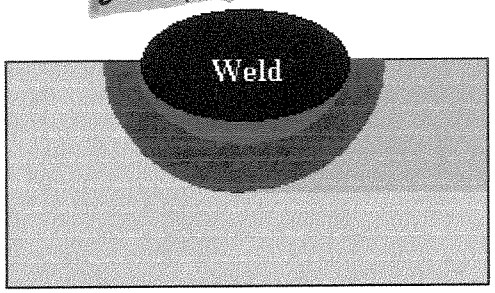
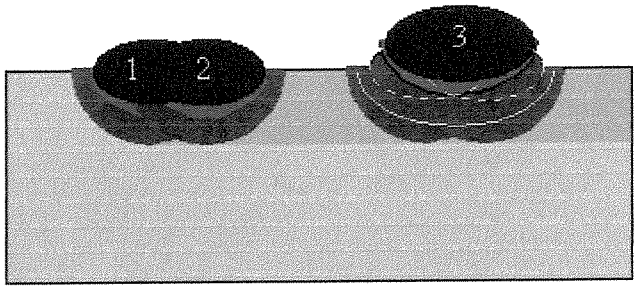
NTSB D039 90
D057 D060 D059



Consider a single run of weld on a plate. The parent metal directly under the weld has suffered grain coarsening, shown red. The parent metal below this area experiences grain refinement, shown blue.

Course grains are normally defined as greater than 50μm in size, grains less than this size are classed as fine. The grains can only be measured by sectioning the specimen and subjecting it to a metalographic examination



Therefore, to improve HAZ toughness we need a welding technique that either reduces or eliminates this course region from the parent metal.

Course grained structures in the weld metal will still reduce toughness, but not to the same extent as in the parent metal.

The first layer of weld should consist of small beads, deposited using low heat input to ensure minimum penetration into the parent metal. This can be achieved by using small electrodes, welding in the horizontal position, and adjusting the angle of the electrode or torch to minimise penetration. Great care must be taken to avoid hydrogen cracking and lack of fusion defects.

A 50/50 bead overlap will reduce the course grained area, but not necessarily remove it altogether.

Depositing a bigger weld bead on top of the smaller ones, such that its refined zone overlaps the coarse areas created by the original runs, is the preferred technique. Sometimes the first beads are ground down slightly to enable the refined zones of the next beads to line up correctly.

The final bead of any welding sequence should be deposited in the middle of the cap, away from the parent metal.

Unfortunately, whilst this may appear easy in theory, in practice it can be difficult to achieve. It requires the production of many test weld simulations and metallographic examinations, before sufficient confidence can be gained to perform the actual production weld. Therefore it's much easier to carry out PWHT; except for repairs carried out in situations where PWHT may be impractical.