**ALUMINUM ALLOY, SHEET, HEAT TREATABLE, STRUCTURAL, HIGH STRENGTH, THIN GAGE** **NOT TO BE USED FOR NEW DESIGN** — **WSS-M2A175-A1**

**ALUMINUM ALLOY, SHEET, HEAT TREATABLE, STRUCTURAL, HIGH STRENGTH, THICK GAGE** — **WSS-M2A175-A2**

**ALUMINUM ALLOY, SHEET, HEAT TREATABLE, STRUCTURAL, HIGH STRENGTH, LOW COPPER** — **WSS-M2A175-A3**

**ALUMINUM ALLOY, SHEET, HEAT TREATABLE, STRUCTURAL, ENERGY ABSORPTION** — **WSS-M2A175-A4**

**ALUMINUM ALLOY, SHEET, HEAT TREATABLE, STRUCTURAL, OVERAGED** — **WSS-M2A175-A5**

**ALUMINUM ALLOY, SHEET, HEAT TREATABLE, STRUCTURAL, AIR QUENCHED, OVERAGED** — **WSS-M2A175-A6**

## 1. SCOPE

The materials defined by these specifications are for direct cast, 6000 series, heat treatable aluminum sheet.

Ford Motor Company may, at its option and in agreement with the local or regional supplier, define additional and/or restricted technical delivery requirements such as mechanical properties, forming characteristics, and/or pretreatment for a specific grade and/or part. The defined requirements shall be mandatory and no characteristics shall conflict with these engineering specifications.

## 2. APPLICATION

These global specifications were released originally for stamped automotive body parts.

### 2.1 LIMITATIONS

The yield strength of the material in the part after the paint baking process is a function of the amount of forming deformation and the time-temperature profile during the paint baking process. The mechanical property values shown in Table 2 apply only to the listed condition; individual parts will have different properties, depending on specific processing in the vehicle manufacturing plants.

### 2.2 DEFINITIONS

Variant A1 is a structural alloy with gage thicknesses less than or equal to 1.5 mm, typically applied to non-visible structural parts (Class 3) where high strength and modest ductility are required. This variant is applicable to parts that may be susceptible to intergranular corrosion or stress corrosion cracking, or parts that will be heat treated after forming.

| Date | Action | Revisions | Rev 03 |
|---|---|---|---|
| 2015 02 02 | Editorial | See Summary of Revisions | C. Mracna, NA |
| 2014 10 30 | Revised | Added T52; See Summary of Revisions | C. Mracna, NA |
| 2013 11 06 | Released | | C. Mracna, NA |

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Variant A2 is a structural alloy with gage thicknesses of 0.8 to 4.0 mm, typically applied to non-visible structural parts (Class 3) where high strength and modest ductility are required. This variant is applicable to parts that may be susceptible to intergranular corrosion or stress corrosion cracking, or parts that will be heat treated after forming.

Variant A3 is a low copper, structural alloy with gage thicknesses 0.8 to 4.0 mm, typically applied to non-visible structural parts (Class 3) where high strength and modest ductility are required. This variant is applicable to parts that may be susceptible to intergranular corrosion or stress corrosion cracking, or parts that will be heat treated after forming.

Variant A4 is an energy absorption alloy, typically applied to non-visible structural parts (Class 3) where controlled in-service deformation behavior and thermal stability are desired.

Variant A5 is a high formability, structural alloy with gage thicknesses greater than 1.5mm, typically applied to non-visible structural parts (Class 3). This variant is applicable for parts having design features that require the material to be stamped in O temper and subsequently require heat treatment using a water quench to a strengthened T72 temper.

Variant A6 is a high formability, structural alloy with gage thicknesses greater than 1.5mm, typically applied to non-visible structural parts (Class 3). This variant is applicable for parts having design features that require the material to be stamped in O temper and subsequently require heat treatment using an air quench to a strengthened T52 temper. T52 is an air quench heat treatment used to maintain as-stamped dimensional tolerances.

## 3. REQUIREMENTS

### 3.1 STANDARD REQUIREMENTS FOR PRODUCTION MATERIALS

Material suppliers and part producers must conform to the Company's Standard Requirements for Production Materials (WSS-M99P1111-A).

Material suppliers and part producers must conform to the Company's Quality System Requirements. In order for materials to comply with the requirements of the material specification they shall be sourced from suppliers listed in the Ford Motor Company Approved Source List, ASL (See also paragraph 4.2).

### 3.2 CHEMICAL COMPOSITION
(ASTM E34, ASTM E716, ASTM E1251)

3.2.1 Chemical Composition

The upper and lower limits of chemical composition of the controlled elements shall be established by the supplier by any of the listed methods and included in the Supplier's Control Plan. In case of dispute, the referee method shall be ASTM E34.

The tabulated upper and lower limits of chemical composition for each variant may not agree with those listed in the Aluminum Association "Teal Sheets." The values in Table 1 take precedence.

Ladle 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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Table 1: Ladle Chemical Composition (weight percent maximum, unless shown as a range or a minimum; balance Al)

| | A1/A2 | A3 | A4 | A5/A6 |
|---|---|---|---|---|
| Si | 0.55 – 0.95 | 0.50 – 1.00 | 0.30 - 0.60 | 0.45-0.75 |
| Fe | 0.30 | 0.30 | 0.30 | 0.60 |
| Cu | 0.50 - 0.80 | 0.20 | 0.20 | 0.20-0.30 |
| Mn | 0.30 | 0.15 | 0.15 | 0.10 |
| Mg | 0.55 - 0.95 | 0.40 - 0.80 | 0.40 - 0.70 | 0.75-1.00 |
| Cr | 0.10 | 0.05 | 0.05 | 0.05-0.25 |
| Zn | 0.10 | 0.10 | 0.10 | 0.10 |
| Ti | 0.10 | 0.10 | 0.10 | 0.10 |
| Others (each) | 0.05 | 0.05 | 0.05 | 0.05 |
| Others (total) | 0.15 | 0.15 | 0.15 | 0.15 |

## 3.3 MECHANICAL PROPERTIES

(ASTM E8M, ASTM B557M, 50 mm gauge length; ASTM E517, FLTM BB 114-02)

Mechanical properties are valid in the longitudinal, transverse, and diagonal directions, except as noted. Certification of ongoing production material shall be in accordance with regional and/or local requirements. In cases of dispute, test data obtained from supplier retained samples that have been stored under environmentally controlled conditions will serve as the arbitrator. The samples shall be tested at a third party laboratory.

Mechanical properties shall be valid for a period of between thirty (30) and ninety (90) days following solution heat treatment unless otherwise noted.

For the determination of mechanical properties, the material cross sectional area shall be defined as that of the aluminium alloy; contribution of any surface treatments to the calculated cross-sectional area used for stress calculations is neglected.

The test specimen geometry and orientation relative to the rolling direction are to be established locally to certify on going production material.

Yield Strength is defined as 0.2% proof stress. Yield strength and ultimate tensile strength shall be measured per ASTM B557M.

Uniform elongation shall be measured per ASTM E8, Sec. 7.9.3 or 7.9.3.2. In cases of dispute, section 7.9.3 shall be the umpire method.

Plastic Strain Ratio (r-value) is defined for a specific test direction with respect to the rolling direction. It is measured at 10% elongation.

Normal anisotropy (r-bar, $r_{avg}$, or $r_m$) is calculated from the individual r-values per ASTM E517.

Yield Strength (T81, T82, T52 & T72), Long Term Thermal Stability, and Minimum Retained Ductility properties are defined and measured per FLTM AB 107-01. Yield Strengths (T81 & T82) are measured at 30 days.

Bendability is defined and measured per FLTM BB 114-02. r/t is calculated based on a bend rating of 5. T81, T82, T52 & T72 Thermal Treatments are defined per FLTM AB 107-01.

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