One of the biggest problems that RIT Technical Services metallurgists come across when we visit foundries is chunk graphite. It is especially common in jobbing foundries that produce castings with a wide range of section sizes using common chemistries and alloys. Chunk graphite occurs only in the thermal centers of heavy section castings – those with sections greater than 2 inches (50 mm). See Figure 1.

Normally this defect will not be seen unless the casting is heavily machined into these sections or the part is cut up or happens to fail in service. This failure to see the defect, because it is usually hidden, is why it is so important to eliminate the cause before it occurs.

The microstructural appearance is shown in Figure 2. The result of this graphite shape is that the properties in these defective areas are dramatically reduced. The resulting matrix structure is ferritic giving lower tensile strength, yield strength and BHN hardness. The close proximity of the graphite particles also reduces the elongation and impact strength.

There are several theories as to exactly how this shape occurs. But for the sake of brevity I will not go into them here. However, we do know why it happens though. High concentrations (for the section size) of the following elements are the normal cause: C, Ce, Ca, Si, and/or Ni.

However, Cerium is not a cure all. There is an optimum level for each circumstance in casting production. Excessive Ce, in the absence of tramp elements (those that promote flake graphite), in heavy section regular Ductile Iron will almost always cause chunk graphite. Most MgFeSi alloys contain some level of Ce. This is usually fine for thin section parts, but does not work for all section sizes. This is a big problem in jobbing foundries where they want to minimize the amount of the alloys on hand. However, all chemistry control is made more difficult and must be varied when there is a wide range of castings and section sizes. See Suggestion Sheet 84 for the correct carbon/silicon and CE values for the section size and type of iron to be produced.
If the foundry must maintain an excess of Ce and it cannot easily be removed by changing treatment alloys, then adding a graphite flake forming element may be necessary to eliminate the chunk graphite. See Suggestion Sheet # 80. The easiest of these elements to find and use is antimony (Sb). An addition of 0.005% to a heavy section (>50 mm) (>2 in) ferritic iron will usually eliminate the chunk graphite, if the Ce level is not too high. See Figure 3. In addition to the elimination of the chunk graphite the addition of Sb improves the nodularity and nodule count. Both improvements are helpful to obtain the best properties in these heavy sections.

Since Sb is such a strong pearlite stabilizing element an addition of 0.02% with 0.01% Ce will not only produce good graphite structure, but will also promote a 100% pearlitic matrix.

For additional reading on this subject the reader should refer to our Volume I Production 1992, chapter 4.