SAND2016-8076PE

Used Fuel Disposition Campaign

Update on Residual Stress Measurements from the SNL Mockup Container

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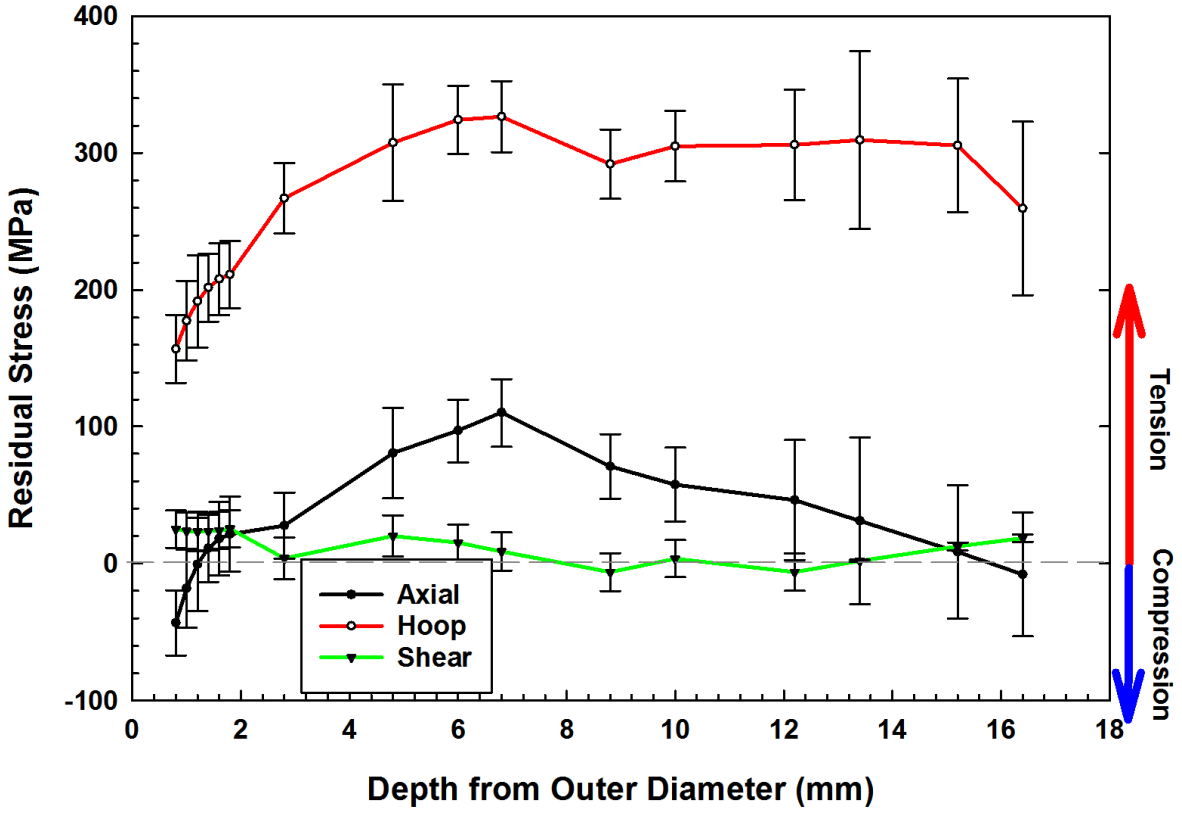
WRS Data from the Mockup

- **Sandia report for mockup stress measurements is delayed, awaiting final data processing by Veqter. Draft report issued June 30, 2016; final report within a month(?).**
- **Previous presentation by D. Enos showed deep-hole drilling results, reviewed here as a reminder**
  - High through-wall tensile stresses at weld centerlines and in HAZ for all welds.
  - Highest tensile stresses near simulated weld repairs.
- **Preliminary data from contour mapping is provided here.**
  - Tensile stress zones around welds vary with the weld type, but generally extend 3-4 cm from the weld centerline.
  - Slightly narrower for the longitudinal weld than for the circumferential weld.

Residual Stresses in Circumferential Weld (Centerline)

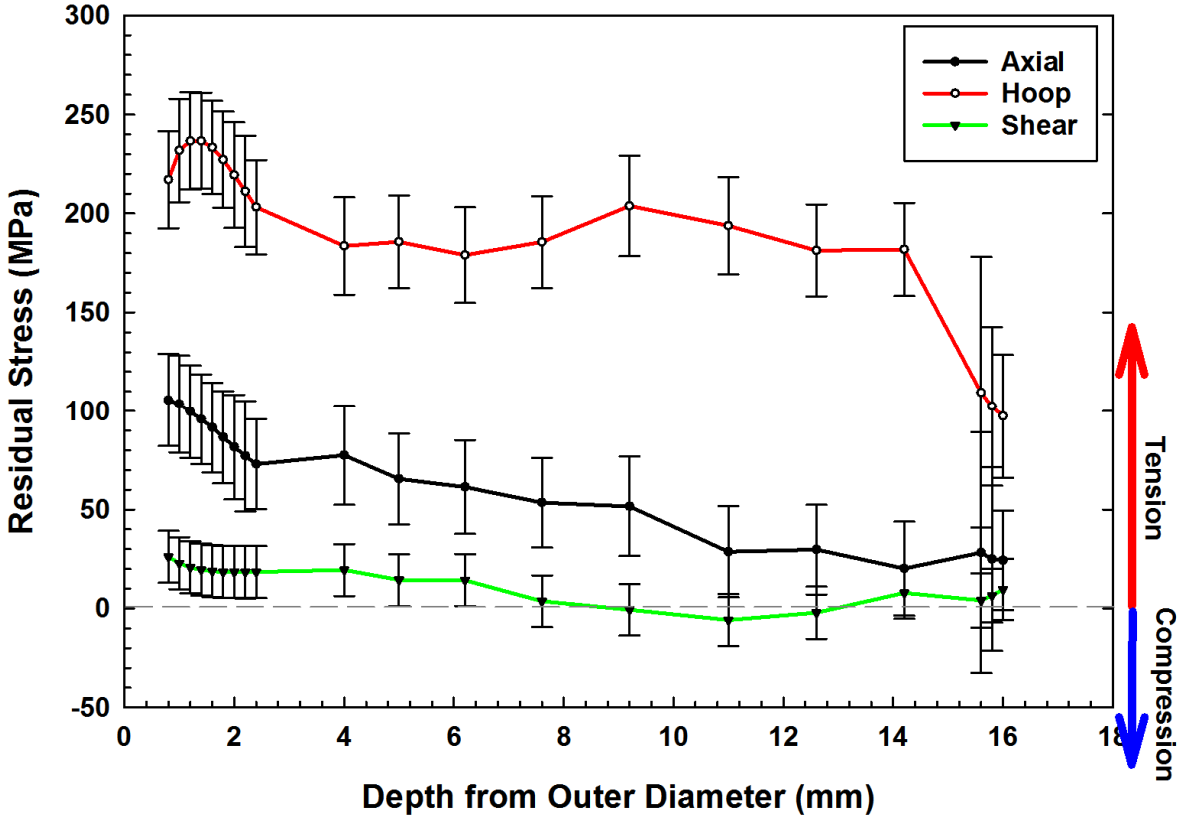
- Due to large stresses present in weld, material will yield as the core is cut for traditional DHD – as a result, incremental DHD measurements are made



- DHD near surface, iDHD in bulk
- Hoop stress strongly tensile through wall
- Axial stress compressive at surfaces, tensile through bulk
- Single measurement location

Residual Stresses in Circumferential Weld (HAZ)

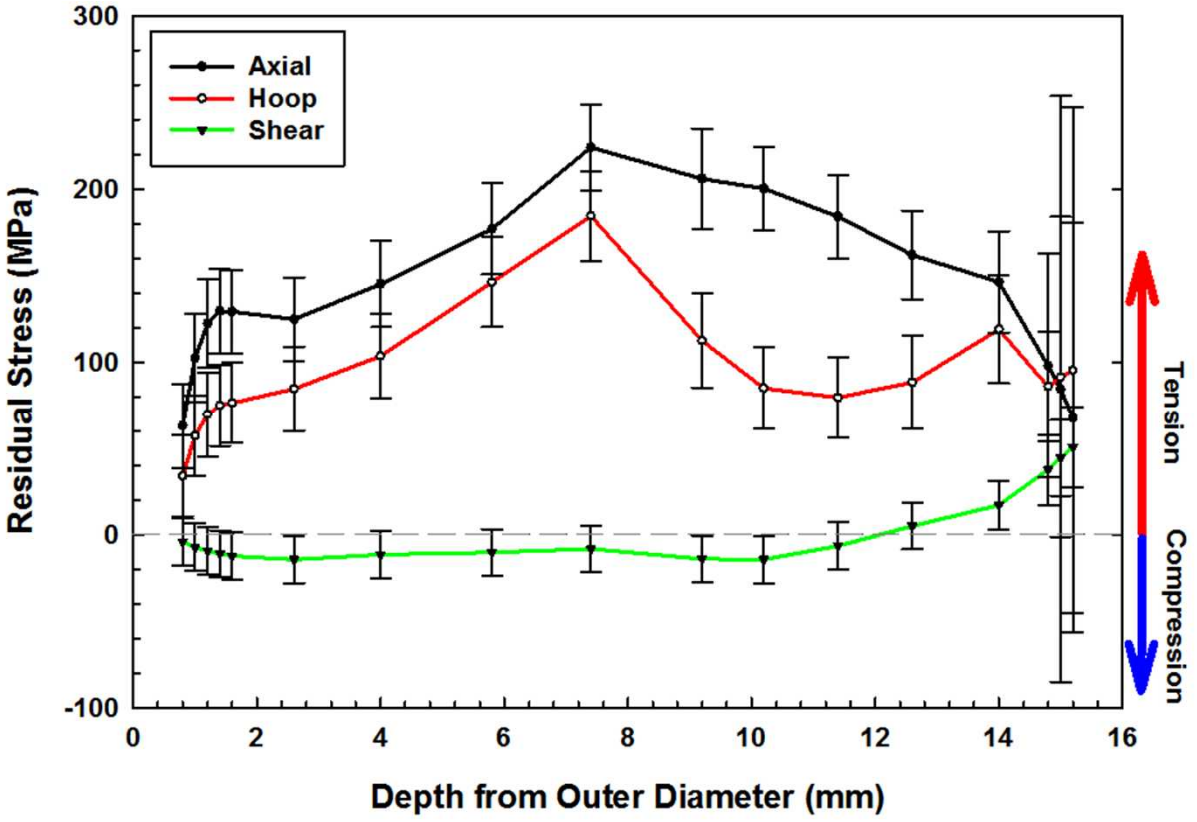
- Due to large stresses present in weld, material will yield as the core is cut for traditional DHD – as a result, incremental DHD measurements are made



- DHD near surface, iDHD in bulk
- Hoop stress strongly tensile through wall
- Axial stress lower in magnitude, but tensile through thickness
- Single measurement location

Residual Stresses in Longitudinal Weld (HAZ)

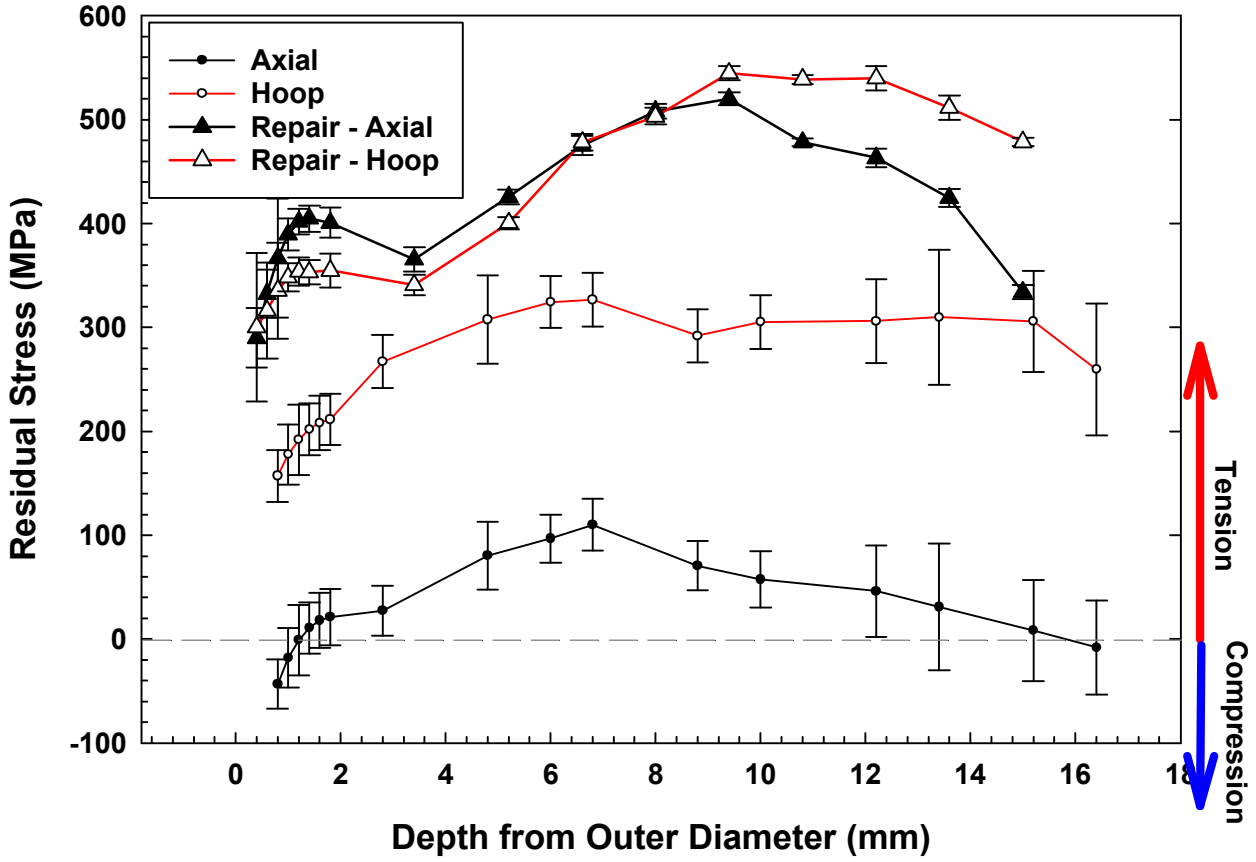
- Due to large stresses present in weld, material will yield as the core is cut for traditional DHD – as a result, incremental DHD measurements are made



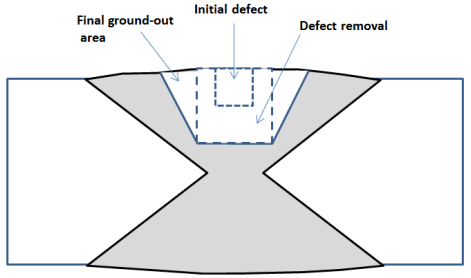
- DHD near surface, iDHD in bulk
- Axial stress strongly tensile through wall
- Hoop stress lower in magnitude, but tensile through thickness
- Single measurement location

Residual Stresses in Repair: Circumferential Weld (Centerline)

- Dramatic increase in magnitude of stresses, particularly in the axial direction, when a repair is made

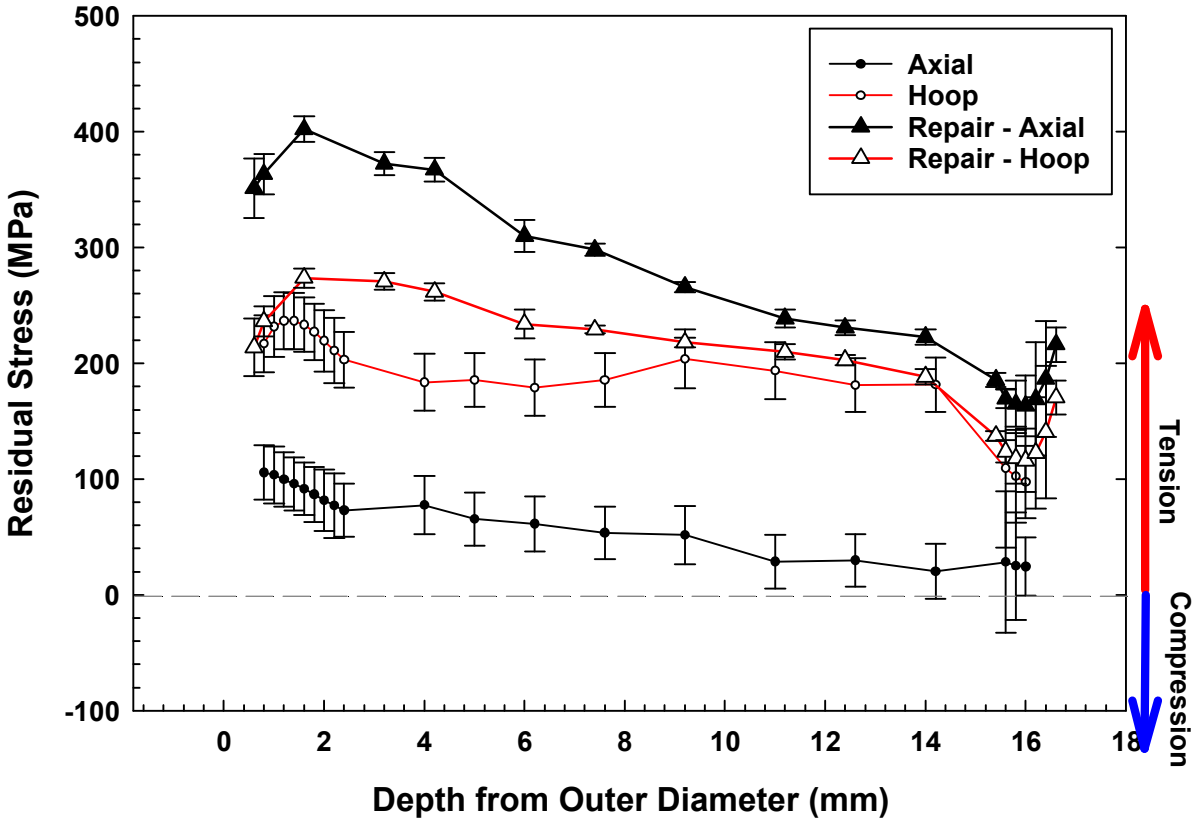


- *DHD near surface, iDHD in bulk*
- *Both axial and hoop stresses dramatically increased in weld repair*

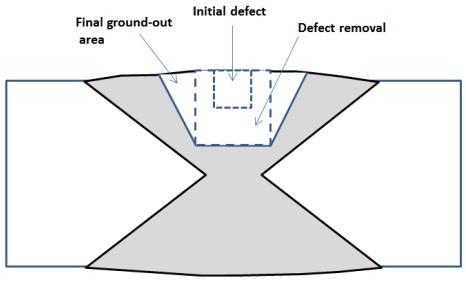


Residual Stresses in Repair: Circumferential Weld (HAZ)

- **Dramatic increase in magnitude of stresses, particularly in the axial direction, when a repair is made**

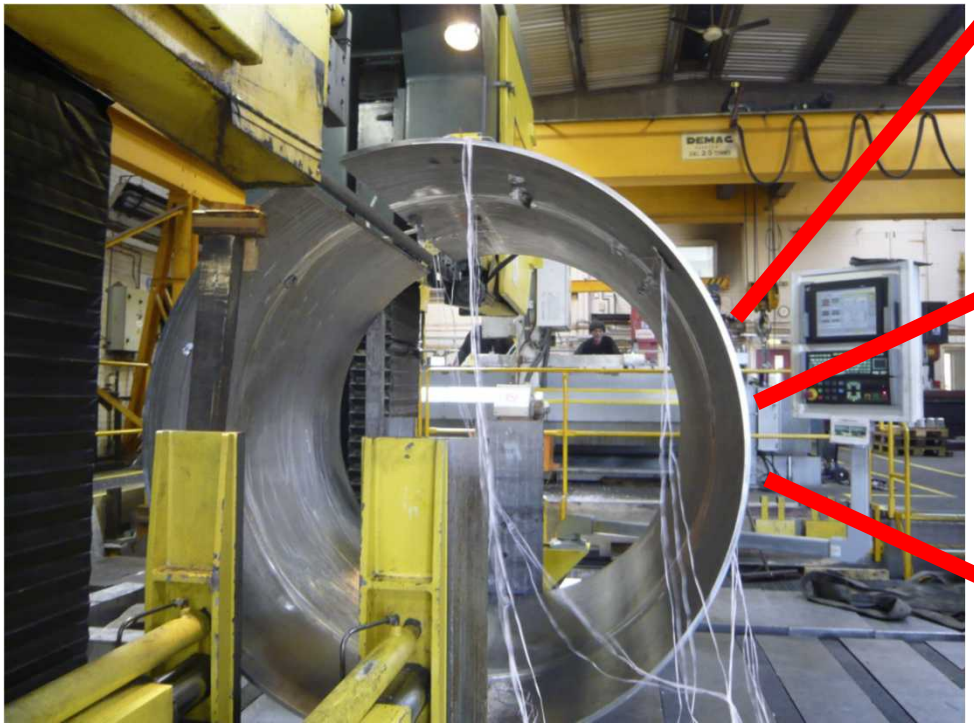


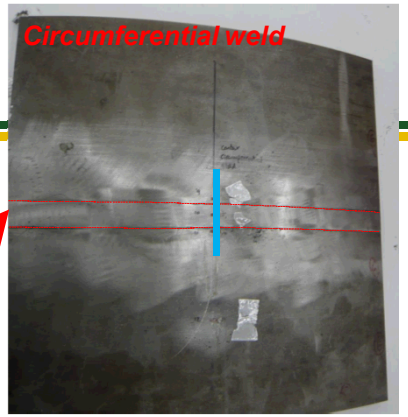
- *4mm from weld toe*
- *DHD near surface, iDHD in bulk*
- *Hoop stress increased in region of weld repair*
- *Axial stress dramatically increased in weld repair*
- *Less significant increase in hoop stress at ID, but axial stress is elevated*

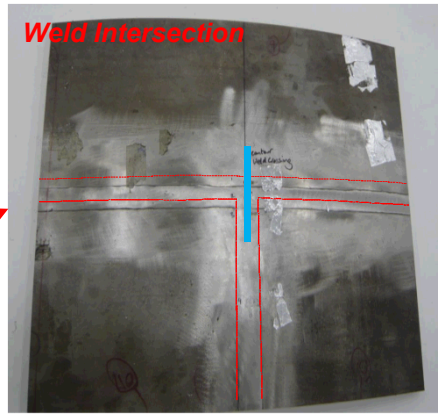


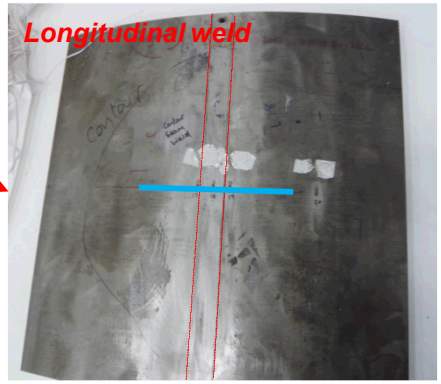
Contour Measurement Locations

- **Mockup sectioned for contour measurements.**
  - Provide map of residual stresses
  - EDM cutting complete, Measurement in progress









Used Fuel Disposition

Contour Maps, Circumferential and Longitudinal Welds

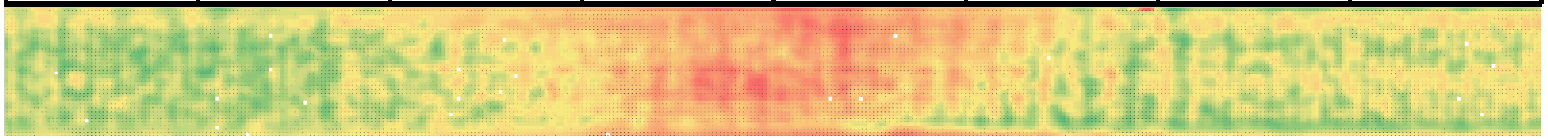
Tensile stresses perpendicular to the cut surface.

Results match measured DHD stresses well. Maximum stresses at weld centerline over 400 MPa

Circumferential weld

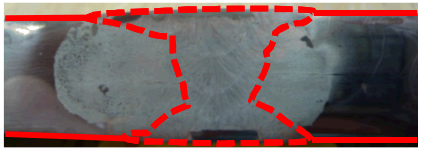
Approximate distance from weld centerline, mm

100 75 50 25 0 25 50 75 100



MPa
400
300
200
100
0
-100
-200
-300

Weld beads are ~25 mm wide

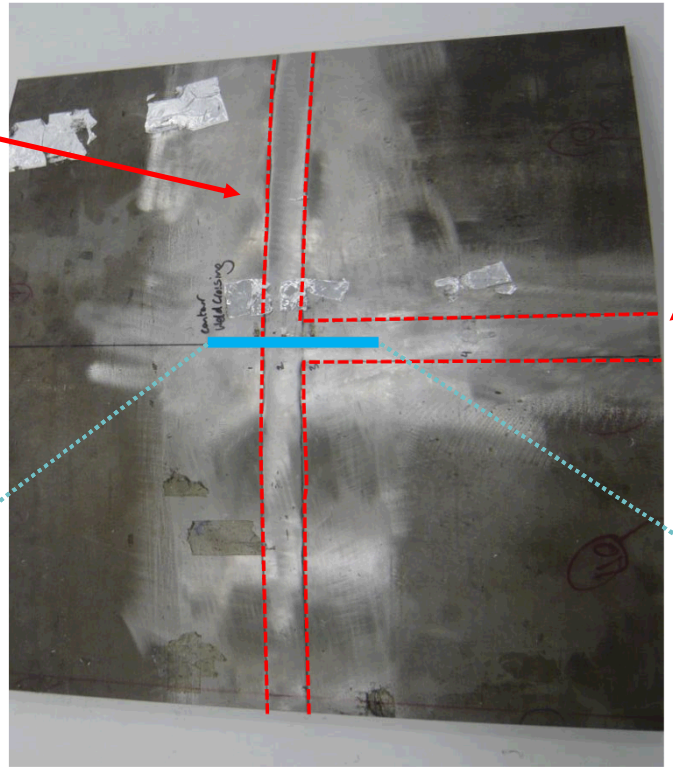


Longitudinal weld

Approximate distance from weld centerline, mm

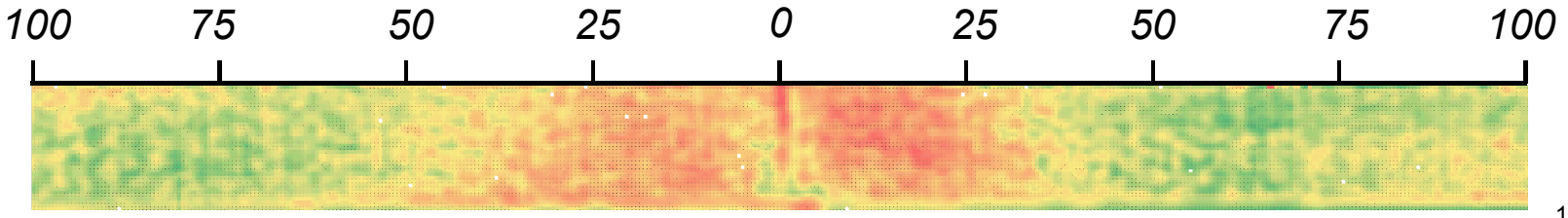
100 75 50 25 0 25 50 75 100

Contour Map, Weld Intersection



Maximum tensile stresses at weld centerline over 500 MPa

Approximate distance from weld intersection, mm



Conclusions

- Weld beads are ~2.5 cm wide.
- High tensile stresses extend on the order of 3-4 cm from the weld centerline, less than 2.5 cm (1 inch) from the weld edge.
- Some variation in width of high stress region with weld type—slightly narrower for the longitudinal weld than for the circumferential weld.
- The most susceptible zone for SCC will be a narrow region along the welds; inspection protocols should take this into account.