M. E. Williams and Associates, Inc.

"Excellence in Metallurgical Engineering"

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Case Study: Vendor Qualification

By

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Subject

After evaluating a number of U.S. based ductile iron foundries whose castings failed to meet ASTM A536 specifications, this foundry showed that it was capable of meeting the customer's specifications. Examination of ductile iron casting and test bar to determine if the foundry was capable of producing ductile cast iron according to ASTM A536, 60-45-12. Examination was by hardness testing and microstructure, and the test bar was also examined for chemical composition and mechanical properties.

Hardness Testing

The hardness testing was done according to ASTM E384, using a Vickers indenter and a 500 gram load. The results of the testing are given in the table that follows. The specified hardness range for this part is 156 to 217 Brinell Hardness Number.

Hardness Test Data
(Brinell Hardness Number)

Location	Vickers	STD DEV	MAX VALUE	MIN VALUE	BHN
Test Bar	172.00	10.57	181.00	154.00	163.60
Casting	189.00	12.15	204.00	170.00	179.80

The average hardness of the test bar and casting was within the 156 to 217 Brinell Hardness range given for ASTM A536, 60-45-12.

Chemical Analysis

Chemical analysis was done according to the following ASTM Specifications: E1019 for carbon and sulfur, and E415 for the other elements. The results of the analysis are given in the table that follows.

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Test Bar Chemical Analysis (Percent by Weight)	
Element/Location	Test Bar
Carbon	3.05
Manganese	0.45
Phosphorous	0.048
Sulfur	<0.005
Silicon	2.89
Nickel	0.03
Chromium	0.02
Molybdenum	0.01
Copper	0.08
Magnesium	0.04
Carbon Equivalent	4.03

The total carbon is low for typical ductile cast iron (for some specifications), but the carbon equivalent is mid-range for ductile cast iron. For ASTM A536, the chemical composition is subordinate to the mechanical properties.

Mechanical Testing

The mechanical tests were done according to ASTM E8. The results are given in the table that follows.

Test Bar Mechanical Properties	
Test Bar	Mechanical Properties
Tensile Strength	78400 psi
Yield Strength	52500 psi
Elongation	18.3%

The mechanical properties exceed the minimums for ASTM A536, 60-45-12 ductile cast iron.

Metallographic Examination

Figures 1 and 3 show the graphite distribution in the casting. It is specified to be 90% minimum Types I and II graphite. Casting, Figure 1, contained 100% Types I and II graphite. The test bar, Figure 3, contained 100% Types I and II graphite. The graphite distribution in both the casting and test bar was uniform across the entire cross sections that were examined.

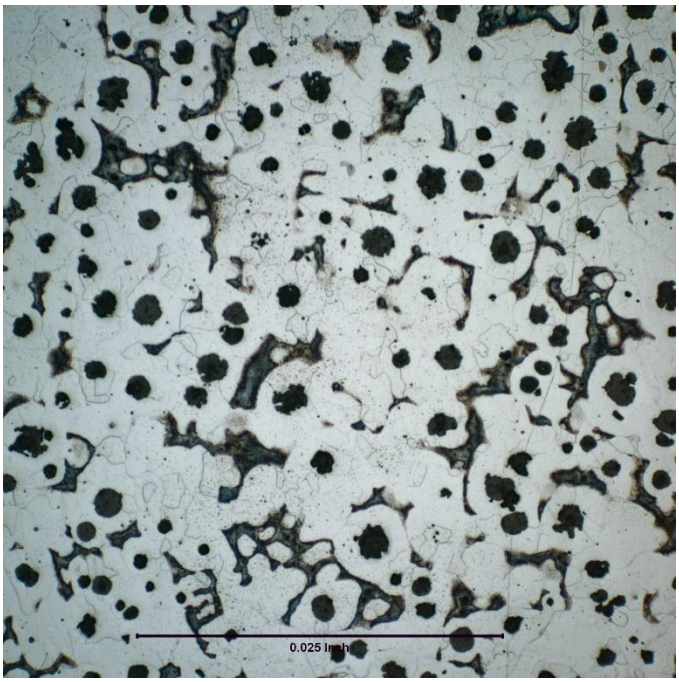

Figure 1 – 100X Graphite Distribution in Casting

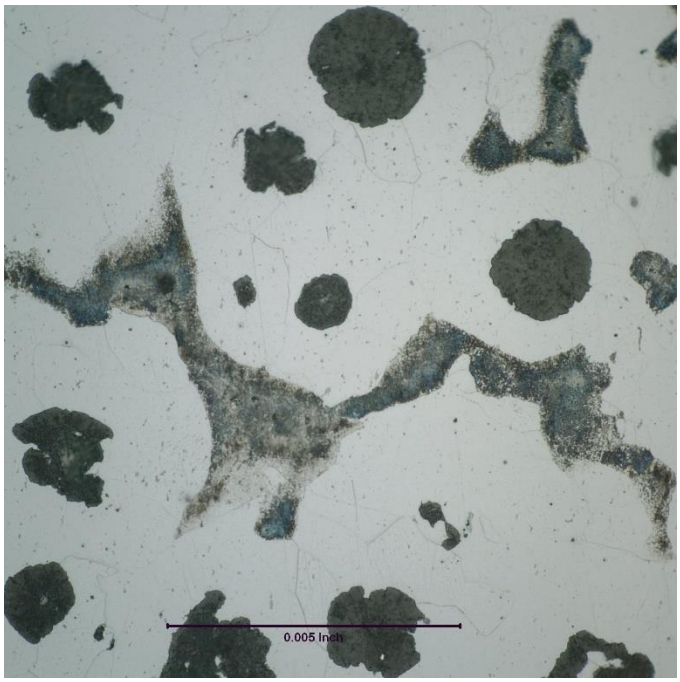

Figure 2 – 400X Microstructure of Casting

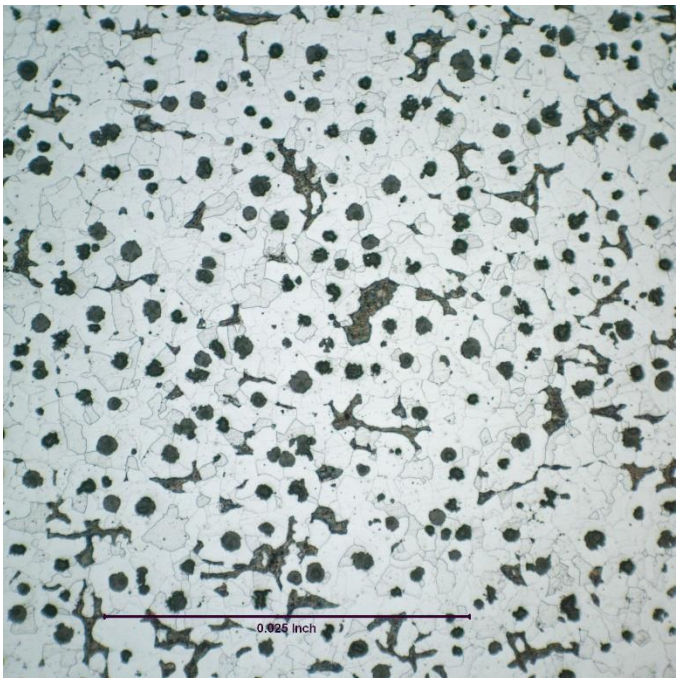

Figure 3 – 100X Graphite Distribution in Test Bar

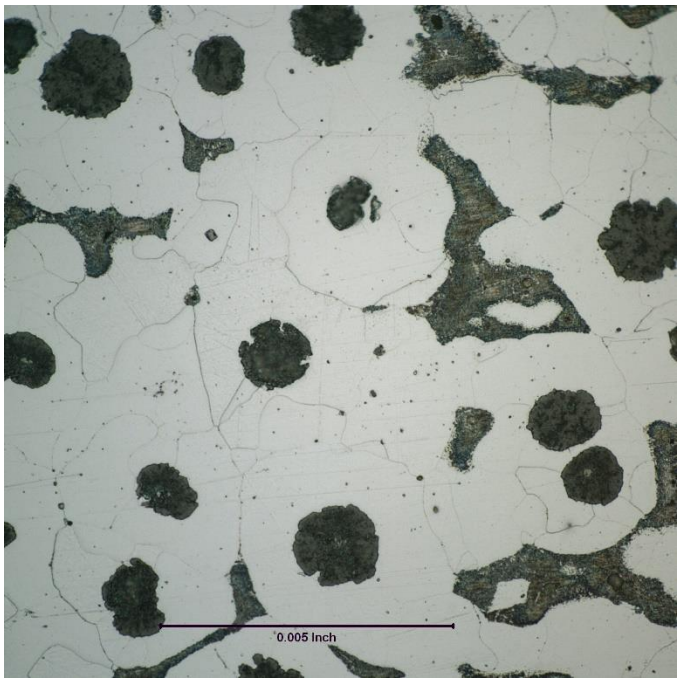

Figure 4 – 400X Microstructure in Test Bar

The microstructures, Figures 2, and 4, consisted of ferrite, the white areas, graphite, the dark grey-to-black areas, and pearlite, the iridescent areas. No carbides were found. The microstructure was consistent with 60-45-12 ductile cast iron.

Conclusions

1. The graphite nodule shape was very good.

2. There were no carbides present.

3. The microstructure, hardness, chemistry, and mechanical properties were consistent with the requirements of 60-45-12 ductile cast iron.

4. The examination showed that this foundry was capable of producing 60-45-12 ductile iron castings to ASTM A536.