

IN-SERVICE WELDING

Bart Coombs

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In-Service Welding

Pipeline Repair/ In-Service Welding

- Repair corrosion damage
- Installation of branch connections
- Installation of plugging fittings



In-Service Welding

Issues with In-Service Welding

- Hydrogen Cracking (Known by several names, Delayed Cracking, Underbead Cracking, Hydrogen Induced Cracking, etc.)
- Burnthrough

[Go to video](#)



In-Service Welding

Iron-Iron Carbide Phase Diagram

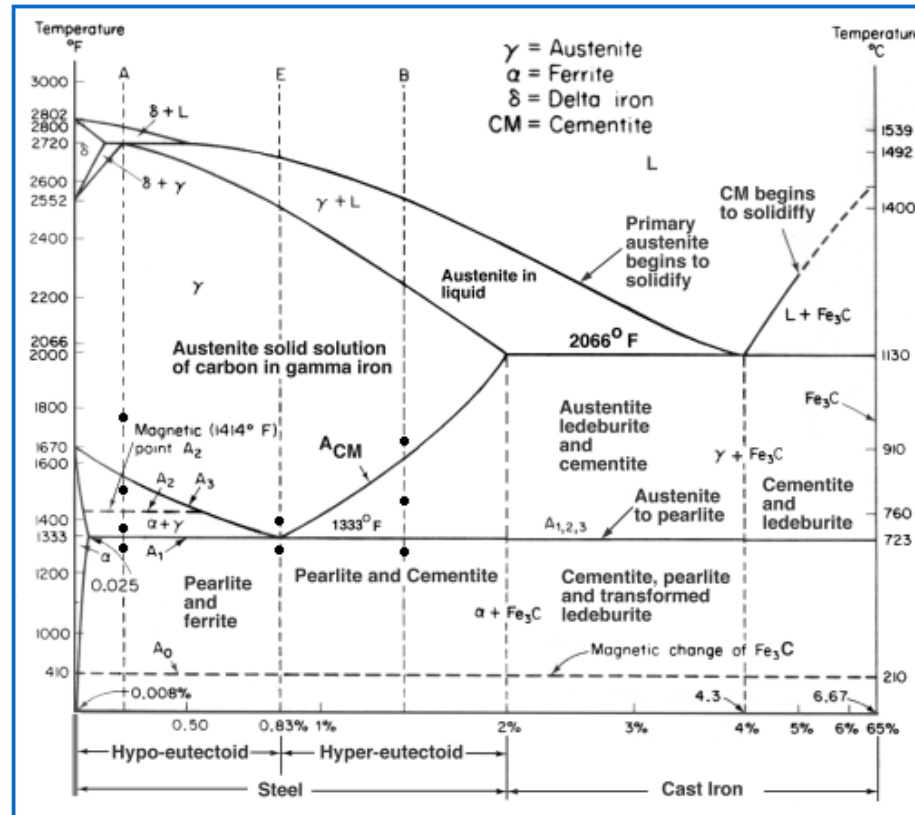
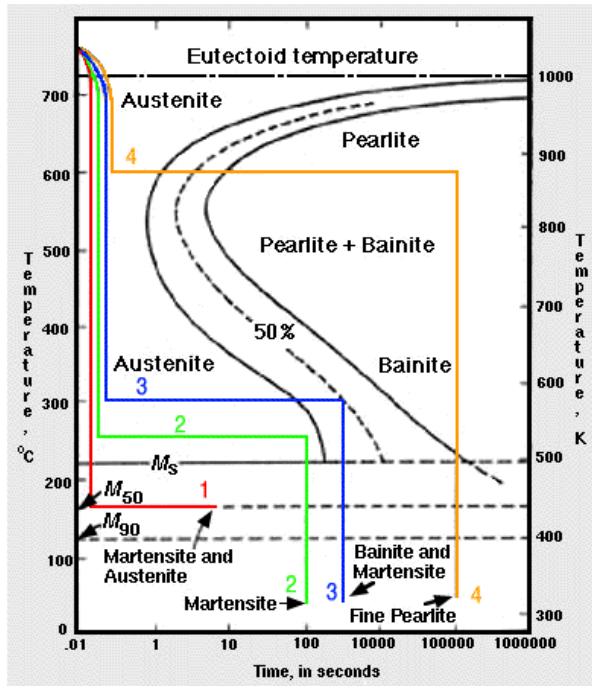


Fig 1: Fe-Fe₃C Phase Diagram (clickable), *Materials Science and Metallurgy*, 4th ed., Pollack, Prentice-Hall, 1988



In-Service Welding

Time Temperature Transformation Diagram

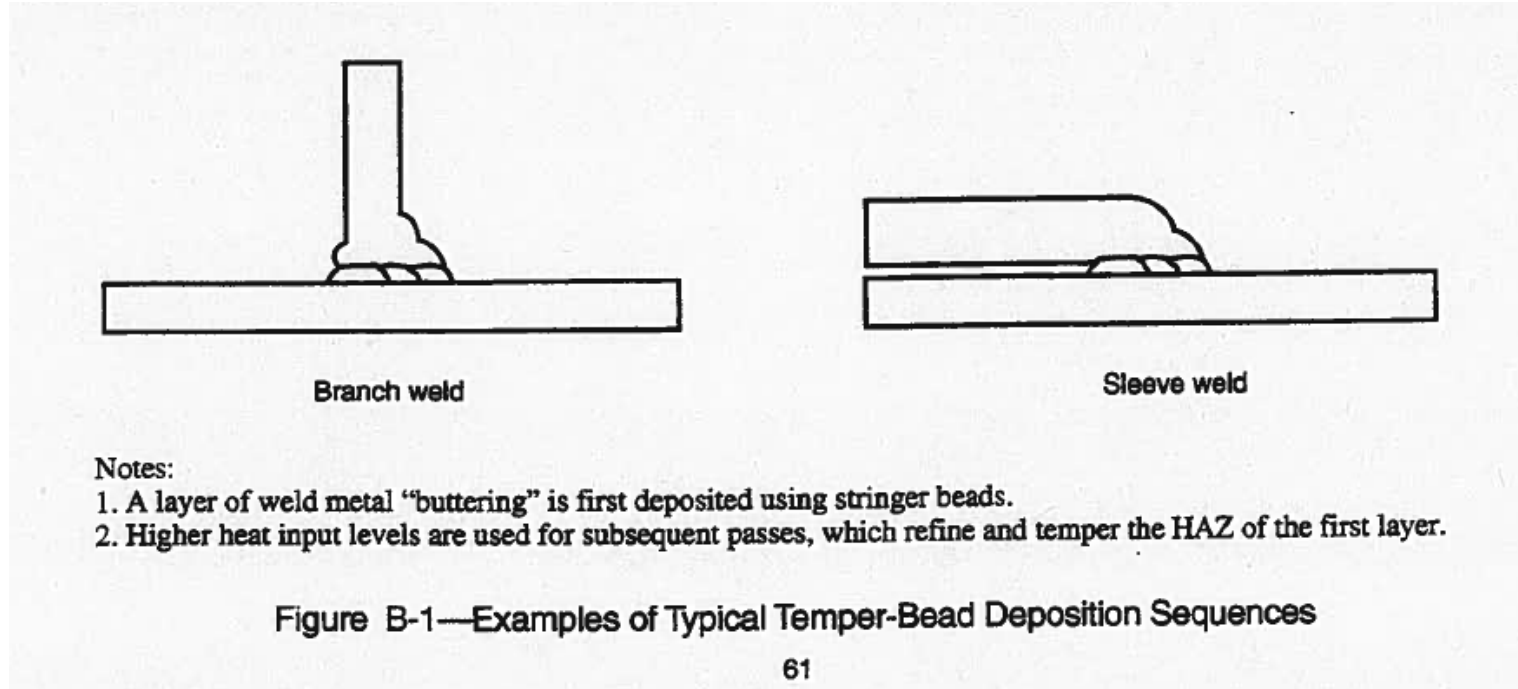


- (Red) The specimen is cooled rapidly to 433 K and left for 20 minutes. The cooling rate is too rapid for pearlite to form at higher temperatures; therefore, the steel remains in the austenitic phase until the M_s temperature is passed, where [martensite](#) begins to form. Since 433 K is the temperature at which half of the austenite transforms to martensite, the direct [quench](#) converts 50% of the structure to martensite. Holding at 433 K forms only a small quantity of additional martensite, so the structure can be assumed to be half martensite and half retained austenite.
- (Green) The specimen is held at 523 K for 100 seconds, which is not long enough to form bainite. Therefore, the second quench from 523 K to room temperature develops a martensitic structure.
- (Blue) An isothermal hold at 573 K for 500 seconds produces a half-bainite and half-austenite structure. Cooling quickly would result in a final structure of martensite and bainite.
- (Orange) Austenite converts completely to [fine pearlite](#) after eight seconds at 873 K. This phase is stable and will not be changed on holding for 100,000 seconds at 873 K. The final structure, when cooled, is fine pearlite.



In-Service Welding

Temper Bead / Pipe Buttering



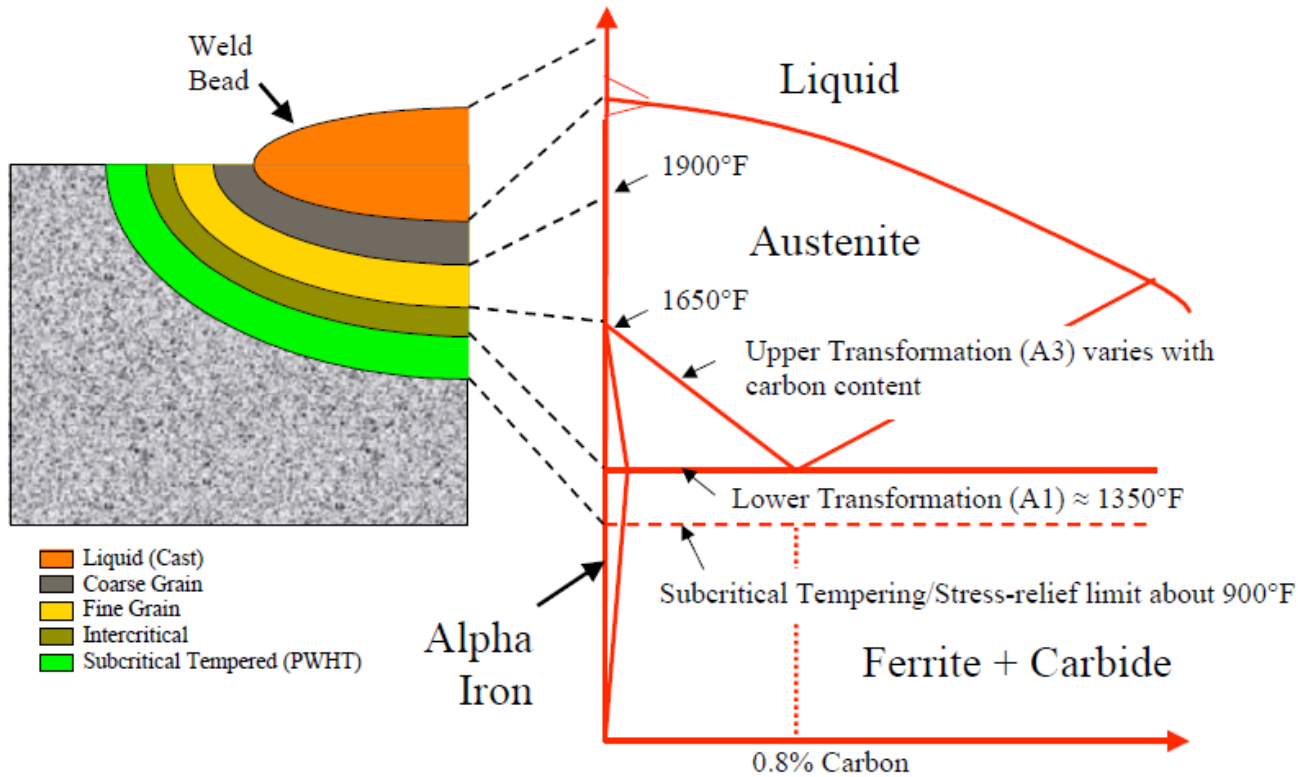


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Temper Bead / Pipe Buttering

Figure 1

Figure shows HAZ transition points for various parts of the HAZ as related to the iron-carbon equilibrium diagram.



By Walter J. Sperko



In-Service Welding

Flow / No Flow Conditions

Flow conditions can reduce the threat of burn through, but can adversely effect the weld properties.



In-Service Welding

Utility Applications

- High Pressure Water Lines
- High Pressure Gas Pipelines
- Other?



In-Service Welding

Questions?