precipitation of micro-alloying elements.

Compared to dual phase steels they show a higher yield ratio, lower work hardenability and good hole expansion ratios.

6.1.10 Ferritic Steel with Nano-precipitates Strengthening (FN)

FN steels are Hot Rolled steels characterised by finely dispersed nano-precipitates (mostly carbides and nitrides) in a single phase ferritic microstructure. The single phase microstructure enables these low alloyed steels to offer a combination of high tensile elongation and hole expansion ratio (HER), compared to hot rolled Multiphase materials of similar strength level.

6.1.11 Martensitic Steels (MT)

Martensitic steels have a mainly martensitic microstructure with small amounts of ferrite and/or bainite and thus a very high strength. Drawability is limited; these steel grades are more suited for bending processes like roll forming.

6.1.12 TWIP Steels (TW)

TWIP steels have a high manganese content that causes the steel to be fully austenitic at room temperatures. A large amount of deformation is driven by the formation of twins. The twinning causes a high value of the instantaneous hardening rate (n value) as the microstructure becomes progressively finer with increasing plastic strain. The resultant twin boundaries act like grain boundaries and strengthen the steel. TWIP steels combine extremely high strength with extremely high stretchability.

These steel grades when supplied with a zinc coating (GI, EG, GA) will require additional development for arc, laser and spot welding processes. Application engineers must receive approval from Materials Engineering when specifying an arc or laser welding process for joints using a combination of these materials and coatings.

6.1.13 Structural Steel (ST)

Structural Steel are thermo-mechanically hot-rolled flat products made of high yield strength steels, fine grained, weldable and suitable for cold forming.

6.1.14 Quenching & Partitioning Steel (QP)

QP heat-treatments of appropriately alloyed steels typically consist of an ‘Austenitization - Interrupted Quench – Partition – Final Quench’ heat treatment procedure. During the partitioning stage carbon escaping from the supersaturated martensite partitions into the austenite, stabilizing it and preventing further transformation to martensite during the final quench to room temperature.

These steel grades when supplied with a zinc coating (GI, EG, GA) will require additional development for arc, laser and spot welding processes. Application engineers must receive approval from Materials Engineering when specifying an arc or laser welding process for joints using a combination of these materials and coatings.

6.2 Coating Types

6.2.1 Electrogalvanized Coating (EG)

Zinc coating with a zinc content of at least 99.9 % by mass electrolytically applied in a continuous coating process on a suitable prepared steel surface.

6.2.2 Electrogalvanneal (Zn-Fe) Coating (EGA)

The bulk iron content of unexposed zinc-iron alloy coatings produced by either the hot-dip (GA) or electrogalvanized (EGA) process shall be 7 to 16 weight %.

The bulk iron content of critical exposed (Codes E), electrogalvanized (EGA) zinc-iron alloy coatings shall be 10 to 20 weight %.

6.2.3 Electrogalvanized Zinc-Nickel Coating (ZN)

Electrogalvanized zinc-nickel alloy coating with a Nickel content from 9 % to 13 % by mass.

6.2.4 Hot Dip Zinc Coating (GI)

Zinc coating applied in a continuous process by passing the sheet steel through a molten bath with a zinc content of at least 99 % by mass.

6.2.5 Hot Dip Coating with Zinc-Iron Alloy (Galvannealed, GA)

This zinc-iron alloy coating is generated by immersing the prepared strip in a molten bath containing a zinc content of at least 99 % and a subsequent annealing. At the same time iron diffuses into the zinc layer.

The bulk iron content of unexposed zinc-iron alloy coatings produced by hot-dip (GA) process shall be 7 to 16 weight %. The bulk iron content of critical exposed hot-dip (GA) zinc-iron alloy coating shall be 7 to 14 weight %.

6.2.6 Hot Dip Aluminum-Silicon Coating (AS)

This coating shall be applied through continuous hot dip process using molten aluminum-silicon bath.

The bulk silicon content in the coating shall be 6 % – 11 %.

6.2.7 Zinc-Magnesium Coating (ZM)

This coating shall be applied through continuous hot dip process using molten zinc-magnesium-aluminium bath. Magnesium and Aluminium content shall be respectively from 1.0 % to 3.5 %.

For the exposed components the content of Al shall be from 1.0 % to 3.0% and of Mg from 1.0% to 2.0%.

6.2.8 Physical Vapor Deposition (ZV)

Zinc vapor are deposited under vacuum directly on to the continuously moving sheet steel surface to produce a thin adherent uniform layer. Process involves zinc vapor production in a vapor generator through thermal activation and subsequently deposited through a wide array jet to achieve very high

deposition rate to achieve high corrosion performance product. Coating is especially suited for AHSS sheet due since this process involves much lower sheet temperatures and no exposure to hydrogen.

6.3 Coating Mass

Coating mass for coated steel sheets shall be determined in accordance with ISO 1460. Either coating mass or coating thickness may be used to determine the coating class shown in Table 2.

Table 2 - All Coating Types and Coating Mass

Coating Type	Coating Class	Coating Mass per Side (Master) Triple Spot Test g/m²	Coating thickness per Side (micrometer)
EG	45	45 - 65	6.3 - 9.1
	60	60 - 80	8.4 -11.2
	75	75 - 95	10.5 - 13.3
ZV	45	45 - 65	6.3 - 9.1
	60	60 - 80	8.4 -11.2
	75	75 - 95	10.5 - 13.3
EGA(1)	30	30 - 60	4.2 - 8.5
	45	45 - 75	6.3 - 10.5
ZN	32	32 - 46	4.5 - 6.5
GI	45	45 - 75	6.3 - 10.5
	60	60 - 90	8.4 - 12.6
	75	75 - 100	10.5 - 14.0
	90	90 - 130	12.6 - 18.2
	100	100 - 140	14.0 - 19.6
	150	150 - 200	21.0 - 28.0
GA	30	30 - 60	4.2 - 8.5
	45	45 - 75	6.3 - 10.5
AS	60	60 - 80	18.0 - 24.0
ZM	35	35 - 55	5.0 – 8.0
	50	50 - 70	8.0 – 11.0
	70	70 - 90	11.0 – 14.0
	100	100 - 120	15.0 – 18.0
	150	150 - 170	23.0 – 26.0

NOTE 1 : Available only in NAFTA

6.4 Nomenclature and Examples for Steel Designation

The coding system for sheet steel products on engineering part drawings and manufacturing engineering documents shall use a nomenclature consisting of the material standard number, steel type and product type, grade for mild steel (Table 3) or minimum yield strength and minimum tensile strength for HSS, AHSS, and UHSS (Table 4) in MPa. The coating is designated by coating type and coating mass for side

A and side B of the sheet in g/m² per side. Uncoated material is specified by using “Uncoated” instead of coating type and mass. Surface quality is designated as either U for unexposed or E for exposed applications. Nomenclature scheme is shown in Figure 1.

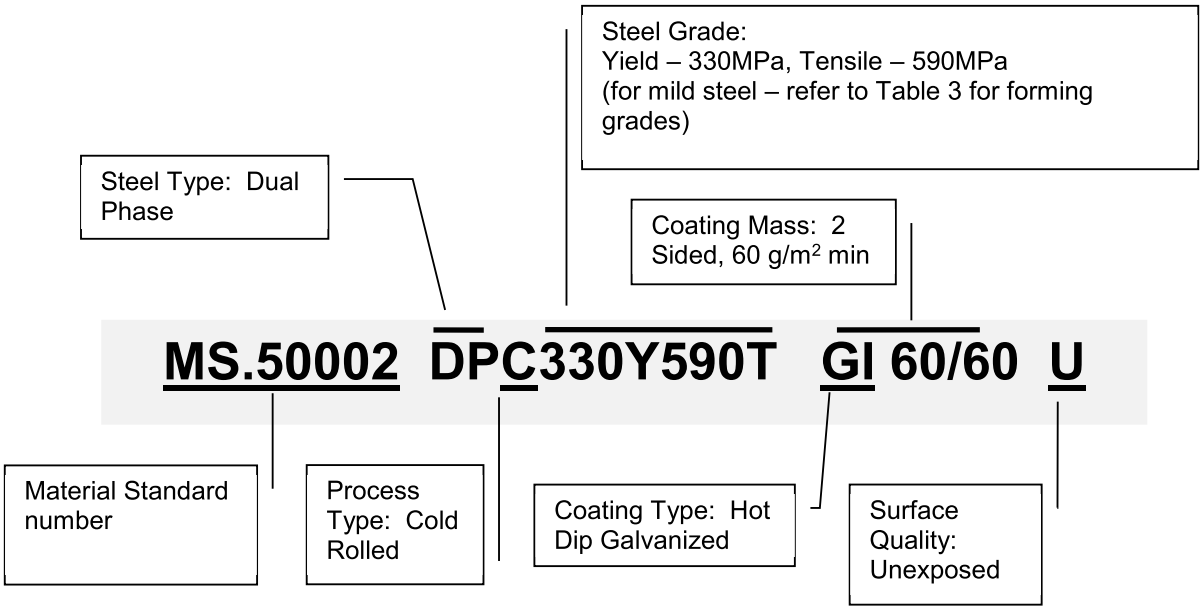

Figure 1 - Schematic for Sheet Steel Coding System

6.4.1 Mild Steel

Cold rolled mild steel grades are CR01 through CR05, while, hot rolled mild steel grades are numbered HR11 through HR13 based on formability.

Table 3 - Coding System of Mild Steel

Steel Type	Product Type	Forming Grade	Coating Type	Coating Mass Side A / Side B g/m²	Surface
Mild steel	C.... Cold rolled H.... Hot rolled	CR01 CR02 CR04 CR05 CR06 HR11 HR12 HR13	Uncoated EG ... Electrogalvanized (pure Zn) EGA … Electrogalvanneal (Zn-Fe) ZN…..Electrogalvanized (Zn-Ni) GA ... Hot-dip galvannealed (Zn-Fe) GI…..Hot-dip galvanized (pure Zn) AS….Hot-dip Aluminum-Silicon ZM…Hot-dip Zinc-Magnesium	nn/nn	U ... Unexposed E ... Exposed

CR01, HR11 - moderate forming requirements.
CR02, HR12 Drawing Quality
CR04, HR13 Deep Drawing Quality
CR05 severe forming requirements.
CR06 particularly severe forming requirements.

Examples :

MS.50002 CR05 EG60/60 E
Designates cold rolled mild steel grade CR05, electro galvanized with minimum coating mass of 60 g/m² on each side, and exposed quality.

MS.50002 HR12 Uncoated U.

Designates hot rolled uncoated mild steel grade HR12, and unexposed surface quality.

Table 4 - Coding System of HSS, AHSS and UHSS

Steel Type	Product Type	YS and UTS MPa	Coating Type	Coating Mass Side A / Side B g/m²	Surface
IF ..... IF-HSS BH.... Bake Hardenable LA .... High Strength Low Alloy MC….Fine Grain Low Alloy DP.... Dual Phase DP-HF.. Dual Phase High Formability TR.... TRIP TB….TRIP DUAL FB…..Ferritic-Bainitic MP…..Multiphase FN…..Ferritic Steel with Nano-precipitates Strengthening MT….Martensitic TW…TWIP QP…Quenching & Partitioning ST…..Structural	C ..... Cold Rolled H.... Hot Rolled X .... CR or HR	nnnYnnnT	Uncoated EG ... Electrogalvanized (pure Zn) EGA. Electrogalvanneal (Zn-Fe) ZN…..Electrogalvanized Zn-Ni ZV.... Zinc Vapor Deposition GA ... Hot-dip galvannealed (Zn-Fe) GI…..Hot-dip galvanized (pure Zn) AS….Hot-dip Aluminium-Silicon ZM….Hot-dip Zinc-Magnesium	nn/nn	U….Unexposed E....Exposed B….Bumper Quality

6.4.2 IF-HSS, BH, HSLA, DP, TRIP, FB, MP, MT AND TWIP STEELS

Examples :

MS.50002 BHC210Y310T EG60/60 E.

Designates bake hardening cold rolled steel with 210 MPa minimum yield strength and 310 MPa minimum tensile strength, Electro Galvanized steel with minimum coating mass of 60 g/m² on each side, and Exposed quality.

MS.50002 DPC330Y590T GI60/60 U.

Designates dual phase cold rolled steel with 330 MPa minimum yield strength and 590 MPa minimum tensile strength, hot dip galvanized steel with minimum coating mass of 60 g/m² on each side, and unexposed quality.

6.4.3 Bumper Quality Steel

MS.50002-LAH340Y410T-Uncoated B

Designates hot rolled high strength low alloy uncoated sheet steel with minimum yield strength of 340 MPa, with bumper quality surface and appearance requirements.

MS.50002-LAH340Y410T- GI60/60 B

Designates hot dip galvanized hot rolled high strength low alloy sheet steel with minimum yield strength of 340 MPa, with bumper quality surface and appearance requirements.

MS.50002-IFC180Y330T-EG60/60 B

Designates cold rolled IF-High Strength 180 Mpa minimum yield strength steel, electro galvanized with minimum coating mass of 60 g/m² on each side, with bumper quality surface and appearance requirements.

7 CHEMICAL COMPOSITION

Chemical composition is based on mass % of product (ladle, coil or sheet/blank) analysis.

Table 5 - Chemical Composition for CR Mild Steels

Grade	Carbon NOTE(1)	Manganese	Phosphorus	Sulfur	Aluminum NOTE(3)
CR01	0.13 max	0.60 max	0.030 max	0.035 max	N/A
CR02	0.13 max	0.50 max	0.030 max	0.020 max	N/A
CR04(2)	0.08 max	0.50 max	0.025 max	0.020 max	0.015 min
CR05(2)	0.025 max	0.30 max	0.020 max	0.020 max	0.015 min
CR06(2)	0.020 max	0.25 max	0.020 max	0.020 max	0.015 min

NOTE 1 : Letter B must be added when a minimum carbon content of 0.015% or 0.0003% (3 ppm) boron is required (i.e. CR04B).
NOTE 2 : Aluminium killed fine grain steel. Total Al content ≥ 0.015%. Titanium, Niobium and other alloying elements can be used in combination for fully stabilized products. No change in mechanical properties for at least six months.
NOTE 3 : Total aluminium (free and combined).

Table 6 - Chemical Composition for HR Mild Steels

Grade	Carbon NOTE(1)	Manganese	Phosphorus	Sulfur	Aluminum NOTE(2)
	% Max	% Max	% Max	% Max	% Min
HR11, HR12	0.13	0.60	0.030	0.035	N/A
HR13	0.10	0.50	0.025	0.020	0.015

NOTE 1 : A minimum of .0003% (3 ppm) Boron must be present in steels with C less than 0.02%.
NOTE 2 : Total aluminium (free and combined). Titanium, Niobium and other alloying elements can be used in combination for fully stabilized products.

Table 7 - Chemical Composition For Cold Rolled Interstitial Free High Strength Steel (IF-HSS)

Grade	C	Si	Mn	P	S	Al	Ti	Nb
	% Max	% Max	% Max	% Max	% Max	% Min	% Max	% Max
IFC180Y330T	0.01	0.30	0.70	0.08	0.025	0.010	0.12	0.09
IFC210Y340T	0.01	0.30	0.90	0.08	0.025	0.010	0.12	0.09
IFC240Y360T	0.01	0.30	1.60	0.10	0.025	0.010	0.12	0.09
IFC280Y380T	0.01	0.30	1.60	0.10	0.025	0.010	0.15	0.09

Table 8 - Chemical Composition for CR Bake Hardenable Steel (BH-HSS)						
Grade	C	Si	Mn	P	S	Al
	% Max	% Max	% Max	% Max	% Max	% Min
BHC180Y290T	0.06	0.50	0.70	0.060	0.025	0.015
BHC210Y310T	0.08	0.50	0.70	0.085	0.025	0.015
BHC240Y340T	0.10	0.50	1.00	0.100	0.030	0.010
BHC280Y380T	0.11	0.50	0.8	0.120	0.025	0.010

Table 9 - Chemical Composition for CR or HR High Strength Low Alloy (HSLA) Sheet Steel									
HSLA GRADE	C	Si	Mn	P	S	Al	Ti	Nb	Nb+Ti+V
	% Max	% Max	% Max	% Max	% Max	% Min	% Max	% Max	% Range
LAX210Y310T	0.10	0.50	0.70	0.030	0.025	0.015	0.15	0.09	0.0 – 0.22
LAX240Y320T	0.10	0.50	0.70	0.030	0.025	0.015	0.15	0.09	0.0 – 0.22
LAX270Y340T	0.12	0.50	1.00	0.030	0.025	0.015	0.15	0.09	0.0 – 0.22
LAX300Y360T	0.12	0.50	1.30	0.030	0.025	0.015	0.15	0.09	0.01 - 0.22
LAX340Y410T	0.12	0.50	1.50	0.030	0.025	0.015	0.15	0.09	0.01 - 0.22
LAX380Y450T	0.12	0.60	1.50	0.030	0.025	0.015	0.15	0.09	0.01 - 0.22
LAX420Y480T	0.12	0.60	1.60	0.030	0.025	0.015	0.15	0.09	0.01 - 0.22
LAX500Y560T	0.12	0.60	1.70	0.030	0.025	0.015	0.15	0.09	0.01 - 0.22
LAX550Y620T	0.15	0.60	1.80	0.030	0.025	0.015	0.15	0.09	0.01 - 0.22

Table 10 - Chemical Composition for Hot Rolled Small Grain Size (MC) Low Alloyed Steels								
MC Grade	C	Si	Mn	P	S	Al	Ti	Nb
	% Max	% Max	% Max	% Max	% Max	% Min	% Max	% Max
MCH550Y600T	0.12	0.50	1.80	0.030	0.025	0.015	0.15	0.10
MCH600Y650T	0.12	0.50	1.90	0.030	0.025	0.015	0.22	0.10
MCH650Y700T	0.12	0.50	2.00	0.030	0.025	0.015	0.22	0.10
MCH700Y750T	0.12	0.50	2.10	0.030	0.025	0.015	0.22	0.10

Table 11 - Chemical Composition for Advanced High Strength CR And HR Steel NOTES(1,2,3)***

Grade Type	C	Si	Mn	P	S	Al	Cu	Ti+Nb	Cr+Mo	B
	Max %	Max %	Max %	Max %	Max %	Range %	Max %	Max %	Max %	Max %
DPC290Y490T	0.14	0.50	1.8	0.080	0.015	0.01 - 1.0	0.20	0.15	1.00	0.005
DPC330Y590T	0.15	0.75	2.5	0.080	0.015	0.01 - 1.5	0.20	0.15	1.40	0.005
DPC420Y780T	0.18	1.0	2.5	0.080	0.015	0.01 - 2.0	0.20	0.15	1.40	0.005
DPC550Y980T	0.20	1.0	2.9	0.080	0.015	0.01 - 2.0	0.20	0.15	1.40	0.005
DPC700Y980T	0.23	1.0	2.9	0.080	0.015	0.01 - 2.0	0.20	0.15	1.40	0.005
DPC820Y1180T	0.23	1.0	2.9	0.080	0.015	0.01 - 2.0	--	0.15	1.40	0.005
DPH330Y580T	0.14	1.0	2.2	0.085	0.015	0.015 - 1.0	0.40	0.15	1.40	0.005
TRC400Y690T(4)	0.24	2.0	2.2	0.080	0.015	0.015 - 2.0	0.20	0.20	0.60	0.005
TRC440Y780T(4)	0.26	2.2	2.5	0.080	0.015	0.015 - 2.0	0.20	0.20	0.60	0.005
FBH440Y580T	0.18	0.8	2.0	0.050	0.010	0.015 - 2.0	0.20	0.15	1.00	0.010
FBC440Y580T	0.18	0.8	2.0	0.050	0.010	0.015 - 2.0	0.20	0.15	1.00	0.010
MPH620Y780T	0.18	1.0	2.2	0.080	0.015	0.015 - 1.2	0.20	0.15	1.00	0.005
MPH660Y760T	0.18	1.3	2.2	0.080	0.015	0.015 - 1.2	0.20	0.2	1.00	0.005
MPH780Y980T	0.23	1.3	2.7	0.080	0.015	0.015 - 1.4	0.20	0.2	1.00	0.005
FNH680Y780T	0.13	0.5	2.1	0.02	0.010	0.005 – 1.2	0.20	0.15	1.00	0.008
FNH850Y960T	0.13	0.5	2.1	0.02	0.01	0.005 – 1.2	0.20	0.15	1.00	0.008
MPC570Y780T	0.18	1.0	2.5	0,080	0.015	0.015 - 2.0	0.20	0.15	1.20	0.005
MPC780Y980T	0.23	1.0	2.7	0,080	0.015	0.015 - 1.4	0.20	0.15	1.20	0.005
MPC900Y1180T	0.25	1.2	2.9	0,080	0.015	0.015 - 1.4	0.20	0.15	1.20	0.005
MTC700Y900T	0.30	2.2	3.0	0.020	0.025	min 0.010	0.20	0.15	1.00	N/A
MTH900Y1200T										
MTC950Y1200T										
MTC1030Y1300T(5)										
MTC1200Y1500T(5)										

NOTE 1: In addition to requirements shown in the table, %Ni+%Cr+%Mo ≤ 1.5

NOTE 2: All DP grades with C% <0.015 must have a minimum of 0.0003% (3 ppm) Boron.

NOTE 3: MT grades that have critical spot welding requirements may be restricted to S ≤ 0.010

NOTE 4: (Si + Al) max. 2.0

NOTE 5: Diffusible hydrogen shall be < 0.3 ppm by weight.

Table 12 - Chemical Composition for Advanced High Strength Steels With High RA (Retained Austenite) Content NOTES(1,2,3)***

Grade Type	C	Si	Mn	P	S	Al	Cu	Ti+Nb	Cr+Mo	B
	Max %	Max %	Max %	Max %	Max %	Range %	Max %	Max %	Max %	Max %
TBC340Y590T(3)	0.15	1.0	2.5	0.040	0.015	0.01 – 1.5	0.20	0.15	1.40	0.005
TBC420Y780T(3)	0.18	1.0	2.5	0.080	0.015	0.01 - 2.0	0.20	0.15	1.40	0.005
TBC700Y980T(3,4)	0.25	1.8	2.9	0.040	0.010	0.01 – 2.0	0.20	0.15	1.40	0.005
TBC600Y980T(4)	0.25	2.0	2.5	0.040	0.010	0.01 – 2.0	0.2	0.10	1.40	0.005
TBC850Y1180T(4)	0.25	2.2	2.9	0.040	0.010	0.01 – 2.0	0.20	0.15	1.40	0.005
QPC650Y980T(4)	0.25	2.0	2.5	0.015	0.010	0.01 – 2.0	0.20	0.15	1.40	0.005

NOTE 1: Engineering shall not specify an arc welding (PS-50001/01) or laser welding process (PS.50005/02) for zinc coated products (GA/GI/EG) using these retained austenite bearing steels without prior approval from Materials Engineering.
NOTE 2: In addition to requirements shown in the table, %Ni+%Cr+%Mo $\leq$ 1.5
NOTE 3: Ceq. max. 0.86, where Ceq. = C+(Mn+Si)/6
NOTE 4: Si + Al max. 2.0

Table 13 - Chemical Composition for TWIP Steels (TW)

Grade	C	Si	Mn		S	Al
	% range	% Max	% Min	% Max	% Max	% Max
TWC450Y950T	0.50 – 0.80	0.80	12.0	20.0	0.025	2.50

Table 14 - Chemical Composition for Structural Steels (ST)

Grade	C	P	S	Mn	Si	
	% max	% max	% max	% max	% max	
STH235Y360T (1)	0.19	0.55	0.55	--	--	
STH235Y360T-FG (2)		0.50	0.50			
STH270Y430T (1)	0.19	0.55	0.55	--	--	
STH270Y430T-FG (2)		0.50	0.50			
STH350Y510T (1)	0.22	0.55	0.55	1.60	0.60	
STH350Y510T-FG (2)		0.40	0.40			

NOTE 1: Only Killed (NO welded applications);
NOTE 2: Killed fine grain (for welded applications)

8 PERFORMANCE REQUIREMENTS OF THE MATERIAL

Products covered under this standard are to be procured only from mill sources that are qualified by FCA US. See document SD.00013.

8.1 Mechanical Properties

The steel products shall meet the mechanical properties on delivery as specified in Table 15 through Table 31. Tests shall be performed per LP.7M001 using a Type 1 sample (50 mm gage length, ASTM type) or a Type 2 sample (80 mm gage length, DIN type), as required by the purchaser. For hot rolled material (typical material with more than 1.8 mm of thickness), with a thickness > 3 mm, the tests shall be performed using the proportional specimen with L0 = √5,65 S0 (S0: specimen cross-sectional area) to determine the elongation A for EMEA region.

The testing direction shall be longitudinal unless otherwise specified elsewhere in this document. The yield strength shall be measured at 0.2 % offset. If yield point elongation is present, the lower yield strength shall be used. Plastic strain ratio r shall be determined at 20 % strain per ISO 10113. Strain hardening exponent n for all but the DP grades shall be determined at 10 to 20 % strain per ISO 10275.

For DP grades, n shall be determined at 4 to 6 % strain, as well as at 10% to UE (uniform elongation).

Elongation is shown for both the ASTM 50 mm and DIN 80 mm gauge lengths. Compliance with the standard is based on the 50 mm values.

For coated sheet steel products – coating shall not be removed from the tensile specimen before testing and no compensation shall be made to the strength of the steel based on coating thickness.

Bake hardenable steels, dual phase steels and TRIP steels shall have yield strength increases due to work hardening from strain imparted during forming and an additional strengthening increment that occurs during the paint-baking process.

For purpose of analysis of the strength of the stamped component, in many cases it is not possible to conduct standard tensile test due to lack of flat surface area for specimen preparation. In such cases either the surface hardness or bulk hardness can be used for estimation of the material strength. Refer to MS.50027 for relationship between the hardness and tensile properties.

Table 15 - Mechanical Properties in Transverse Direction for CR Mild Steel

Low Carbon CR Grade	YS Range (MPa)	TS Range (MPa)	A_{50} % min(1)	A_{80} % min	$n_{10\%-20\%}$ min(2)	$r_{-90°}$ min NOTE(3)
CR01	140 - 300	270 - 410	30	28	-	-
CR02	140 - 240	270 - 370	34	34	0.16	1.3
CR04	140 - 210	270 - 350	38	38	0.18	1.6
CR05	140 -180	270 - 330	40	39	0.2	1.9
CR06	110 - 170	270 - 330	42	41	0.22	2.1

NOTE 1 : ZnNi and galvanneal coated steels: total elongation shall be reduced by 2%.
NOTE 2 : The n value can be 0.01 lower for ZnNi and galvanneal coated products.
NOTE 3 : The r-90° value can be 0.2 lower for thickness > 1.4 mm and/or galvanneal coated products.

Table 16 - Mechanical Properties in Transverse Direction for HR Mild Steel

Low Carbon HR Grade	YS Range (MPa)	TS Range (MPa)	A % min.	A_{50} % min	A_{80} % min	$n_{10\%-20\%}$ min
HR11	210 – 320	310 - 430	32	30	28	0.14
HR12	180 – 290	270 - 400	34	32	30	0.16
HR13	180 - 260	270 - 380	37	35	33	0.18

Table 17 - Mechanical Properties in Longitudinal Direction of if High Strength CR Steel

IF-High Strength CR Grade	YS Range (MPa)	TS Range (MPa)	A_{50} % min	A_{80} % min	$n_{10\%-20\%}$ min	r_0 min	r_{bar} min
IFC180Y330T	180 - 240	330 - 400	38	35	0.19	1.2	1.4
IFC210Y340T	210 - 270	340 - 430	36	33	0.18	1.1	1.3
IFC240Y360T	240 - 320	360 - 460	34	31	0.17	1.0	1.2
IFC280Y380T	280 - 340	380 - 470	32	29	0.16	0.9	1.1

Table 18 - Mechanical Properties in Longitudinal Direction of BH(1) High Strength CR Steel

BAKE HARDENING CR Grade	YS Range (MPa)	TS Range (MPa)	A_{50} % min	A_{80} % min	$n_{10\%-20\%}$ min	r_0 min	YS NOTE(2) min
BHC180Y290T	180 - 240	290 - 360	35	34	0,17	1.1	240
BHC210Y310T	210 - 290	310 - 400	33	32	0,16	1	260
BHC240Y340T	240 - 300	340 - 440	31	29	0.15	1	300
BHC280Y380T	280 - 360	380 - 470	28	26	0.12	N/A	340

NOTE 1 : Steel must be available at the stamping plant within 3 months of steel production, and materials must be stamped within 6 months from steel production date.
NOTE 2 : Post 2% Strain and Bake Treatment.

Table 19 - Mechanical Properties in Longitudinal Direction of HSLA (High Strength Low Alloy) Cold Rolled Steel

HSLA CR Grade	YS Range (MPa)	TS (MPa), min	A_{50} % min	A_{80} % min	$n_{10\%-20\%/UE}$ min
LAC210Y310T	210 - 300	310	31	29	0.15
LAC240Y320T	240 – 320	320	29	27	0.15
LAC270Y340T	270 – 350	340	27	25	0.14
LAC300Y360T	300 – 380	360	25	23	0.14
LAC340Y410T	340 – 430	410	23	21	0.12
LAC380Y450T	380 – 470	450	21	19	0.12
LAC420Y480T	420 – 520	480	18	17	0.11
LAC500Y560T	500 – 600	560	14	13	0.09
LAC550Y620T	550 – 690	620	12	11	N/A

Table 20 - Mechanical Properties in Longitudinal Direction of High Strength Low Alloy (HSLA) Hot Rolled Steel

HSLA HR Grade	YS Range (MPa)	TS (MPa) Min	A % Min	A_{50} % Min (NOTE 1)	A_{80} % Min	$n_{10\%-20\%/UE}$ min
LAH210Y310T	210 - 300	310	37	35	33	0.15
LAH240Y320T	240 - 320	320	32	30	28	0.15
LAH270Y340T	270 - 350	340	29	27	25	0.15
LAH300Y370T	300 - 380	370	28	26	24	0.14
LAH340Y410T	340 - 420	410	25	24 (23)	22	0.13
LAH380Y450T	380 - 460	450	23	22 (21)	21	0.12
LAH420Y480T	420 - 520	480	22	22 (20)	20	0.11
LAH500Y560T	500 - 600	560	20	20 (18)	18	0.09
LAH550Y620T	550 - 690	620	18	18 (16)	17	N/A

NOTE 1 : Information between parentheses is for coated products.

Table 21 - Mechanical Properties in Longitudinal Direction of Fine Grain Low Alloy Steels (MC)

MC Steel Grade	YS Range (MPa)	TS Range (MPa)	Elongation		
			A % Min	A_{50}% min	A_{80}% min
MCH550Y600T	550 - 670	600 - 760	14	13	12
MCH600Y650T	600 - 720	650 - 820	13	12	11
MCH650Y700T	650 - 760	700 - 880	12	11	10
MCH700Y750T	700 - 820	750 - 950	12	11	10

Table 22 - Mechanical Properties in Longitudinal Direction of Dual Phase (DP) CR Steel

Dual Phase CR Grade	YS Range (MPa)	TS (MPa) min	A_{50} % min	A_{80} % min	$n_{4\text{-}6\%}$ min	$n_{10\%\text{-}UE}$ min	BH2 min
DPC290Y490T	290 - 380	490	26	24	0.19	0.15	30
DPC330Y590T	330 - 430	590	21	20	0.18	0.14	30
DPC420Y780T	420 - 550	780	15	14	0.15 0.12(1)	0.11	30
DPC550Y980T	550 - 730	980	9	8	0.08	N/A	30
DPC700Y980T	700 - 850	980	8	7	N/A	N/A	30
DPC820Y1180T	820 - 1130	1180	5	4	N/A	N/A	30

NOTE 1: Valid only for NA production.

Table 23 - Mechanical Properties in Longitudinal Direction of Dual Phase (DP) HR Rolled Steel

Dual Phase	YS Range (MPa)	TS Range (MPa) min.	A % min	A_{50} % min	A_{80} % min	$n_{4\text{-}6\%}$ min	$n_{10\%\text{-}UE}$ min	BH 2 min
DPH330Y580T	330 - 450	580	23	21	19	0.16	0.13	30

Table 24 - Mechanical Properties in Longitudinal Direction of Transformation Induced Plasticity TRIP Cold Rolled Steel

TRIP CR Grade	YS Range (MPa)	TS (MPa) Min	A_{50} % min	A_{80} % min	$n_{4\text{-}6\%}$ min	$n_{10\%\text{-}20\%/UE}$ min	BH2 min
TRC400Y690T	400 – 520	690	25	24	-	0.19	30
TRC440Y780T	440 – 570	780	22(1)	21(1)	-	0.16(2)	30

NOTE 1 : For Galvannealed material the values are reduced by 5 units
NOTE 2 : For Galvannealed material the value is min. 0.12.

Table 25 - Mechanical Properties in Longitudinal Direction for Advanced High Strength Steels With High RA (Retained Austenite) Content NOTE(1)

TRIP CR Grade	YS Range (MPa)	TS (MPa) Min	A_{50} % min	A_{80} % min	$n_{4\text{-}6\%}$ min	$n_{10\%\text{-}20\%/UE}$ min	BH2 min
TBC330Y590T	330 - 430	590	27	26	0.20	0.16	30
TBC420Y780T	420 – 560	780	19	18	0.17	0.14	30
TBC700Y980T	700 – 900	980	15	14	-	-	40

Table 25 - Mechanical Properties in Longitudinal Direction for Advanced High Strength Steels With High RA (Retained Austenite) Content NOTE(1)

TRIP CR Grade	YS Range (MPa)	TS (MPa) Min	A_{50} % min	A_{80} % min	$n_{4\text{-}6\%}$ min	$n_{10\%\text{-}20\%/UE}$ min	BH2 min
TBC330Y590T	330 - 430	590	27	26	0.20	0.16	30
TBC420Y780T	420 – 560	780	19	18	0.17	0.14	30

NOTE 1: Engineering shall not specify an arc welding (PS-50001/01) laser welding process (PS.50005/02) or resistant spot welding for zinc coated products (GA/GI/EG) using the retained austenite bearing steels without prior approval from Materials Engineering.

Table 26 - Mechanical Properties in Longitudinal Direction of Ferritic-Bainitic (FB)

Ferritic-Bainitic HR Grade	YS Range (MPa)	TS Range (MPa)	A % min	A_{50} % min	A_{80} % min	$n_{4\text{-}6\%}$ min	$n_{10\%\text{-}UE}$ min	H.E.I. min
FBH440Y580T	440 - 600	580 – 700	18	16	15	-	-	65

Table 27 - Mechanical Properties in Longitudinal/Transversal Direction of Multiphase (MP) Hot Rolled Steel

Multiphase HR Grade	Dir.	YS Range (MPa)	TS Range (MPa)	A % min	A_{50} % min	A_{80} % min	$n_{4\text{-}6\%}$ min	BH2	H.E.I. min
MPH660Y760T NOTE 1	L	660 - 820	760 – no max	14	12	10	-	30	45
MPH780Y980T	L	780 – 950	980 – no max	9	7	6	-	30	-

NOTE 1 : For hot dip coated material the elongation (A50 and A80) % values are reduced by 1 unit.

Table 28 - Mechanical Properties in Longitudinal Direction of Ferritic Steel with Nano-precipitates (FN) Hot Rolled Steel***

Ferrite with Nano-precipitates HR Grade	YS Range (MPa)	TS Range (MPa)	A % min	A_{50} % min	A_{80} % min	$n_{4\text{-}6\%}$ min		H.E.I. min
FNH680Y780T	680 - 800	780 – 920	16	15	13	-		70
FNH850Y960T	850 - 1000	960 – 1120	13	12	11	-		40

NOTE 1 : For hot dip coated material the elongation (A50 and A80) % values are reduced by 1 unit.

Table 29 - Mechanical Properties in Longitudinal Direction of Multiphase (MP) CR Steel

Multiphase CR Grade	YS Range (MPa)	TS Range (MPa) min	A_{50} % min	A_{80} % min	$n_{4\text{-}6\%}$ min	$n_{10\%\text{-}UE}$ min	H.E.I. min
MPC570Y780T	570 - 720	780 - 920	11	10	-	-	-
MPC780Y980T	780 - 950	980 - 1140	7	6	-	-	-
MPC900Y1180T	900 - 1150	1180 - 1350	5	4	-	-	-

Table 30 - Mechanical Properties in Longitudinal Direction of Martensitic (MT) CR and HR Steel

Martensitic CR Grade	YS Range (MPa)	TS Range (Mpa)	A_{50} % min	A_{80} % min
MTC700Y900T NOTE 1	700 -1000	900-No Max	4	3
MTC950Y1200T NOTE 2	950 -1200	1200-No Max	4	3
MTH900Y1200T NOTE 2	900 - 1150	1200-No Max	6	5
MTC1030Y1300T NOTE 2	1030 - 1300	1300 - No Max	-	-
MTC1200Y1500T NOTE 2	1200 - 1500	1500 - No Max	-	-

NOTE 1: Not recommended for body structural applications. Added for manufacturing of small clips/clamps/fasteners.
NOTE 2: Diffusible hydrogen must be ≤ 0.3 ppm by weight.

Table 31 - Mechanical Properties in Longitudinal Direction of TWIP (TW) Cold Rolled Steel

TWIP CR Grade	YS range (MPa)	TS min (MPa)	A_{50} % min	A_{80} % min	r min	$n_{4\%-40\%}$ min
TWC450Y950T	450 - 600	950	47	45	0.80	0.35

Table 32 - Mechanical Properties in Longitudinal Direction of Structural Steel (ST) Hot Rolled Steel

ST HR Grade	YS min. (MPa)	TS range (MPa)	A % min	A_{50} % min	A_{80} (%) min
STH235Y360T (1)	235	360 - 460	25	23	21
STH235Y360T-FG (2)					
STH270Y430T (1)	270	430 - 530	22	20	19
STH270Y430T-FG (2)					
STH350Y510T (1)	350	510 - 610	20	18	17
STH350Y510T-FG (2)					

NOTE 1 : Only Killed (NO welded applications)
NOTE 2: Killed fine grain (for welded applications)

8.2 Developmental Steel Grades

The sheet steel AHSS grades covered in Table 33 and 34 below are material engineering approved but still under development for manufacturability. These sheet steel grades can be considered for future vehicle lightweight applications. MATERIALS ENGINEERING MUST BE NOTIFIED OF ANY INTENDED USE. All forming and joining techniques being considered must be verified. Actual weld stack ups and operations must be evaluated for approval.

Forming simulations must be verified through actual stamping trials for verification.

Table 33 - Chemical Composition for Advanced High Strength Steels Under Engineering Development NOTES(1,2,3).

Grade Type	C	Si	Mn	P	S	Al	Cu	Ti+Nb	Cr+Mo	B
	Max %	Max %	Max %	Max %	Max %	Range %	Max %	Max %	Max %	Max %
TBC700Y980T(4,5)	0.26	1.8	2.9	0.040	0.010	0.01 – 2.0	0.20	0.15	1.40	0.005
TBC600Y980T(5)	0.26	2.0	2.5	0.040	0.010	0.01 – 2.0	0.2	0.10	1.40	0.005
TBC850Y1180T(5)	0.26	2.2	2.9	0.040	0.010	0.01 – 2.0	0.20	0.15	1.40	0.005
QPC650Y980T(5)	0.26	2.0	2.5	0.015	0.010	0.01 – 2.0	0.20	0.15	1.40	0.005

NOTE 1: In addition to requirements shown in the table, %Ni+%Cr+%Mo ≤ 1.5
NOTE 2: All DP grades with C% <0.015 must have a minimum of 0.0003% (3 ppm) Boron
NOTE 3: MT grades that have critical spot welding requirements may be restricted to S ≤ 0.010
NOTE 4: Si + Al max. 2.0
NOTE 5: Diffusible hydrogen must be ≤ 0.3 ppm by weight.

Table 34 - Mechanical Properties in Longitudinal Direction for Advanced High Strength Steels Under Engineering Development NOTE(1).

TRIP CR Grade	YS Range (MPa)	TS (MPa) min	A_{50} % min	A_{80} % min	$n_{4\text{-}6\%}$ min	$n_{10\%\text{-}20\%/UE}$ min	BH2 min
TBC600Y980T	600 - 750	980	19	18	-	-	30
TBC700Y980T	700 – 900	980	15	14	-	-	40
TBC850Y1180T	850-1050	1180	13	12	-	-	30
QPC650Y980T	650 – 850	980	15	14	0.10	-	-

NOTE 1: Engineering shall not specify an arc welding (PS-50001/01) laser welding process (PS.50005/02) or resistant spot welding for zinc coated products (GA/GI/EG) using the retained austenite bearing steels without prior approval from Materials Engineering.

8.3 Discontinued Steel Grades

Sheet steel grades in Tables 35 and 36 have been discontinued and shall not be specified for any new part or new vehicle design.

Table 35 - Discontinued Sheet Steel Grades(1)

Chemical Composition for Steel

Grade Type	C	Si	Mn	P	S	Al	Cu	Ti+Nb +V	Cr+Mo	B
	Max %	Max %	Max %	Max %	Max %	%	Max %	Max %	Max %	Max %
LAC830Y860T(2)	0.15	0.60	2.10	0.030	0.025	0.015 min		0.15		
DPC340Y590T(3)	0.15	0.75	2.5	0.080	0.015	0.01 - 1.5	0.20	0.15	1.40	0.005
TRC360Y590T(3)	0.20	0.6	2.0	0.080	0.015	0.015 - 1.6	0.20	0.15	0.60	0.005
MPH620Y780T/ MPH680Y780T(3)	0.18	1.0	2.2	0.080	0.015	0.015 - 1.2	0.20	0.15	1.00	0.005

NOTE 1: Only for current and carry over parts, not to be used for new design.
NOTE 2: In addition to requirements shown in the table, %Nb+%Ti+%V will be in range of 0.01-0.22
NOTE 3: In addition to requirements shown in the table, %Ni+%Cr+%Mo $\leq$ 1.5

Table 36 - Discontinued Sheet Steel Grades

Mechanical Properties in Longitudinal Direction Except as Noted

TRIP CR Grade	YS Range (MPa)	TS (MPa) min	A_{50} % min	A_{80} % min	$n_{4\text{-}6\%}$ min	$n_{10\%\text{-}UE}$ min	BH2 min
DPC340Y590T	340 - 430	590	21	20	0.18	0.14	30
TRC360Y590T	360 – 450	590	28(1)	26(1)	-	0.16	30
LAC830Y860T	830 - 985	860	4	4	-	-	-
MPH620Y780T (1,2) or MPH680Y800T	L T	620 – 780 680 - 800	12	10	-	30	45

NOTE 1 : For Galvannealed material the values are reduced by 5 units
NOTE 2 : For Galvannealed material the values are reduced by 1 units

8.4 Strength - Welded Mechanical Tubing

This standard can be used to specify raw material for use as mechanical welded tubing. The incoming material shall conform to chemical composition requirements of Section 7, and meet the minimum material property requirements included in Section 8.1. For use of steel grades not covered by this standard, refer to other available material standard (MS.50001, MS.50003 or MS.50014).

Refer to relevant process standard for mechanical welded tubing for information on welding process for manufacturing the tube, and requirements for weld wires and filler materials. Finished tube minimum properties will be stated on the part print and tested according to ASTM A 370. Tube tensile properties shall be determined with a full size tubular section or longitudinal strip cut from the tube or pipe, depending on the limits of the test equipment.

Welded tubing covered by this standard shall have weld flash removed from the outside diameter. Inside diameter weld flash shall not exceed the limits called out in the applicable ASTM Standard, in the engineering drawing, or on the purchase requisition. Tube welds are expected to be functional for the intended use and, where necessary, shall meet the appropriate weld tests as detailed in ASTM A513/A513M or A 512 Supplementary Requirements.

8.5 Material Thickness and Tolerance

The detailed engineering part drawing or electronic math file will specify the material thickness and tolerance. The tolerance requirements for various thicknesses and strength levels are listed in PS.50009.

8.6 Technical Supply Requirements.

Refer to 9.50240 Sheet Steel and Strip Technical Supply Requirements.

9 QUALITY

Refer to Section 8 and 10.

10 SPECIAL REQUIREMENTS

10.1 Welding

The steel substrates supplied to this standard shall be suitable for welding by the accepted local welding methods. When the steel is used in welded applications, welding procedures shall be suitable for the steel chemistry and intended service.

When welding is performed on a particular part made from sheet steels covered in this standard, it is the responsibility of the steel supplier, the part manufacturer, and the welder of the parts (assembly) to control both the chemical composition of the steel used and the welding process to ensure continuing compatibility with the appropriate welding process employed. Basic material chemistry, steel thickness, and welding processes and parameters used are major factors affecting weldability. Engineering standards cannot cover all possible variables and circumstances for every application. Additional restrictions and controls in manufacturing may be necessary by any or all parties concerned to produce satisfactory parts and welds.

10.2 Surface Texture and Finish

The steel surface will fall under one of the three categories, Exposed (E), Unexposed (U), or Bumper quality (B).

10.2.1 Unexposed (U)

Material surface shall be free of any major mill defects such as lamination, pinchers, scale, scabs, seams, laps, holes, slivers, gouges, scratches or any other similar defect that may damage the substrate. Included with major mill defect will be a coating defect that can reduce the corrosion performance of the material. These defects could be bare spots, unalloyed edges or any mill condition that compromises coating adhesion. Steel should be free from burrs and foreign material introduced during subsequent

processing steps prior to stamping. Special surface conditions can be pre negotiated and noted on the metal spec and PO.

10.2.2 Exposed (E)***

Material surface shall be free of defects that might affect the uniform appearance of quality paint or an electrolytic coating (elpo electro-deposited primer, cathodic e-coat). Steel should be free from burrs, foreign material introduced during subsequent processing steps prior to stamping. The steel sheet shall meet the surface texture requirements for critical exposed applications as shown in Figure 2 (North America Assembly Plants), Figure 3 (European Assembly Plants) and Figure 4 (LATAM Assembly Plants).

10.2.3 Bumper Quality (B)

Stamped steel surfaces that are decorative plated or painted must be capable of meeting part appearance requirements as defined by a master sample. Decorative plated bumpers shall meet the specified standard as agreed between purchaser and supplier. Post-forming metal finishing may be used on selected surfaces to meet appearance requirements for decorative bumpers.

Surface shall be free of pits, laminations, inclusions, pickups, or other defects which may affect appearance, durability, or function, once plated or painted and as agreed between supplier and purchaser.

Bumper quality steel supplied to this standard shall utilize temper rolled steel to sufficiently eliminate stretcher strain (Lüders Lines) in the formed bumper product. Use of bumper quality steel does not necessarily preclude the need for post-forming and pre-plating/painting metal finish in local areas to meet appearance requirements.

Surface Finish for Sheet Steel for Plated Bumpers

Decorative plated bumpers shall follow requirements of FCA standard PS.50019.

Mill Finish Blanks - All temper rolled steel supplied under this specification shall have the following surface finish: Ra 0.9 microns (35 micro in) maximum, and Rm 80 microns (300 micro in) maximum.

Flat Polished Blanks - Steel blanks shall be finished using a combination dry and wet abrasive belt sequence to Ra 0.3 microns (12 micro in) maximum and Rm 3 microns (118 micro in) maximum, prior to forming. To allow for metal removal in flat polishing, the upper tolerance limit of thickness per PS.50009 is increased by 0.07 mm.

Surface Finish for Sheet Steel for Painted Bumpers

Painted bumpers shall be processed to meet FCA specification for Cathodic Epoxy Electro-coat MS.90124 followed by powder coat per MS-PE-16-2. Cold rolled or hot rolled steel shall be capable of being painted to meet finished part quality requirements.

The surface finish of sheet steel to be used for painted bumpers should have Ra 1.4 microns (55 micro-inch) maximum, and Rm 80 microns (300 micro-inch) maximum. For zinc coated steel refer to Section 6.2 for requirements on, but not limited to, coating composition, coating mass, and coating adhesion.

See Section 6.4 for nomenclature and material call out for use on drawings and engineering documents.

10.3 Cleanability, Phosphateability, and Paint Compatibility.

Unless specified otherwise, the finished uncoated as well as coated sheet or strip shall be coated on all sides with an FCA approved mill oil. Please refer to applicable document for regional requirements. For NAFTA region use MS-9680 " Body-In-White Fluids – Sheet Metal Lubricants And Rust Preventatives".

10.3.1 FCA-US plants and suppliers

For painted applications the coated surface shall be capable of achieving a high quality zinc phosphate conversion coating according to PS-508. The steel must be compatible with phosphate and paint systems and must meet MS.90103.

10.3.2 FCA-ITALY plants and suppliers

Phosphatability and other painting processes must be guaranteed by:

- Tables NPR 5.00604 (for cars), and NPR 5.00606 (for commercial vehicles), if application is for make parts.

- Standard 9.55842 (in according to drawing classes), if application is for buy components.

10.4 Adhesive Compatibility

For bonded applications, the surfaces of the coated and uncoated flat products furnished to this specification shall be capable of being adhered with the respective adhesives specified for the particular application.

10.5 Corrosion Resistance

Only for EMEA, APAC and LATAM Region, the pure zinc coating must follow PS.50027(GI) and PS.50028 (EG) Standards.

11 APPROVED SOURCE LIST

Materials covered by this standard shall only be purchased from those source(s) that are approved by Materials Engineering, document. These documents may be restricted and not shared with suppliers.

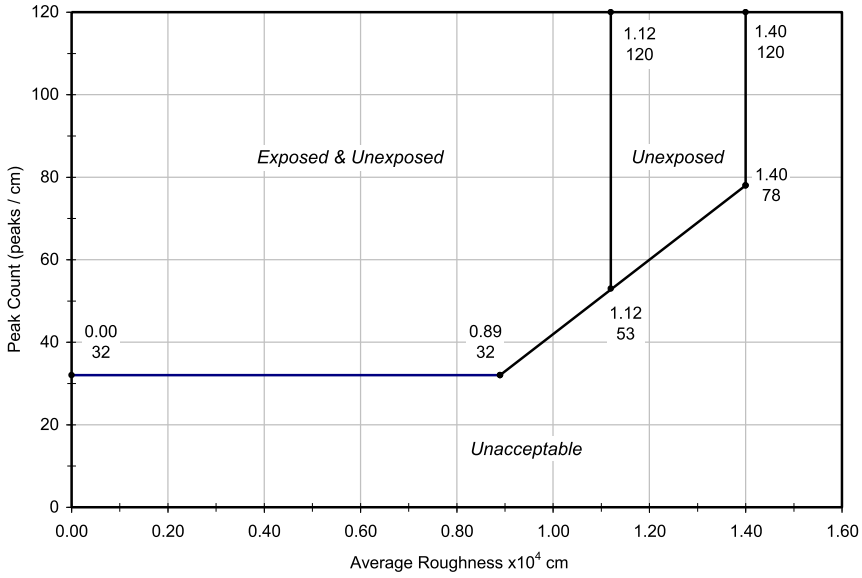

Figure 2 - Surface Roughness Requirements (North America Assembly Plants)

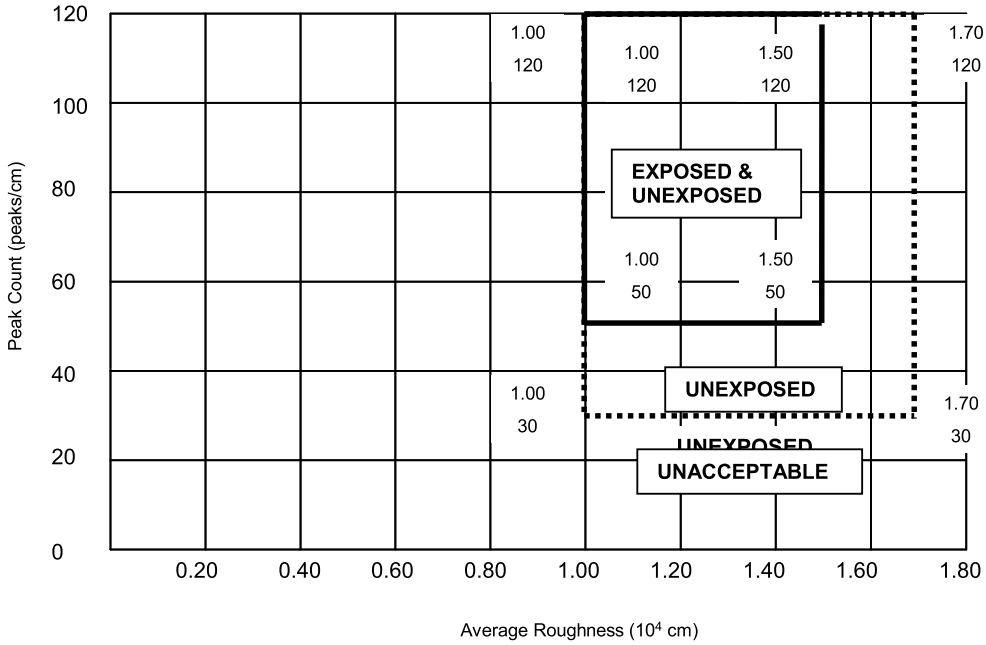

Figure 3 - Surface Roughness Requirements (European Assembly Plants)

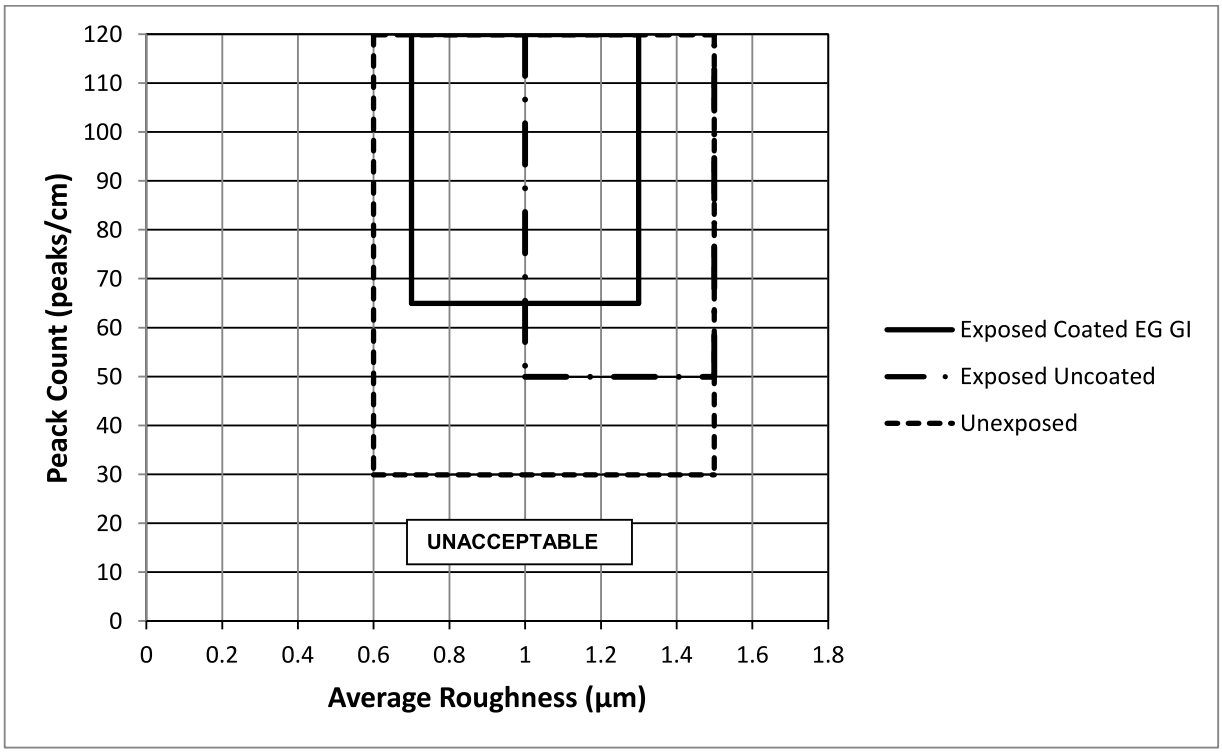

Figure 4 - Surface Roughness Requirements (LATAM Assembly Plants)

Annex A
(Informative)
Correspondence between Old and New Sheet Steel Grades

Table A-1 - Correlation between new nomenclature and old FCA Italy and FCA US nomenclature***		
New FCA Italy-FCA US grade	**Old FCA Italy grade FG52806**	**Old FCA US grade MS-67<S>**
CR01	FEP01	CR01
CR02	FEP02	CR02
CR04	FEP04	CR04
CR05	FEP05	CR05
CR06	FEP06	CR06
New FCA Italy-FCA US grade	**Old FCA Italy grade FG52806**	**Old FCA US grade MS-66<S>**
HR11	FEP11	HR11
HR12	FEP12	HR12
HR13	FEP13	HR13
New FCA Italy-FCA US grade	**Old FCA Italy Grade 52814**	**Old FCA US grade MS-6000<D>**
IFC180Y330T	FEE180 IF	W-025
IFC210Y340T	FEE210 IF	
IFC240Y360T	FEE240 IF	
IFC280Y380T		

New FCA Italy-FCA US grade	**Old FCA Italy grade 52814**	**Old FCA US grade MS-264<S>**
BHC180Y290T	FEE180 BH	025HK
BHC210Y310T	FEE220 BH	030HK
BHC240Y340T		
BHC280Y380T		

New FCA Italy-FCA US grade	**Old FCA Italy grade 52811**	**Old FCA US grade MS-264<S>**
LAC210Y310T		030SK
LAC240Y320T		035SK

Table A-1 - Correlation between new nomenclature and old FCA Italy and FCA US nomenclature***		
LAC270Y340T	FEE270 F	040SK
LAC300Y360T	FEE300 F	045XK
LAC340Y410T	FEE340 F	050XK
LAC380Y450T	FEE380 F	
LAC420Y480T	FEE420 F	060XK
LAC500Y560T	FEE500 F	070XK
LAC550Y620T		080XK
LAC830Y860T		120XK

New FCA Italy-FCA US grade	Old FCA Italy grade 52812	Old FCA US grade MS-264<S>
LAH210Y310T		030SK
LAH240Y320T		035SK
LAH270Y330T	FEE270	040SK
LAH300Y370T	FEE300	045XK
LAH340Y410T	FEE340	050XK
LAH380Y450T	FEE380	
LAH420Y480T	FEE420	060XK
LAH500Y560T	FEE500	070XK
LAH550Y620T		080XK

New FCA Italy-FCA US grade	Old FCA Italy grade	Old FCA US grade MS-264<S>
MCH550Y600T		
MCH600Y650T		
MCH650Y700T		
MCH700Y750T		100XK

New FCA Italy-FCA US grade	Old FCA Italy grade 52815	Old FCA US MS-264<S>
DPC290Y490T	FE500 DP F	490DT
DPC330Y590T	FE600 DP F	590DT
DPC420Y780T	FE 800 DP F	780DT
DPC550Y980T	FE 1000 DP F	980DT
DPC700Y980T	New	New
DPC820Y1180T	New	New

Table A-1 - Correlation between new nomenclature and old FCA Italy and FCA US nomenclature***

New FCA Italy-FCA US grade	Old FCA Italy grade 52815	Old FCA US grade MS-264<S>
DPH330Y580T	FE 600 DP	590DT

New FCA Italy-FCA US grade	Old FCA Italy grade 52815	Old FCA US grade MS-264<S>
TRC400Y690T	FE 700 TRIP F	690TT
TRC440Y780T	FE 800 TRIP F	780TT
TBC330Y590T	New	New
TBC420Y780T	New	New
TBC700Y980T	New	New
TBC600Y980T	New	New
TBC850Y1180T	New	New

New FCA Italy-FCA US grade	Old FCA Italy grade 52815.	Old FCA US grade MS-264<S>
FBH440Y580T	FE 590 FB	590PT
FBC440Y580T	-	590PT
New FCA Italy-FCA US grade	**Old FCA Italy grade 52815**	**Old FCA US grade MS-264<S>**
MPH620Y780T	FE 800 MP HY	-
MPH660Y760T	New	New
MPH780Y980T	FE 1000 MP	-
New FCA Italy-FCA US grade	**Old FCA Italy grade 52815**	**Old FCA US Grade MS-264<S>**
MPC570Y780T	New	New
MPC780Y980T	New	New
MPC900Y1180T	New	New

Table A-1 - Correlation between new nomenclature and old FCA Italy and FCA US nomenclature***		
New FCA Italy-FCA US grade	**Old FCA Italy grade 52815**	**Old FCA US grade MS-264<S>**
MTC700Y900T	New	New
MTH900Y1200T	New	New
MTC950Y1200T	FE 1200 MS	New
MTC1030Y1300T	FE 1300 MS	1300MT
MTC1200Y1500T	FE 1500 MS	1500MT

New FCA Italy-FCA US grade	**Old FCA Italy grade**	**Old FCA US grade**
TWC450Y950T	New	New

New FCA Italy-FCA US grade	**Old FCA Italy grade 52891**	**Old FCA US grade MS-STEEL**
STH235Y360T	FE360C	New
STH235Y360T-FG	FE360D	New
STH270Y430T	FE430C	New
STH270Y430T-FG	FE430D	New
STH350Y510T)	FE510C	New
STH350Y510T-FG	FE510D	New

New FCA Italy-FCA US grade	**Old FCA Italy grade**	**Old FCA US grade**
QPC650Y980T	New	New

End of Annex A

Annex B
(Informative)
Substrate Data Processing Code Numbers

Table B-1 - Substrate Data Processing Code Numbers	
MS-CR	**CODEP Code**
CR01	20300
CR02	20301
CR04	20302
CR05	20303
CR06	20304
MS-HR	**CODEP Code**
HR11	20305
HR12	20306
HR13	20307
IF-CR	**CODEP Code**
IFC180Y330T	20308
IFC210Y340T	20309
IFC240Y360T	20310
IFC280Y380T	20311
BH-CR	**CODEP Code**
BHC180Y290T	20312
BHC210Y310T	20313
BHC240Y340T	20314
BHC280Y380T	20456

Table B-1 - Substrate Data Processing Code Numbers	
HSLA-CR	**CODEP Code**
LAC210Y310T	20315
LAC240Y320T	20316
LAC270Y340T	20317
LAC300Y360T	20318
LAC340Y410T	20319
LAC380Y450T	20320
LAC420Y480T	20321
LAC500Y560T	20322
LAC550Y620T	20323
LAC830Y860T(1)	20324
HSLA-HR	**CODEP Code**
LAH210Y310T	20325
LAH240Y320T	20326
LAH270Y340T	20327
LAH300Y370T	20328
LAH340Y410T	20329
LAH380Y450T	20330
LAH420Y480T	20331
LAH500Y560T	20332
LAH550Y620T	20333
MC-HR	**CODEP Code**
MCH550Y600T	20334
MCH600Y650T	20335
MCH650Y700T	20336
MCH700Y750T	20337
DP-CR	**CODEP Code**
DPC290Y490T	20338
DPC330Y590T	20339
DPC420Y780T	20340
DPC550Y980T	20341
DPC700Y980T	20353
DPC820Y1180T	20354

Table B-1 - Substrate Data Processing Code Numbers	
DP-HR	**CODEP Code**
DPH330Y580T	20342
TRIP-CR	**CODEP Code**
TRC360Y590T(1)	20343
TRC400Y690T	20344
TRC440Y780T	20345
TBC330Y590T	20457
TBC420Y780T	20352
TBC700Y980T	20399
TBC600Y980T	20458
TBC850Y1180T	20460
FB-CR FB-HR	**CODEP Code**
FBH440Y580T	20346
FBC440Y580T	20347
MP-HR	**CODEP Code**
MPH620Y780T	20348
MPH660Y760T	20459
MPH780Y980T	20349
MP-CR	**CODEP Code**
MPC570Y780T	20355
MPC780Y980T	20356
MPC900Y1180T	20357
MT-CR	**CODEP Code**
MTC1030Y1300T	20350
MTC1200Y1500T	20351
TW-CR	**CODEP Code**
TWC450Y950T	20358

NOTE 1 : These sheet steel grades (Tables 32 and 33) have been discontinued and shall not be specified for any new part or new vehicle design.

Table B-1 - Substrate Data Processing Code Numbers	
ST-HR STH235Y360T	**CODEP Code** 20453
STH235Y360T-FG	20454
STH270Y430T	20455
STH270Y430T-FG	20359
STH350Y510T	20450
STH350Y510T-FG	20451
QP-CR	**CODEP Code**
QPC650Y980T	20452

End of Annex B

Annex C
(Informative)
Coating for Unexposed Parts Data Processing Code Numbers

Table C-1 - Coating for Unexposed Parts Data Processing Code Numbers

CODEP Code Unexposed	Old Fiat indication*	Old Chrysler indication	Drawing indication	Coating type
A28	-	-	Uncoated U	bare
A11	ZNT/5/1S	-	EG 00/45 U	Electrogalvanized
A12	ZNT/5/2S	44P	EG 45/45 U	Electrogalvanized
A13	ZNT/7,5/1S	-	EG 00/60 U	Electrogalvanized
A14	ZNT/7,5/2S	55P	EG 60/60 U	Electrogalvanized
A15	ZNT/10/1S	-	EG 00/75 U	Electrogalvanized
A16	ZNT/10/2S	99P	EG 75/75 U	Electrogalvanized
A17	-	-	ZN 00/32 U	Electrogalvanized Zinc-Nickel
A18	-	-	ZN 32/32 U	Electrogalvanized Zinc-Nickel
A19	ZNT/F/5/2S	44	GI 45/45 U	Hot-Dip Galvanized
A20	ZNT/F/7,5/2S	55	GI 60/60 U	Hot-Dip Galvanized
A21	ZNT/F/10/2S	99	GI 75/75 U	Hot-Dip Galvanized
A22	ZNT/F/12/2S	66	GI 90/90 U	Hot-Dip Galvanized
A23	ZNT/F/14/2S	77	GI 100/100 U	Hot-Dip Galvanized
A24	ZNT/F/20/2S	88	GI 150/150 U	Hot-Dip Galvanized
A25	-	22A	GA 30/30 U	Hot Dip Galvannealed (Zinc-Iron)
A26	-	44A	GA 45/45 U	Hot Dip Galvannealed (Zinc-Iron)
A27	ALMT/20	-	AS 60/60 U	Hot Dip Aluminized (Aluminum-Silicon)
A38	-	-	ZM 35/35 U	Hot Dip Zinc-Magnesium
A39	-	-	ZM 50/50 U	Hot Dip Zinc-Magnesium
A40	-	-	ZM 70/70 U	Hot Dip Zinc-Magnesium
A41	-	-	ZM 100/100 U	Hot Dip Zinc-Magnesium
A42	-	-	ZM 150/150 U	Hot Dip Zinc-Magnesium

End of Annex C

Annex D
(Informative)
Coating for Exposed Parts Data Processing Code Numbers

Table D-1 - Coating for Exposed Parts Data Processing Code Numbers

CODEP Code Exposed	Drawing indication	Coating type
A29	Uncoated E	bare
A30	EG 45/45 E	Electrogalvanized
A31	EG 60/60 E	Electrogalvanized
A36	EG 75/75 E	Electrogalvanized
A32	GI 45/45 E	Hot-Dip Galvanized
A33	GI 60/60 E	Hot-Dip Galvanized
A37	GI 75/75 E	Hot-Dip Galvanized
A34	GA 30/30 E	Hot Dip Galvannealed (Zinc-Iron)
A35	GA 45/45 E	Hot Dip Galvannealed (Zinc-Iron)

End of Annex D