Appendix III

Iron-Carbon Diagrams

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The following iron-carbon diagrams reflect only a small portion of the wide variety of possible interpretations of iron-carbon alloy types and their relationship to carbon content, temperature, and cooling rate. See, in particular, the transformation time diagram in Appendix VII.

Schematic iron-carbon diagram

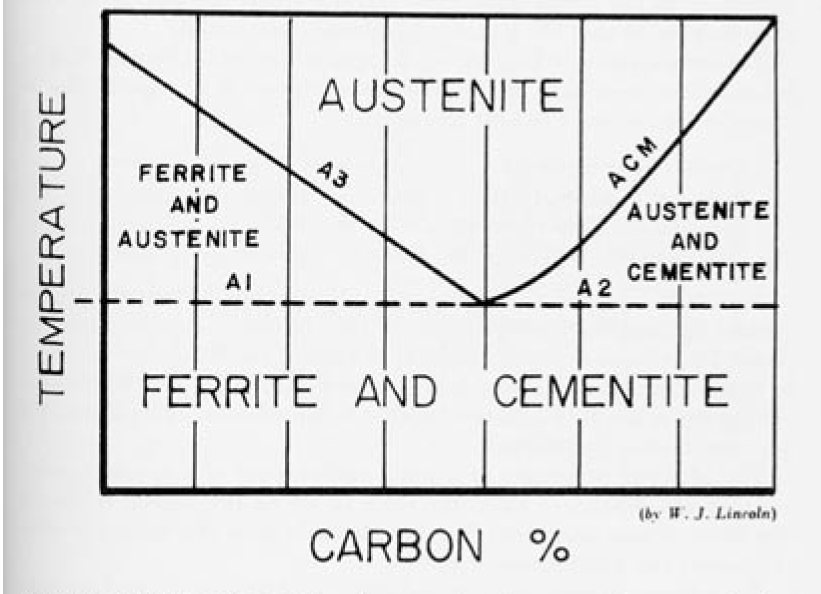
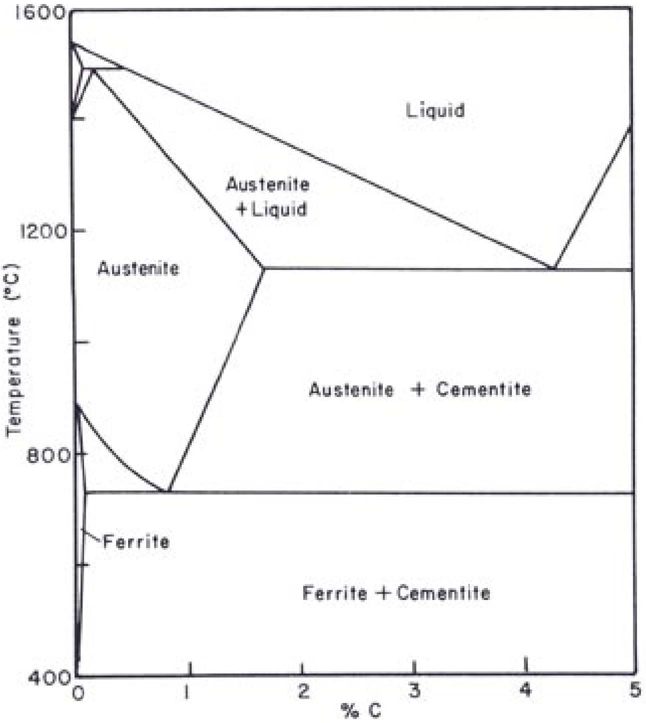


Figure 73. Schematic iron-carbon diagram showing areas important in heat treatment.

Figure 1 Shrager, M. 1961. *Elementary Metallurgy and Metalography*. NY: Dover. pg. 135. Used with permission of Dover.

Iron-carbon phase diagram



A-1. *The iron-carbon phase diagram shows the temperatures and compositions at which the different constituents of iron-carbon alloys are stable. Ordinarily, these constituents are austenite, ferrite, and cementite (iron carbide, Fe_3C). The constituent that Henry Sorby named pearlite consists of plates of cementite in a matrix of ferrite; it is formed by the decomposition of austenite at 723°C. If an alloy containing more than about 2.5 percent carbon is cooled very slowly, or if there is silicon in the iron, the carbon may appear as graphite rather than cementite.*

Figure 2 Gordon, Robert B. © 1996. *American Iron, 1607-1900*. pg. 252. The Johns Hopkins University Press. Reprinted with permission of The Johns Hopkins University Press.

Iron-carbon constitutional diagram 1

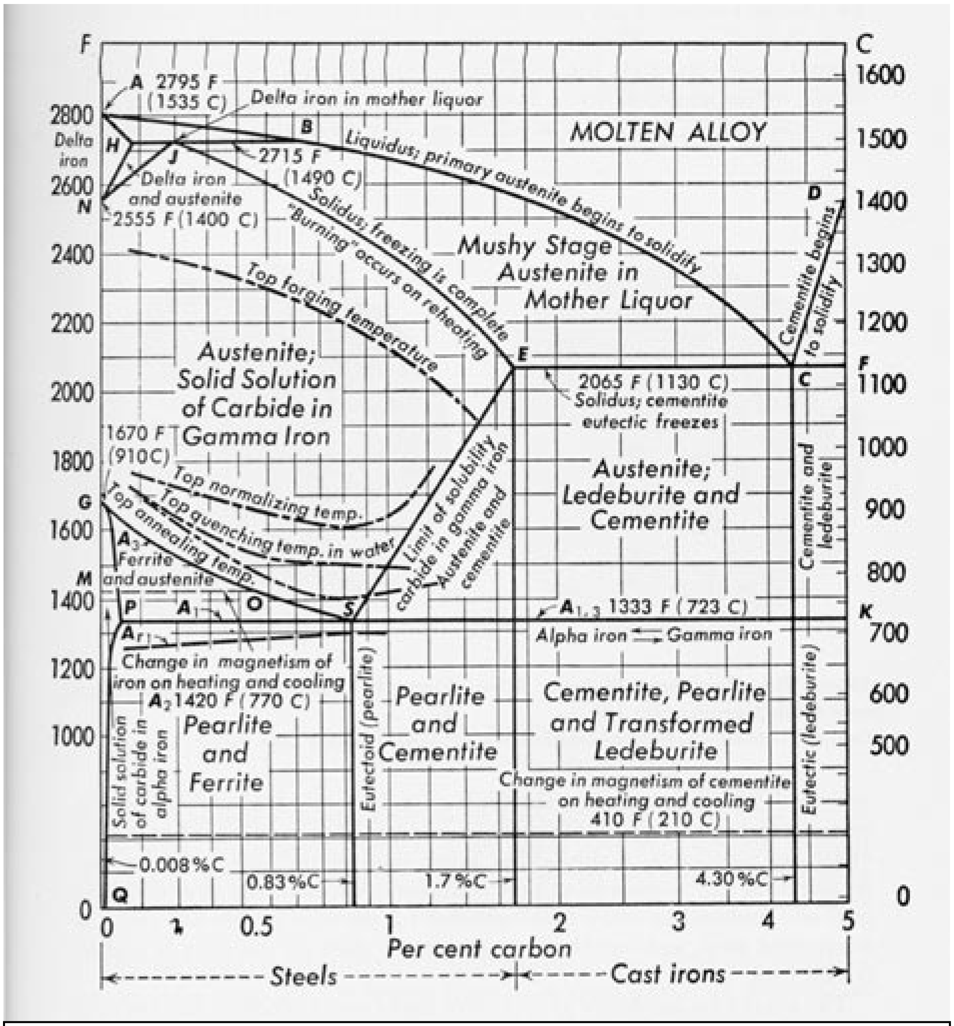
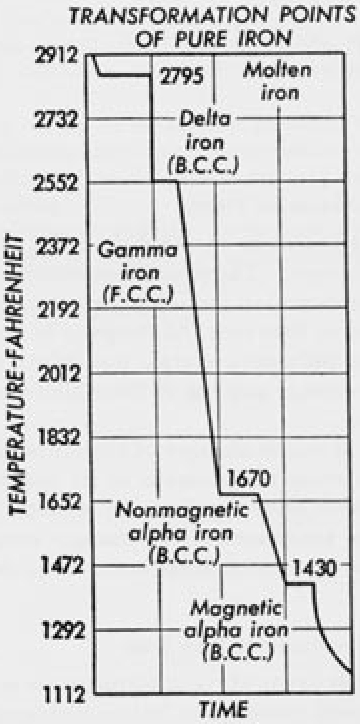


Figure 3 Shrager, M. 1961. *Elementary Metallurgy and Metalography*. NY: Dover. Figure 20. pg. 35. Used with permission of Dover.

Cooling curve of pure iron diagram



TRANSFORMATION POINTS OF PURE IRON

Figure 19. Cooling curve of pure iron.

Figure 4 Shrager, M. 1961. *Elementary Metallurgy and Metalography*. NY: Dover. pg. 34. Used with permission of Dover.

Solidus-liquidus diagram

The nature of steel

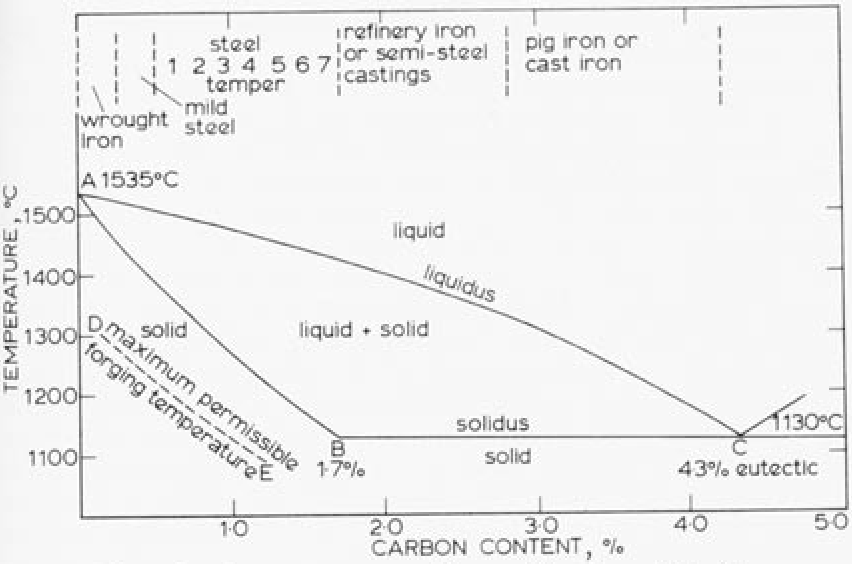


Fig. 3 Effect of carbon content on melting and freezing point of iron

Pure iron freezes and melts at 1 535°C. An alloy of iron with 4·3% carbon freezes and melts at a temperature of 1 130°C; this is a 'eutectic' alloy. All other iron–carbon alloys melt and freeze over a temperature range. This is determined by the line *AC*, which is known as the *liquidus*, and the line *AB*, continued along *BC*, known as the *solidus*. On heating, when the solidus line is reached, partial melting begins, continuing as the temperature rises, and culminating in the alloy becoming completely liquid when the liquidus line is reached. The reverse occurs on cooling. The maximum permissible forging temperature lies below the solidus line, typically as indicated by the line *DE*. Alloys with more than 1·5% carbon are virtually unforgeable.

Also indicated are the classes of material as defined by carbon content, steel for the purposes of the current discussion being an alloy of iron containing 0·5–1·5% carbon.

Figure 5 Barraclough, K.C. 1984a. *Steelmaking before Bessemer: Blister steel, the birth of an industry*. Volume 1. The Metals Society, London, England. pg. 5. Used with permission from the Institute of Materials, Minerals and Mining.

Iron-ironcarbide diagram

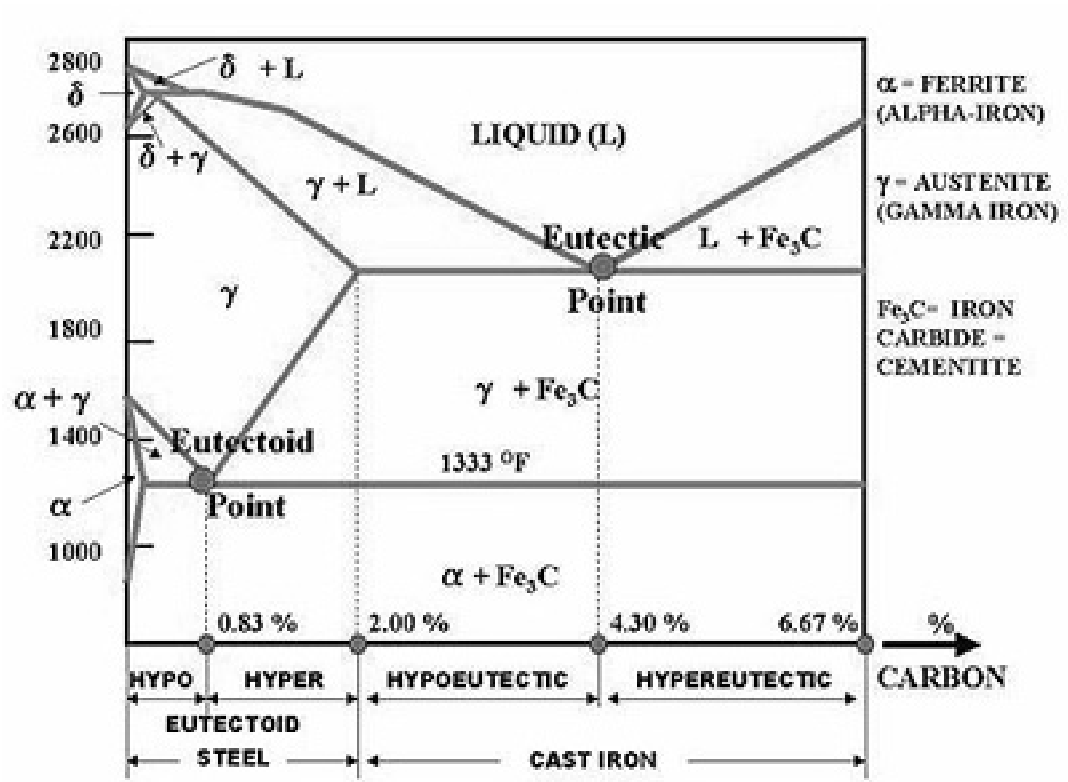


Figure 6 Used with permission from Serdar Z. Elgun.
http://info.lu.farmingdale.edu/depts/met/met205/fe3cdiagram.html

Critical temperature: heating versus cooling diagram

1.8 CHAPTER ONE

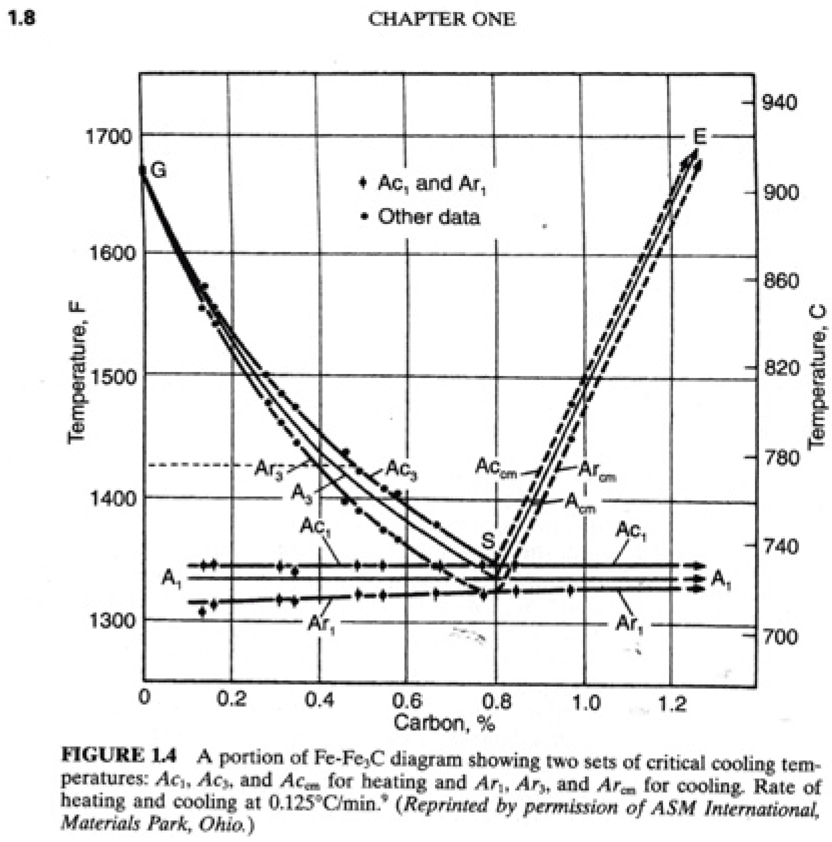


FIGURE 1.4 A portion of Fe-Fe_3C diagram showing two sets of critical cooling temperatures: Ac_1, Ac_3, and Ac_{cm} for heating and Ar_1, Ar_3, and Ar_{cm} for cooling. Rate of heating and cooling at 0.125°C/min.[9] (*Reprinted by permission of ASM International, Materials Park, Ohio.*)

Figure 7 Sinha, Anil Kumar. 2003. *Physical metallurgy handbook*. New York: McGraw-Hill. pg. 1.8. Reproduced with permission of The McGraw-Hill Companies.

Alpha-gamma-cementite eutectoid diagram

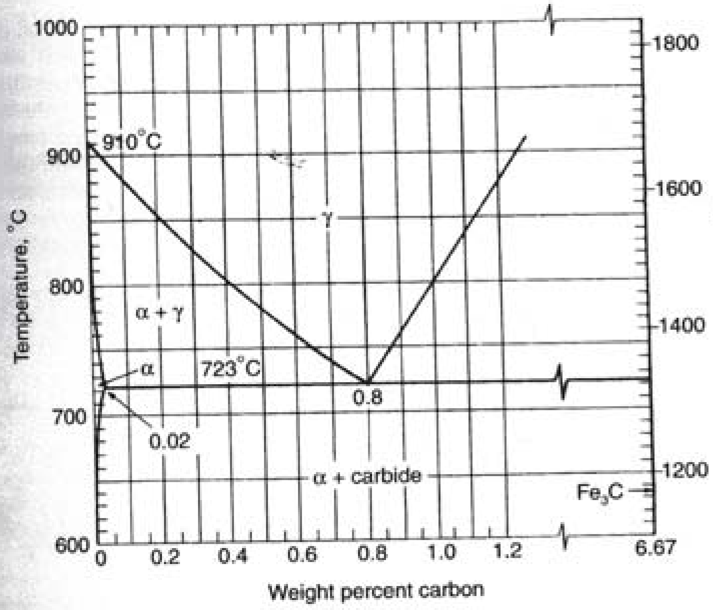
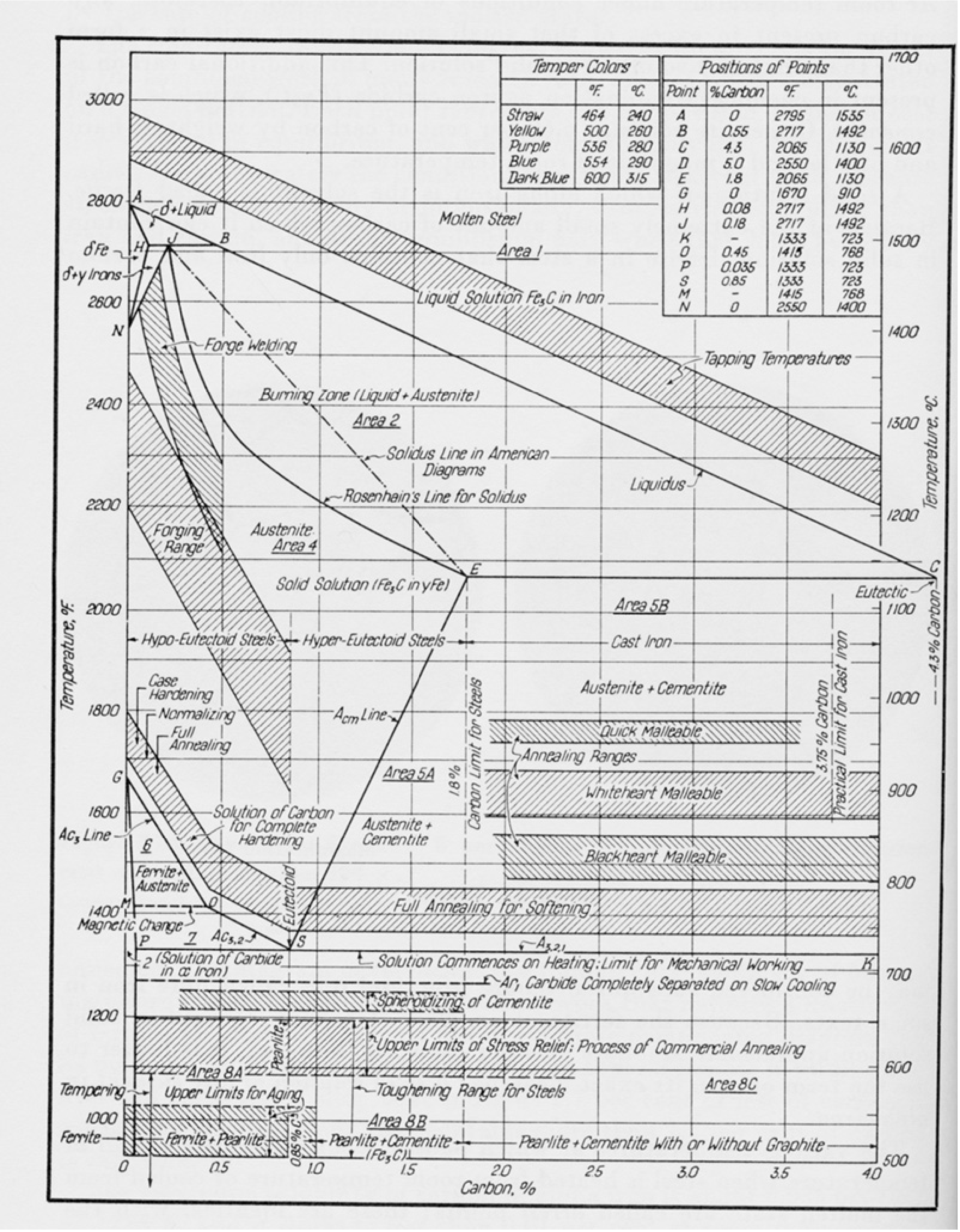


FIGURE 1.5 The eutectoid portion of the Fe-Fe_3C diagram. (*Reprinted by permission of Addison-Wesley Publishing Co., Reading, Massachusetts.*)

Figure 8 Sinha, Anil Kumar. 2003. Physical metallurgy handbook. New York: McGraw-Hill. pg. 1.9. Reproduced with permission of The McGraw-Hill Companies.

Iron-carbon constitutional diagram 2



Temper Colors	°F.	°C.
Straw	464	240
Yellow	500	260
Purple	536	280
Blue	554	290
Dark Blue	600	315

Positions of Points

Point	%Carbon	°F.	°C.
A	0	2795	1535
B	0.55	2717	1492
C	4.3	2065	1130
D	5.0	2550	1400
E	1.8	2065	1130
G	0	1670	910
H	0.08	2717	1492
J	0.18	2717	1492
K	–	1333	723
O	0.45	1415	768
P	0.035	1333	723
S	0.85	1333	723
M	–	1415	768
N	0	2550	1400

Figure 9 Shrager, M. 1961. Elementary Metallurgy and Metalography. NY: Dover. pg. 38. Used with permission from Dover.