ALUMINUM ALLOY, EXTRUSION, HEAT TREATABLE, STRUCTURAL, HIGH STRENGTH — **WSS-M2A177-A1**

ALUMINUM ALLOY, EXTRUSION, HEAT TREATABLE, SEAMLESS, HIGH STRENGTH, GRAIN SIZE CONTROLLED — **WSS-M2A177-A2**

ALUMINUM ALLOY, EXTRUSION, HEAT TREATABLE, STRUCTURAL, MODERATE STRENGTH AND FORMABILITY — **WSS-M2A177-A3**

ALUMINUM ALLOY, EXTRUSION, HEAT TREATABLE, SEAMLESS, MODERATE STRENGTH AND FORMABILITY, GRAIN SIZE CONTROLLED — **WSS-M2A177-A4**

ALUMINUM ALLOY, EXTRUSION, HEAT TREATABLE, STRUCTURAL, ENERGY ABSORBSION — **WSS-M2A177-A5**

ALUMINUM ALLOY, EXTRUSION, HEAT TREATABLE, STRUCTURAL, HIGH STRENGTH, ENERGY ABSORBSION — **WSS-M2A177-A6**

ALUMINUM ALLOY, EXTRUSION, HEAT TREATABLE, STRUCTURAL, HIGH STRENGTH, 6000 SERIES — **WSS-M2A177-A7**

1. SCOPE

The materials defined by these specifications are for 6000 series, heat treatable extruded aluminum tubes and profiles.

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, pretreatment, and/or surface texture, 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 extruded aluminum tubes for structural applications. The manufacturing processes used to form these aluminum tubes include but are not limited to rotary bending, push roll bending, stretch bending, stamping, hydroforming, piercing, laser trimming, and machine trimming. The alloys defined in this specification are not susceptible to intergranular corrosion or stress corrosion cracking.

2.1 LIMITATIONS

The yield strength of the material in the part after the artificial aging heat treatment and / or 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

Date	Action	Revisions	Rev 04
2014 12 17	Released	Added A6 and A7 Suffixes	C. Mracna, NA
2014 06 20	Revised	See Summary of Revisions	C. Mracna, NA
2014 03 06	Editorial	See Summary of Revisions	C. Mracna, NA

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Variant A1 is a structural, multi-hollow extruded tube alloy typically applied to Class 3 non-visible parts where high strength and modest ductility are required. For high strength, these alloys must be artificially aged (e.g. T6) for parts requiring functional performance characterized by controlled in-service deformation.

Variant A2 is a seamless extruded tube alloy typically applied to Class 3 non-visible parts where high strength and modest ductility are required. For high strength, these alloys must be artificially aged (e.g. T6) for parts requiring functional performance characterized by controlled in-service deformation.

Variant A3 is a general structural, multi-hollow extruded tube alloy suitable for Class 3 parts where moderate strength and modest formability are required.

Variant A4 is a general seamless extruded tube alloy suitable for Class 3 parts where moderate strength and modest formability are required.

Variant A5 is a general structural, multi-hollow extruded tube alloy suitable to Class 3 parts where energy absorption and/ or controlled in-service deformation behavior are desired.

Variant A6 is a structural, multi-hollow extruded tube alloy typically applied to Class 3 non-visible parts where high strength and energy absorption are required. These alloys must be artificially aged (e.g. T6 or T7) for functional performance characterized by controlled in-service deformation.

Variant A7 is a structural, multi-hollow extruded tube alloy typically applied to Class 3 non-visible parts where high strength and modest ductility are required. These alloys must be artificially aged (e.g. T6 or T7) for functional characterized by controlled in-service deformation. …

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 AND MICROSTRUCTURE
(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.

Check analyses of extruded tubes 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: Chemical Composition (weight percent maximum, unless shown as a range or a minimum; balance Al)

	A1	A2	A3/A4	A5	A6	A7
Si	0.70 - 1.30	0.70 - 1.30	0.40 - 0.80	0.20 - 0.60	0.30 – 1.5	0.90 – 1.2
Fe	0.5	0.5	0.70	0.35	0.50	0.50
Cu	0.10	0.10	0.40	0.10	0.50	0.05 – 0.30
Mn	0.40 – 1.00	0.10 – 0.60	0.15	0.10	0.60	0.75
Mg	0.60 - 1.20	0.60 - 1.20	0.80 - 1.20	0.45 - 0.90	0.30 – 1.50	0.70 – 1.0
Cr	0.25	0.25	0.35	0.10	0.35	0.25
Zn	0.20	0.20	0.25	0.10	0.20	0.05
Ti	0.10	0.10	0.15	0.10	0.20	0.10
V	-	-	-	-	0.30	-
Others (each)	0.05	0.05	0.05	0.05	0.10	0.05
Others (total)	0.15	0.15	0.15	0.15	0.20	0.15

3.2.2 Average Grain Size,
(ASTM E112, Comparison Procedure)

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3.3 MECHANICAL PROPERTIES

(ASTM B557M, 50 mm gauge length; ASTM E517)

Mechanical properties are valid in the longitudinal direction parallel to extrusion direction, 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 seven (7) and sixty seven (67) 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 is to be established locally to certify ongoing production material.

Yield Strength is defined as 0.2% proof stress.

Yield Strength (T81 & T6), Long Term Thermal Stability, and Minimum Retained Ductility After T81 or T6 thermal treatment are defined and measured per FLTM AB 108-01. Yield Strength (T81 & T6) and Minimum Retained Ductility After T81 or T6 properties are measured at 7 days post extrusion.

Uniform elongation shall be measured per ASTM E8M, Sec. 7.9.3 or 7.9.3.2. In cases of dispute, section 7.9.3 shall be the umpire method.

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