ALUMINUM CASTING ALLOY, CYLINDER HEAD, LIGHT DUTY **WSS-M2A178-A1**
ALUMINUM CASTING ALLOY, CYLINDER HEAD, NORMAL DUTY **WSS-M2A178-A2**
ALUMINUM CASTING ALLOY, CYLINDER HEAD, HEAVY DUTY, DIESEL **WSS-M2A178-A3**
ALUMINUM CASTING ALLOY, CYLINDER HEAD, HEAVY DUTY, GASOLINE **WSS-M2A178-A4**

1. SCOPE

The materials defined by these specifications are heat treated aluminum-silicon casting alloys.

2. APPLICATION

These specifications were originally released for materials used in manufacture of permanent mold cast cylinder heads. A1 is artificially over-aged aluminum-silicon-copper-magnesium alloy for light duty gasoline engine applications. A2 is solution treated and artificially over-aged aluminum-silicon-copper-magnesium alloy for normal duty gasoline engine applications. A3 is solution treated and artificially aged premium aluminum-silicon-copper-magnesium alloy for heavy duty diesel engine applications. A4 is solution treated and artificially aged premium aluminum-silicon-copper-magnesium alloy for heavy duty gasoline engine applications.

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).

3.2 CHEMICAL COMPOSITION (Weight Percent)
(ASTM E1479/ ASTM E1251)

	A1	A2	A3	A4
Silicon, Si	6.0 – 8.5%	6.0 – 8.5%	6.5 – 7.5%	6.5 – 7.5%
Copper, Cu	2.8 – 4.0%	2.8 – 4.0%	0.40 – 0.60%	0.40 – 0.60%
Iron, Fe	0.80% max	0.80% max	0.20% max	0.20% max
Magnesium, Mg	0.20 – 0.60%	0.20 – 0.60%	0.20 – 0.45%	0.20 – 0.45%
Nickel, Ni	0.30% max	0.30% max	---	---
Manganese, Mn	0.60% max	0.60% max	0.15% max	0.15% max
Zinc, Zn	0.80% max	0.80% max	0.10% max	0.10% max
Titanium, Ti	0.25% max	0.25% max	0.25% max	0.25% max
Lead, Pb	0.15% max	0.15% max	---	---
Tin, Sn	0.10% max	0.10% max	---	---
Strontium, Sr	60 – 200 ppm	60 – 200 ppm	60 – 400 ppm	60 – 400 ppm
Calcium, Ca	---	---	20 ppm max	20 ppm max
Phosphorus, P	---	---	15 ppm max	15 ppm max
Others (Each)	0.05% max	0.05% max	0.05% max	0.05% max
Others (Total)	0.25% max	0.25% max	0.15% max	0.15% max
Aluminum	Balance	Balance	Balance	Balance
Mn:Fe Ratio	1:2 min	1:2 min	1:2 min	1:2 min

Date	Action	Revisions	Rev. 2
2015 01 30	Revised	See Summary of Revisions	G. Weber, NA
2014 12 17	Released	Added –A4	G. Weber, NA
2013 08 22	Released	A1, A2, A3	G. Weber, NA

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The composition shall be selected from within the above range. Specific composition limits and foundry practice to meet performance and manufacturing requirements will form part of the Control Plan for each individual component geometry and supplier.

Ford and the supplier shall agree upon the test method(s) used for performing chemical analysis of molten aluminum or cylinder head castings. The recommended method is optical emission spectroscopy (OES) (ASTM E1251), but inductively-coupled argon plasma spectroscopy (ICP) (ASTM E1479) may be used for research and failure analysis. In case of dispute over OES results, ICP shall be used as an umpire method.

3.3 HEAT TREATMENT

(Ford W-HTX, ASTM B917)

Components shall be subjected to heat treatment as defined below, to achieve the required mechanical properties and dimensional stability.

A1 T5-type treatment consisting of controlled cooling from casting temperature followed by artificial over-aging to stabilize the casting

A2 T7-type treatment consisting of cooling from casting temperature, solution treatment, controlled quenching from solution treatment temperature and artificial over-aging the casting to a substantially stable condition

A3/A4 T6-type treatment consisting of cooling from casting temperature, solution treatment, controlled quenching from solution treatment temperature, and artificial aging to achieve maximum fracture resistance

3.3.1 Engineering Drawing Requirements

Heat treatment parameters, including the appropriate quench medium, must be designed to achieve the required mechanical properties and dimensional stability, and determined individually for each component. As appropriate for the required heat treatment process, the following process parameters shall be fully specified on the Engineering Drawing and reflected in the Supplier Control Plan, which is agreed upon between Ford and the supplier:

- Solution treatment temperature range and time at temperature range
- Maximum delay between solution treatment and quenching
- Quench medium
- Controlled air cooling parameters
- Minimum quench temperature and hold time
- Artificial aging temperature range and time at temperature range

3.3.2 Restrictions

A2 When a liquid quenching medium is used, the temperature of the quenchant at the beginning of quenching shall be not less than 90 °C.

A3 & A4 When a liquid quenching medium is used, the temperature of the quenchant at the beginning of quenching shall be not less than 60 °C.

3.3.3 Air Quenching

Air quenching may be an acceptable alternative to liquid quenching for some applications, in which case details of the air quench process shall be included in the heat treatment process parameters.

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