



GRAY CAST IRON, CYLINDER LINERS

WSE-M1A320-A3

GRAY CAST IRON, CYLINDER LINERS, HIGH DURABILITY

WSE-M1A320-A4

GRAY CAST IRON, CYLINDER LINERS, ROUGH CAST OUTSIDE DIAMETER

WSE-M1A320-A5

1. SCOPE

The materials defined by these specifications are gray cast iron with controlled hardness and microstructure to achieve optimum cylinder bore functional characteristics.

2. APPLICATION

These specifications were released originally for materials used as cylinder liners in aluminum blocks. The A4 material was added for long-term durability and improved oil consumption. The A5 material was added for un-machined OD liners, directly cast in the block.

3. REQUIREMENTS

3.1 APPROVED SOURCES

This specification does not use approved sources. Any reliable supplier meeting these requirements may be used.

3.2 CHEMICAL COMPOSITION (Weight Percent)

	A3	A4	A5
Carbon (total)	3.00 - 3.50	3.00 - 3.50	3.00 - 3.70
Carbon Equivalent	4.40 max	4.40 max	4.00 - 4.40
Silicon	2.00 - 2.80	2.00 - 2.80	2.00 - 2.80
Manganese	0.50 - 1.00	0.50 - 1.00	0.50 - 1.00
Phosphorus	0.10 - 0.40	0.10 - 0.40	0.25 max
Sulfur	0.12 max	0.12 max	0.12 max
Chromium	0.10 - 0.40	0.10 - 0.40	0.05 - 0.40
Copper + Nickel*	-----	0.20 - 1.50	0.10 - 1.00
Tin	0.15 max	0.15 max	0.15 max
Vanadium	0.03 max	0.03 max	0.03 max
Titanium	0.04 max	0.04 max	0.04 max
Tungsten	0.02 max	0.02 max	0.02 max
Molybdenum	-----	0.20 - 0.50	-----

Carbon Equivalent = Total Carbon + 1/3 Silicon

* Nickel may be substituted for copper or visa versa to the extent that the total nickel plus copper equals specified amount.

Specific composition limits and foundry practice to meet performance and manufacturing requirements will form part of an agreed Control Plan for individual components.

Date	Action	Revisions	Rev. 07
2017 01 13	Revised	A5 Added, See Summary of Revisions	T. Covert, NA
2016 07 25	Inactive	A1 and A2	A. Wedepohl, NA
1991 05 08	Released	Released A1	J. Webster

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3.3 HARDNESS

(ASTM E10 / ISO 6506, P/D2 Ratio = 30:1;
ASTM E18 / ISO 6507)

Rough cast liner Brinell hardness test location is on a ground flat area on the OD at least 25 mm from the skirt end of the casting. Finished liner hardness and location shall be taken as shown on Engineering Drawing or Control Plan.

A3 / A4 / A5

Rough cast >10mm 205-273 HB

Rough cast <10mm & Finished* 205-273 HB
94-106 HRB *Average of three readings.

Method for hardness measurement of thin wall cylinder liners

- Cut section of liner along the length of the liner resulting in a long section
- Machine or grind the OD surface until texture is removed and flat
- Machine or grind the ID surface only until parallel and flat with the OD surface (do not remove any more than the minimum amount of material than needed to achieve a flat sample)

The width of the cut section of the liner will be dependent on the diameter and thickness of the liner. Care must be taken to ensure the thickness of the liner and the measurement surface area meets the requirements for the measurement method.

3.4 MICROSTRUCTURE

(Average over a minimum of 10 adjacent fields at 100X magnification)
(ASTM A247 / ASTM E562)

A3/A4: Evaluate microstructure at any position greater than 2 mm from finished outer diameter. The graphite structure at the wear surface of a finished liner at a point approximately 25 mm from the flange end shall consist as defined in the following.

A5: Evaluate microstructure in a zone 1–2 mm from cast OD surface (OD surface as defined on the liner engineering drawing). Also see Figure 1 below.

Form VII flake graphite as follows:

	A3	A4	A5
Type A, % (size)	Permissible	50% min (4-7)	50% min (4-8)
Type B, % (size)	75% max (6-8)	---	---
Type D&E, % (size)	75% max (6-8)	25% max (4-8)	25% max (4-8)

The graphite morphology, size and matrix microstructure content may be measured by comparison to available industry charts, or by quantitative methods (ASTM E562 or approved image analysis techniques). In case of dispute, the quantitative metallurgical method will be the umpire method.