

HIGH CARBON STEEL, COLD ROLLED STRIP (Cross Reference Specification)

1. SCOPE

1.1 This specification provides cross reference information for CNH high carbon, cold rolled (CR) strip steel. It is intended to replace the CNH Former Company Material Specifications listed in Annex A and should be used on all applicable new drawings.

1.2 All National Standards and related test methods are to be latest issue unless otherwise specified.

Table 1 CNH Grade and Material Description	
CNH Grade	Description
All Grades are cold rolled high carbon steel strip supplied in the annealed condition ⁽¹⁾ .	
A	Carbon content range of referenced grades is 0.47 to 0.70% by weight. Typical applications include flat springs and applications where ease of hardening and tempering after forming are desired. This grade is less susceptible to quench cracks because of the lower carbon content.
B	Carbon content range of referenced grades is 0.65 to 0.80% by weight. Typical applications include wear plates and knife sections. The higher carbon content improves wear resistance. This grade may be heat treated if required.
C	Carbon content range of referenced grades is 0.80 to 1.10% by weight. Typical applications include wear plates and other heavy duty, high wear applications.

(1) See Table 3 for typical hardness range data for the CNH Grades in the annealed condition.

2. APPLICATION

2.1 Cold rolled high carbon steel strip is produced to chemical composition requirements and is supplied in the annealed condition for ductility. This strip is generally used where high tensile and fatigue strengths are important. It is used either as-supplied for flat applications or in the hardened and tempered condition after forming.

2.2 Strip is typically available in a minimum thickness of 0.254 mm (0.010 in.) up to 3.175 mm (0.125 in.) in North America. In Europe, strip is typically available in thicknesses up to 4.00 mm (0.157 in.). All grades of materials may be available in limited quantities as strip in North America up to 4.75 mm (0.187 in.) and in limited quantities as coil below 0.2032 mm (0.010 in.). Strip in thicknesses greater than 4.75 mm (0.187 in.) are available for purchase in the hot rolled condition.

2.3 All three CNH grades (see Table 1) are commonly available with the grade selected dependent on the application. In general, the weldability of these grades is poor and not recommended. If welding of these steels is necessary, consult a welding engineer for required special welding procedures and weld quality verification

2.3.1 All grades are typically formed or processed to final shape in the annealed condition prior to heat treatment. After processing, the part will normally be quenched and tempered to attain the desired hardness for the given application. Faster quenching mediums can result in higher hardness; however, quench cracking may result if the quench rate is too severe for the grade of steel selected. Grades A and B are often hardened by the induction hardening process. Grade A has the lowest hardenability and Grade C has the highest hardenability.

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Table 2 Local Material and National Standard References			
CNH Grade	ASTM	DIN^(1, 2)	EN⁽¹⁾
A	ASTM A684, 1050-1065	DIN 17222, Ck55, Ck60	EN 10132-4, C55S+A, C60S+A
B	ASTM A684, 1074 (1070)	DIN 17222, Ck67, Ck75	EN 10132-4, C67S+A or C75S+A
C	ASTM A684 1085, 1086, 1095	DIN 17222, Ck85, Ck101	EN 10132-4, C85S+A, C90S+A, C100S+A

(1) Referenced DIN specifications have been superseded by European Standard EN 10132. Former DIN designations may continue to be recognized by many suppliers and steel producers.

(2) DIN tolerance standards are DIN 1544 (Superseded by EN 10140)

2.3.2 Selecting the hardness for a quenched and tempered spring application involves a balance between strength and notch sensitivity. For this reason, springs are commonly quenched and tempered to an intermediate hardness range of 42-47 HRC (Hardness Rockwell C scale) with Grade A steel. For wear applications, both increased hardness and carbon content will result in improved wear resistance, therefore the highest applicable hardness should be designated. Grade B or C steels should be used in these wear applications with the specified hardness commonly achieved by quenching and tempering and in some cases induction hardening. For wear applications that are notch sensitive and require higher toughness, such as knife sections that are subsequently induction hardened, a hardness range of 50-55 HRC should be specified. For applications that do not experience fatigue or impact loading, a higher hardness range of 55-60 HRC can be selected with quench and temper heat treatment. See Table 4 for typical mechanical properties in the heat treated condition.

2.3.3 Austempering is a special hardening treatment designed to reduce distortion and cracking in higher carbon steels. An example application is austempered knife sections. It normally produces less distortion than conventional quench and tempering since it is an isothermal process that occurs above the martensite start temperature (M_s). Austempering also provides increased toughness and wear resistance compared to quench and tempered steels of the same hardness. Austempering is less commonly used and is usually more costly than conventional hardening processes.

2.4 Zinc electroplating for improved corrosion resistance is not recommended for heat treated MAT1027 steels. These steels are susceptible to hydrogen embrittlement associated with the electroplating process due their high carbon content and high hardness after heat treatment. Where improved corrosion resistance is required specify mechanical zinc plating, Type ZNM YCR per CNH MAT0310. Susceptibility to hydrogen embrittlement is essentially eliminated with mechanical zinc plating. Improved corrosion resistance is also generally achieved by painting parts and should be considered for these steels before electroplating. If electroplating is necessary, see the baking requirements in CNH MAT0310 for parts with measured surface hardness above 34 HRC (or equivalent) and all highly stressed cold worked parts.

2.5 Pickling, descaling or other surface preparation may be required for applications, such as painted parts, where improved surface finish is needed. Where surface finish is critical to the application, this requirement should be negotiated with the supplier and noted on the purchase order.

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2.6 The cutting of these strip steels with laser, plasma torch, or other high temperature processes should be avoided for certain applications as resulting hard zones on cut edges can negatively affect formability of the stock and reduce the fatigue life. Also, hard surfaces and scale can cause excessive wear on mating surfaces. Strip steel that is laser cut may require improved flatness and reduced residual stress compared to conventional strip steel. Cold reduced or temper rolled strip may be required to meet these requirements. For strip that will be painted, use of nitrogen shielding gas to limit oxide deposits (scale) or buffing edges to remove oxides is recommended to assure adequate paint adhesion. Acid pickling may also be used to remove scale, but should be pickled for the minimum possible time as high carbon steels are prone to hydrogen embrittlement. Manufacturing and/or purchasing are responsible to negotiate the correct material conditions with suppliers to meet these requirements in addition to requirements in designated National Standards.

3. RELATED SPECIFICATIONS

ASTM E140 Standard Hardness Conversion Tables - Metals
CNH ENPJ100 (86619032) Significant Characteristics
CNH DWGD100 (86979040) Specifying Steel Sheet Thickness
CNH MAT0310 (87303277) Zinc Plating
CNH MAT1003 (86979049) Metallic Material Designations on Engineering Drawings

4. GRADES

4.1 LOCAL / NATIONAL STANDARDS

Applicable National Standards for high carbon, cold rolled strip steel are listed in Table 2. In general, it is permissible to produce a part from any of the Table 2 comparable National Standard grades for a corresponding CNH Grade when no special strength or composition requirements are specified.

5. REQUIREMENTS

5.1 CNH strip steel shall meet all requirements of the applicable National Standard and any special requirements specified on the engineering drawing.

5.2 DIMENSIONS AND TOLERANCES

5.2.1 Strip products shall conform to the permissible variations in dimensions as specified in the designated National Standard.

5.2.2 It is recommended that the strip thickness be specified on engineering drawing per the guidelines of CNH DWGD100 (86979040).

6. SPECIAL REQUIREMENTS

Optional conditions or grades listed in National Standards may be applied as special requirements (SPCL). These requirements shall be indicated on the engineering drawing and apply to both the CNH grade and National Standard specified.

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7. INSPECTION AND REJECTION

All strip material supplied to this specification shall be equivalent in every respect to samples approved by the purchasing CNH location. While the purchasing location may test samples from incoming shipments for quality assurance, the supplier is responsible for ensuring that shipments meet the stated requirements without depending upon the purchaser's inspection.

8. DRAWING SPECIFICATIONS

8.1 Specifying a restricted (RSTR) or special (SPCL) material may require the use of a significant characteristic per CNH Engineering Procedure ENPJ100 (86619032). This determination will be made as part of the design review process.

8.2 The title block of engineering drawings shall contain material designations as described in CNH MAT1003 (86979049) Metallic Material Designations on Engineering Drawings. The following are examples of material designations for cold rolled high carbon strip on drawings:

8.2.1 Preferred materials; also see Table 2.

CNH Material CR Strip, CNH MAT1027, Grade A
Local Material CR Strip, ASTM A684, Grade 1055

8.2.2 Restricted Material (RSTR):

CNH Material CR Strip, CNH MAT1027, Grade B, RSTR
Local Material See Notes

Material Note (on drawing):

CR Strip, EN 10132-4, C67S+A
No Alternate Material Permitted

8.2.3 Spring Application – Heat Treated

CNH Material CR Strip, CNH MAT1027, Grade A
Local Material See Notes

(Example note placed on drawing)

Material Note:

CR Strip, EN 10132-4, C55S+A

Heat Treat:

Quench and tempered after forming per MAT4050
Furnace temper to a surface hardness of 42-47 HRC
Measure surface hardness at location indicated

8.2.4 Special Requirement-Non-listed Material

CNH Material CR Strip, CNH MAT1027, SPCL
Local Material CR Strip, ASTM A684, 1049

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9. DESIGN PROPERTIES

9.1 Expected mechanical properties of CNH grades based on comparable National Standard strip materials are provided in Tables 3 and 4 for engineering guidance. Property values are not guaranteed for these steels, therefore values in Table 3 should be used only as guidelines in the design process. Table 3 provides values as ranges that are representative of the referenced materials in the annealed condition for a given CNH grade. In the case of tensile strength, the range of expected maximum values for referenced steels in the CNH grade is provided. Table 4 gives approximate property values for the CNH grades that are attainable for these steels in the heat treated condition based on converted hardness ranges corresponding to applications discussed in Section 2.3.2.

9.2 CNH Engineering must consider the differences in dimensional tolerances and mechanical properties of referenced National Standard strip materials to assure functionality, reliability, and serviceability of a part when manufactured in different parts of the world. In applications where these differences can not be compensated for in the design, the material may be restricted to the originally specified local material as described in CNH MAT1003 (86979049) Metallic Material Designations on Engineering Drawings.

Table 3 Typical Mechanical Properties, As-Received ⁽¹⁾⁽²⁾

CNH Grade	Condition	Tensile Strength, Range of Maximums MPa (psi) ⁽⁴⁾	Yield Strength, Range of Maximums, MPa (psi) ⁽⁴⁾	Elongation, Range of Minimums, % ⁽⁴⁾	Hardness Range, HB ⁽³⁾
A	Annealed	600-660 (87,000 - 95,500)	480-560 (69,000- 81,000)	10 to 17	175 to 197
B	Annealed	640-650 (93,000 - 94,500)	510-500 (74,000 - 72,500)	10 to 16	185 to 200
C	Annealed	670-690 (97,000 - 100,000)	535-540 (77,500 - 78,000)	10 to 15	192 to 220

(1) Values are approximate and can vary as steel service centers may not guarantee exact properties.

(2) Higher carbon content steels (>0.60% carbon) are supplied in a spheroidized annealed condition.

(3) HB (Brinell hardness) values given are estimated for annealed and spheroidized annealed conditions where appropriate (>0.60% carbon).

(4) Ranges provided are the range of maximum / minimum values for the National Standard grades referenced in Table 2.

Table 4 Typical Mechanical Properties in Heat Treated Condition ⁽¹⁾⁽²⁾⁽³⁾

CNH Grade Typically Specified	Surface Hardness, Typical Range, HRC ⁽⁴⁾⁽⁵⁾	Condition	Tensile Strength, MPa (psi)	Yield Strength, MPa (psi)
A	42-47	Quenched and Tempered	1340-1580 (194,000 - 229,000)	1125-1340 (163,000 - 194,000)
B or C	50-55	Quenched and Tempered	1760-2075 (255,000 - 301,000)	1480-1700 (204,000 - 222,750)
B or C	55-60	Quenched and Tempered	2075-2265 (301,000 - 328,000)	1700-1810 (246,500 - 262,500)

(1) Tensile strength values are approximate and are based on values from SAE J417, Dec1983. Heat treat suppliers shall know tempering temperature and cycle time from experimentation required to achieve hardness shown on drawings.

(2) Yield strength values are approximate and calculated using graphical representation shown in SAE J413. The most conservative (far left) curve in J413 was used.

(3) Yield strength values above 1800 MPa (261,000 psi) are extrapolated based on tensile strength values from SAE J413 graphs.

(4) See Section 2.3.2 for general application information related to the HRC hardness range shown.

(5) HRA (Hardness Rockwell A) or HR15N (Rockwell Superficial Hardness 15N) hardness scales may be preferred or necessary for strip with thickness of 1 mm or less.

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ANNEX A Former Company and National Standard Material Information

1. Table A1 shows Former CNH Company material specifications replaced by this specification.

Table A1 Former CNH Company Material Specifications				
CNH Grade	CASE	NH Pennsylvania FNHA Standard	NH – Zedelgem Engineering Stds	NH Tractor Engineering
A	---	2-A-203 (9842897)	---	Fiat 52512 C50, 52501 C53 NHT-MS-004
B	ES-A7351	2-A-053 (9842879) 2-A-203 (9842897)	WS 50.04, C75 WS 50.04, C75G	Fiat 52554, C72 NHT-MS-004, ESEN-M1A159-HA
C	ES-A7351	2-A-203 (9842897)	---	---

2. Restricted Former Listed National Standard Materials

Table A2 lists National Standard materials that were previously listed as comparable materials for the former Grades. These materials may be designated on existing CNH Industrial drawings and are provided here as a reference only to correlate these materials to former or current Grades. The materials listed in Table A2 shall not be used on new or updated drawings.

Table A2 Former Listed National Standard Materials ⁽¹⁾ (For Reference Only)					
Grade	ASTM	DIN ⁽²⁾	BS ⁽²⁾	EN	FIAT
A	---	---	BS 1449-1.15, CS60	---	Fiat 52501, C53 Fiat 52512, C50
B	---	---	BS 1449-1.15, CS70	---	Fiat 52554, C72
C	---	---	BS 1449-1.15, CS95	---	Fiat 52558, C98

(1) The materials referenced may be found on some drawings and in previous revisions of MAT1027. When drawings are changed, the material specified should be updated to Grades listed in Table 1.

(2) The BS specification is superseded by EN 10132, however it may continue to be recognized by steel suppliers and producers.

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