| | |
|---|---|
| **STEEL, SHEET, COLD ROLLED, DUAL PHASE (CR DP)** | **WSS-M1A368-A/11/A12/A13/A14/A15/A16** |
| **STEEL, SHEET, COLD ROLLED, ENHANCED DUAL PHASE (CR DH)** | **WSS-M1A368-A26/A27** |
| **STEEL, SHEET, HOT ROLLED, DUAL PHASE (HR DP)** | **WSS-M1A368-A31/A32** |
| **STEEL, SHEET, HOT ROLLED, FERRITE BAINITE (HR FB)** | **WSS-M1A368-A42/A43** |
| **STEEL, SHEET, COLD ROLLED, RETAINED AUSTENITE (CR RA)** | **WSS-M1A368-A53/A54/A55** |
| **STEEL, SHEET, COLD ROLLED, COMPLEX PHASE (CR MP)** | **WSS-M1A368-A61/A62/A63** |
| **STEEL, SHEET, HOT ROLLED, COMPLEX PHASE (HR MP)** | **WSS-M1A368-A71/A72** |
| **STEEL, SHEET, COLD ROLLED, MARTENSITIC (CR MS)** | **WSS-M1A368-A81/A82/A83/A84/85** |
| **STEEL, SHEET, HOT ROLLED, MARTENSITIC (HR MS)** | **WSS-M1A368-A91** |

Note: Grades shown in gray typeface are not in the Global material strategy and should not be used without approval from the Global Sheet Metal Tech Club.

## 1. SCOPE

The materials defined by these Global specifications are hot rolled or cold rolled steel sheet with specified tensile strengths from 450 MPa to 1700 MPa, suitable for cold forming such as stamping, roll forming and tube making, and use in automotive applications.

The specification applies to uncoated and coated steel sheet generally categorized as advanced high strength steels:
- Dual Phase (ferrite and martensite microstructure, including grades with low and high yield, DP)
- Dual Phase Improved Formability (ferrite, martensite and retained austenite, DH)
- Ferrite-Bainite (ferrite and bainite microstructure, High Hole Expansion, FB)
- "Multi-Phase" or "Complex Phase" (ferrite, martensite, bainite plus precipitation hardening, MP)
- Retained Austenite (designed with expected amounts of retained austenite, RA)
- Martensitic (mainly martensitic microstructure, MS)

The steel sheet may achieve its final thickness by cold rolling, hot rolling, continuous thin-strip casting, or other means. All requirements of the specific variant are to be met regardless of the final thickness reduction method.

Specification WSS-M1P94-A shall be used where pre-coating by the steel supplier is required. All requirements of the specific variant are to be met with or without pre-coating, except as noted in these specifications or as noted as exceptions on the Engineering Drawing.

| Date | Action | Revisions | Rev. 1 |
|---|---|---|---|
| | | | |
| 2017 09 08 | Revised | See Summary of Revisions | D. Buhro, NA |
| 2012 01 10 | Released | | D. Jordan, NA / A. Toennessen, EU |


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## 2. APPLICATION

These Global specifications were released originally for automotive body and chassis parts.

### 2.1 LIMITATIONS

Common Global Grade Names are provided for information purposes and are not intended to be used on Engineering Drawings or CAD files.

Not all grade / gauge / width / coating combinations are available. Contact Product Development Materials Engineering for assistance or Global Materials and Fastener Standards (gmfs@ford.com) for help in locating the responsible engineer.

Variants shown with an asterisk and gray typeface in Tables 1-9 presently are not in the Global material strategy and should not be used without approval from the Sheet Metal Tech Club. Sources for these grades may not exist in your region. Contact Product Development Materials Engineering for assistance or gmfs@ford.com for help in locating the responsible engineer.

High strength materials delivered to this specification may be sensitive to hydrogen assisted cracking. Electro galvanized products may require baking treatment.

Material supplied to these specifications may contain titanium or other transition metals as alloying additions. Such alloyed steels, if subsequently surface treated by a nitrocarburising and/or oxidizing process, risk becoming embrittled due to the formation of ultrafine TiN or other precipitates. Accordingly, special consideration should be given to low carbon steel that contains intentional additions of titanium or other transition metals for parts that may be subjected to nitrocarburising and/or oxidizing processes.

## 3. REQUIREMENTS

Note: Drawing Precedence – Any part specific exceptions or restrictions of requirements listed in paragraph 3 shall be recorded on the part drawing and have to be considered in all engineering testing and attribute confirmation checklists.

### 3.1 APPROVED SOURCES

This specification requires the use of approved sources. Only the sources identified on the Ford Approved Source List (ASL) can be used when this specification is listed on the drawing, CAD file, or other documents. The list of approved sources is located within Ford at www.mats.ford.com or available externally through a Ford Materials Engineer. See also paragraph 4.1.

### 3.2 CHEMICAL COMPOSITION AND MICROSTRUCTURE
(ASTM E112, JIS G0320, ISO 4967 / ASTM E45)

3.2.1 Chemical Composition
The upper and lower limits of chemical composition of the controlled elements shall be established by the supplier and included in the supplier's Control Plan. Guidelines for chemical composition are provided in section 4.4.

Heat and/or check analyses shall be provided as part of the initial material source approval process in a format suitable for upload into the Ford Material Database.

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The choice of strengthening mechanism and the method of inclusion control, inclusion shape control, and/or stabilization shall be identified for the specific process path in the supplier's Control Plan.

3.2.2 Microstructure

The grain size number shall be established as part of the initial material source approval process and shall be consistent (within 1 unit) throughout the thickness of the sheet.

The steel sheet shall be free from internal defects that adversely affect manufacturing or part functionality. Examples of defects may include: pipe laminations, non-metallic inclusions, segregation, and blowholes. Non-metallic inclusion content shall not exceed a rating of 2.0 for thin and 2.0 for heavy when tested in accordance with ASTM E 45 Method D, Plate I-r, by analysis at 100X.

## 3.3 MECHANICAL PROPERTIES

(ASTM E8M, ASTM E290, ASTM E646, ISO 6892-1, EN 10325, ISO 10275, ISO/TS 16630, JFS T 1001, JIS Z 2241, JIS Z2241)

For initial approval requirements see paragraph 4.1.

Mechanical properties listed are valid in longitudinal direction. Certification of ongoing production material shall be in accordance with regional and/or local requirements.

For the determination of mechanical properties, the material cross sectional area shall be defined as that of the steel substrate only; contribution of any metallic and/or organic coating to the cross-sectional area used for stress calculation is neglected. (i.e. Zn, e-coat and/or paint are not included). This method of determining the cross sectional area of the test bar will be used as the referee method in all cases where the mechanical properties of the incoming material are in dispute.

Yield Strength is defined as lower yield stress or 0.2% proof stress (for materials without marked yield point).

ASTM Total Elongation is measured with an ASTM (50 mm) test bar (ASTM E 8M).
EN Total Elongation is measured with an ISO II (80 mm) test bar (ISO 6892-1).
JIS Total Elongation is measured with a JIS #5 test bar (JIS Z 2241).

Strain Hardening Exponent (n-value) is measured over the range 10-20% strain (or 10% to end of uniform elongation if less than 20%). See ASTM E 646 or ISO 10275. If uniform elongation is less than 12%, n-value shall be reported as $n_{UE} = \varepsilon_{UE}$ (n at uniform elongation equals true strain at uniform elongation.)

For grades with both $n_{4-6}$ value and $n_{10-20}$ value requirements, data is collected for initial source approval. Ongoing coil certification to $n_{4-6}$ value is not required. However, disputed material is expected to meet both n-value ranges if both are called for in the specification. For grades with only $n_{4-6}$ value requirements, the tested value is expected on the material certification.

Required n-value measurements are only valid for material thicknesses up to 6.4 mm. For gauges over 6.4 mm, n-value is not required.

BHI (Bake Hardening Index) is defined as the increase in lower yield strength due exclusively to the baking portion of the following:

Strain 2% in the longitudinal direction, note stress and release load.
Bake at 170 (+/- 2) deg C peak metal temperature for 20 (+/- 1) minutes.

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Determine post-bake yield strength per ASTM E 8M, ISO 6892-1, EN 10325, or JIS Z 2241.
BHI is the difference between the pre-bake stress at 2% strain and the post-bake yield strength.

BHI neglects the contribution of work hardening to yield strength and includes only the contribution due to thermal response. Actual processing conditions (temperature profiles and strain conditions) dictate the observed strength levels of individual parts.

Hole Expansion Ratio (HER)[1] testing shall be performed to ISO/TS 16630 or JIS Z2256. For grades with HER requirements, data is collected for initial source approval. Ongoing coil certification to HER requirements is not required. However, formability disputes will be settled with a 20 sample test taken from the suspect material. The mean of this test is expected to be one standard deviation above the minimum requirement.

Bend testing shall be performed to ASTM E290 using a V-Bend test setup through a 90º bend angle. Other test setups may be acceptable at the discretion of the regional Materials Engineering

Mechanical properties are reported following standard rounding rules.

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