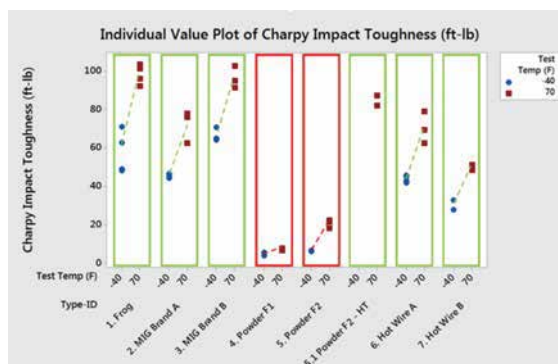


# Holland<sup>®</sup> HAMR<sup>™</sup>

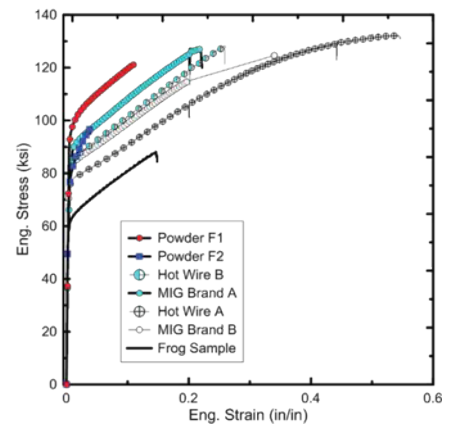
A NEW STANDARD FOR SAFER, LONGER LASTING REPAIRS

## Research and Testing

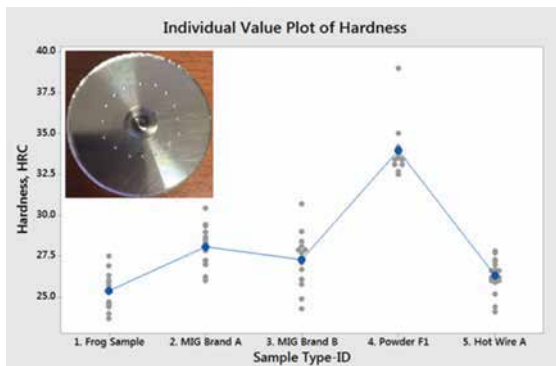
Holland, with support from Union Pacific and Evraz, performed comparative material tests to validate HAMR<sup>™</sup> Welding technology. Key tests chosen for evaluation were Charpy impact, tensile, disc-on-disc wear, hardness, work hardening and heat input. The HAMR<sup>™</sup> welding process produced equivalent characteristics to standard MIG welding manganese and base frog material. See AREMA paper presented at the Fall 2018 meeting. Figures below show some of these comparative results.



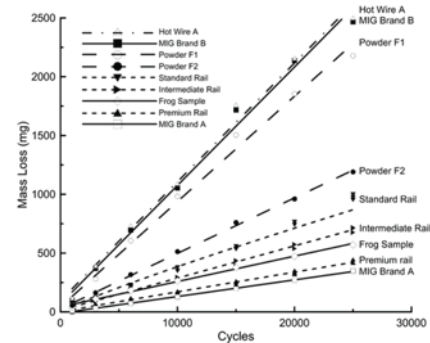
Charpy Impact – Hot Wire equivalent to MIG



Tensile Testing – Exceeds MIG welding performance



Initial Hardness – Equivalent to MIG and Base

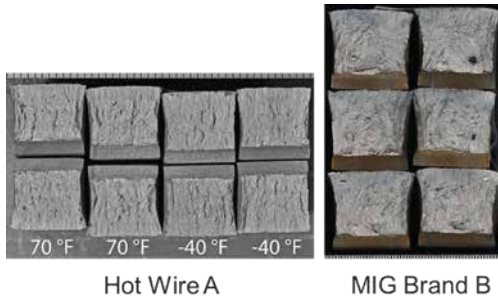


Wear test equivalent to MIG welding

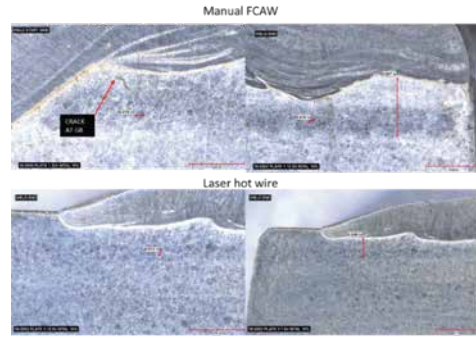
## Benefits

### Longer Life Repairs

HAMR<sup>™</sup> welding key benefits are lower heat input to base material allowing faster welding at the same time keeping base material below 500 degrees F. Robotically welded using hot wire technology produces significantly lower porosity with inter-pass layers. Both are key characteristics providing a longer life to the repair. See cross-sectional view of material build up.



HAMR™ shows significantly less porosity



Lower heat input is clear from grain growth and no microcracking

### Faster Repairs and Full Refurbishments

Field experience has demonstrated the ability to weld three times faster. Lower heat input along with the ability to weld very long passes with gas shielding, with no slag removal required, provides for significant repairs in significantly shorter times. Holland experience has shown consistent ability to lay 10 – 15 pounds of material in 4 – 5 hours, including post weld grinding. This would take 2 – 3 days for manual welding. The largest one day refurbishment was 18 pounds of material in under 6 hours.

## HOLLAND AUTOMATED MANGANESE REFURBISHMENT™

HAMR™ design provides the ability to weld on and beside track, as well as in yard settings. Full refurb service includes Holland HAMR™ weld warranty.



### Production Reporting

Holland produces a daily production report that includes GPS and other location detail, frog or diamond type and serial number or other designation, amount of material for each repair, length and depth of the repair. Sample production reports available upon request.

### Experience

In the first months of production, HAMR™ has operated in temperatures as low as 37 degrees and as high as 95 degrees. HAMR™ has completed over 115 refurbishments, with most taking less than ten hours per frog to complete with an average of nearly 20 pounds per day.