

# **Aluminum Lithium Alloy 2195 Fusion Welding Improvements with New Filler Wire**

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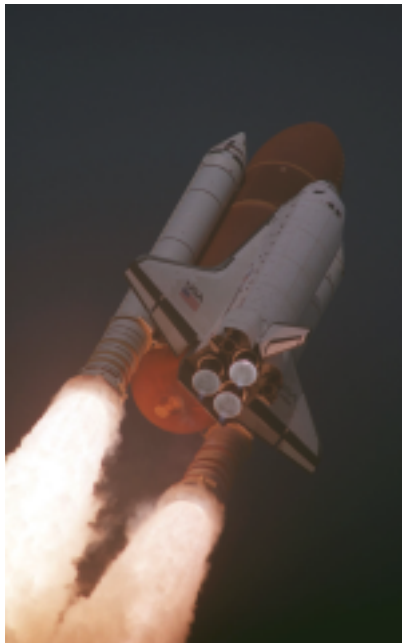


## **2195 Fusion Welding Improvements with New Filler Wire**

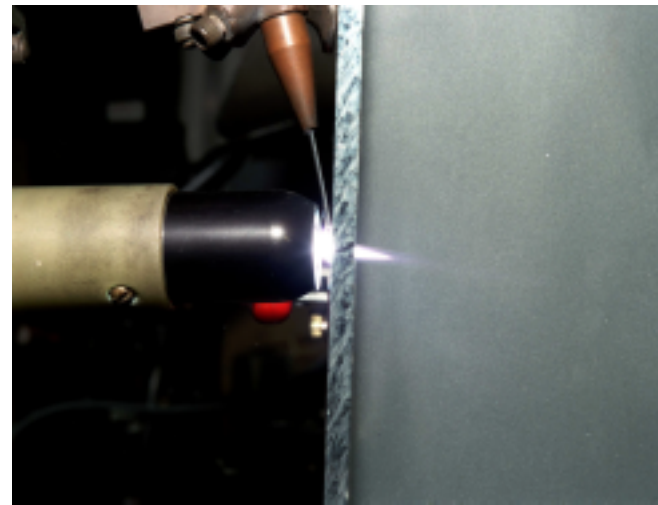
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### **Background**

- **Welding 2195 Aluminum Lithium for the Space Shuttle Super Lightweight External Tank**



**NASA Space Shuttle**

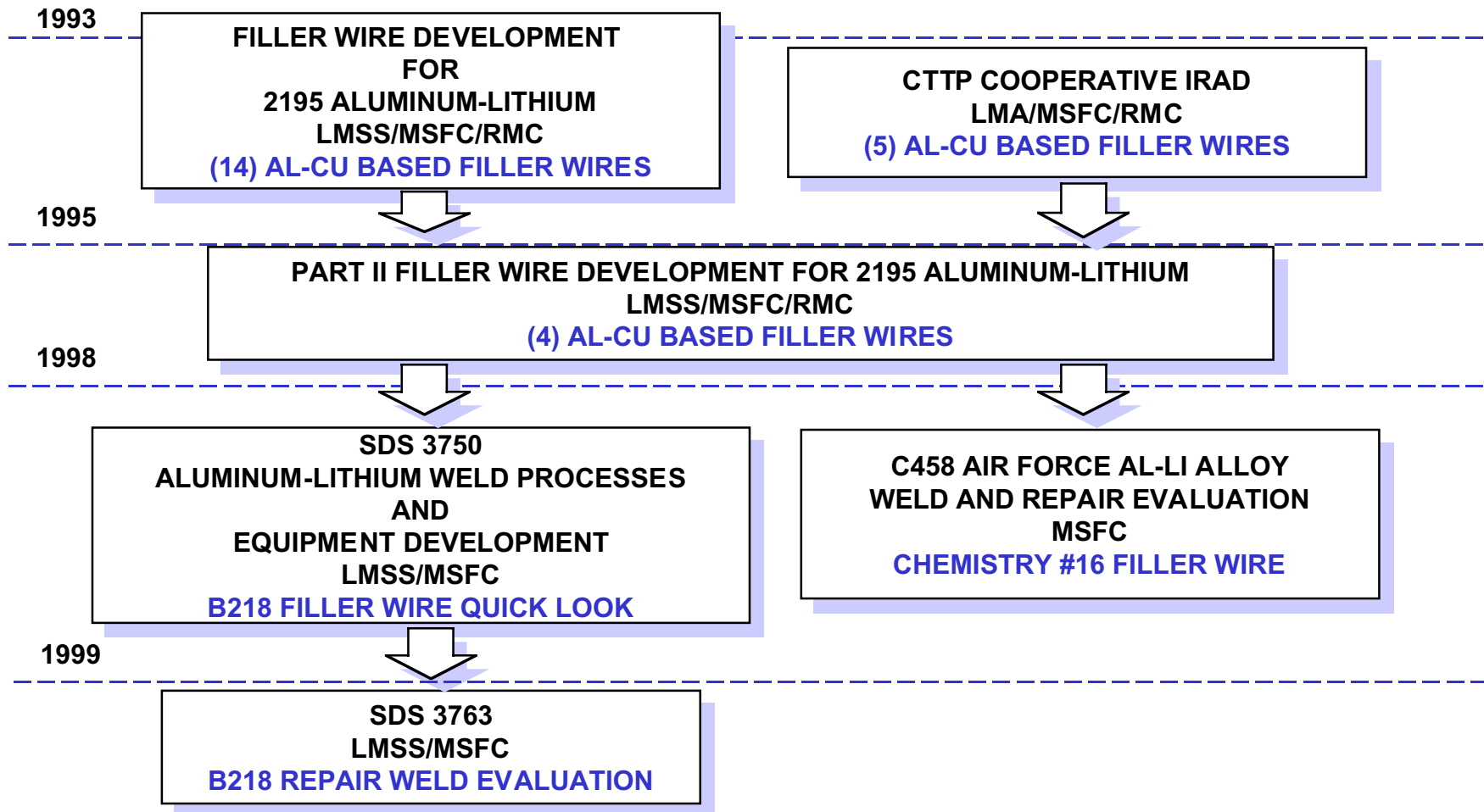


**Variable Polarity Plasma Arc Welding**



# 2195 Fusion Welding Improvements with New Filler Wire

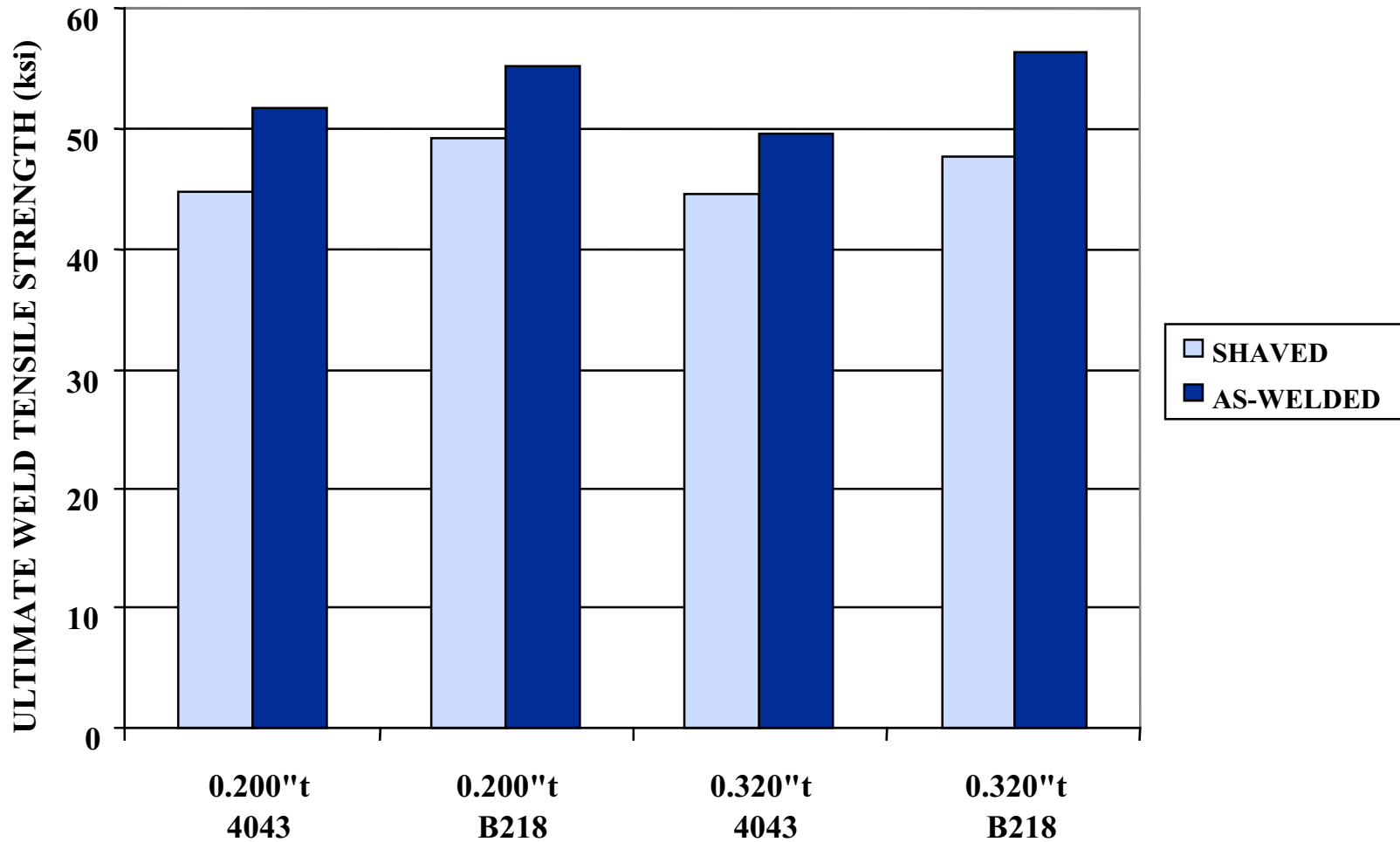
## Background





## 2195 Fusion Welding Improvements with New Filler Wire

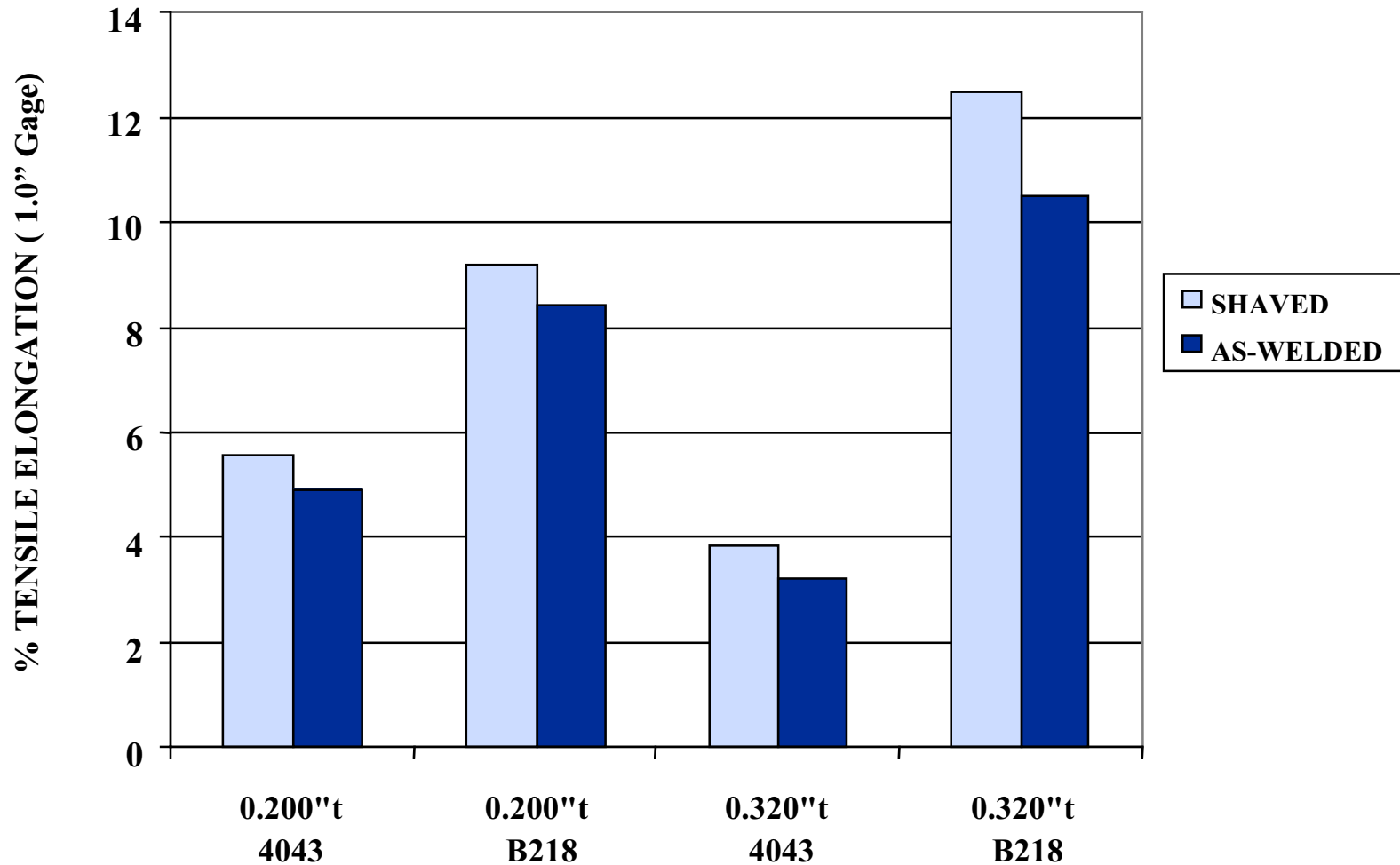
### 2195T8M4 VPPA Weld Ultimate Tensile Strength





## 2195 Fusion Welding Improvements with New Filler Wire

### 2195T8M4 VPPA Weld Tensile Elongation



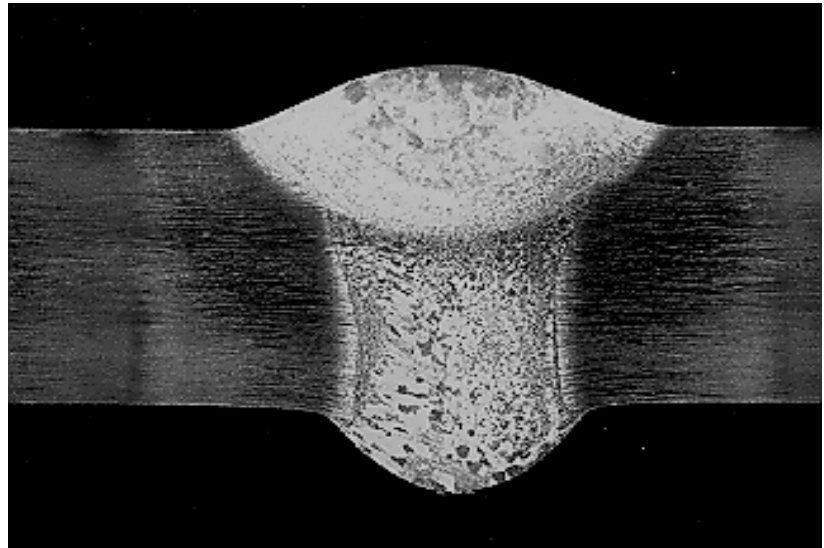


# 2195 Fusion Welding Improvements with New Filler Wire

## VPPA Weld Grain Structure Comparison

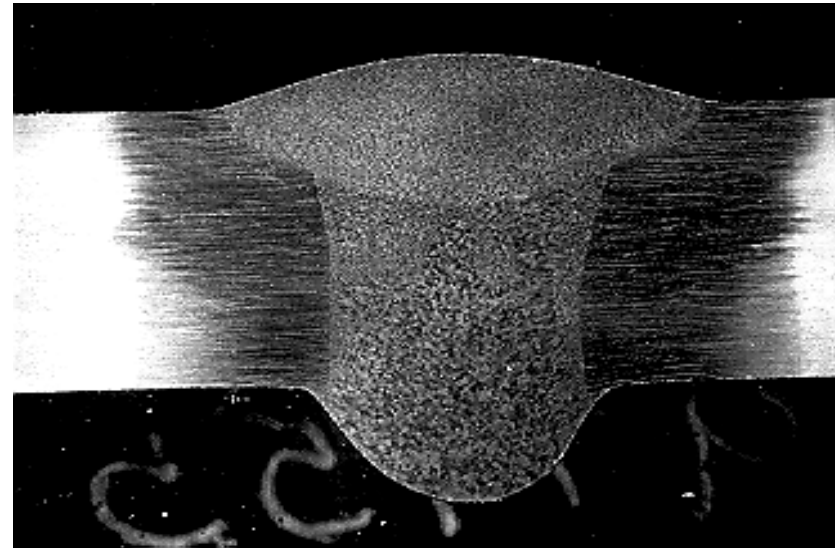
0.320t 2195 PLATE TO 2195 PLATE VPPAW

**4043 WELD FILLER WIRE**



**10X Original Magnification**

**B218 WELD FILLER WIRE**



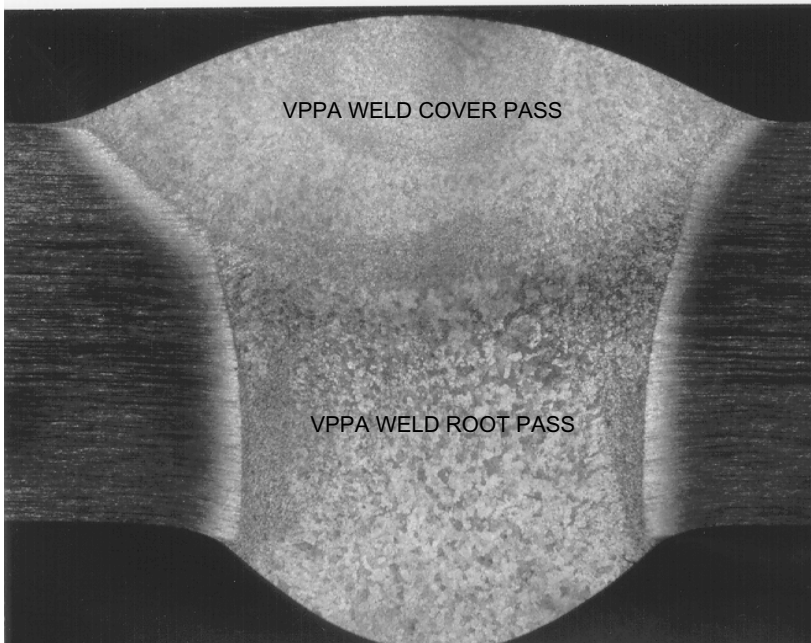
**10X Original Magnification**



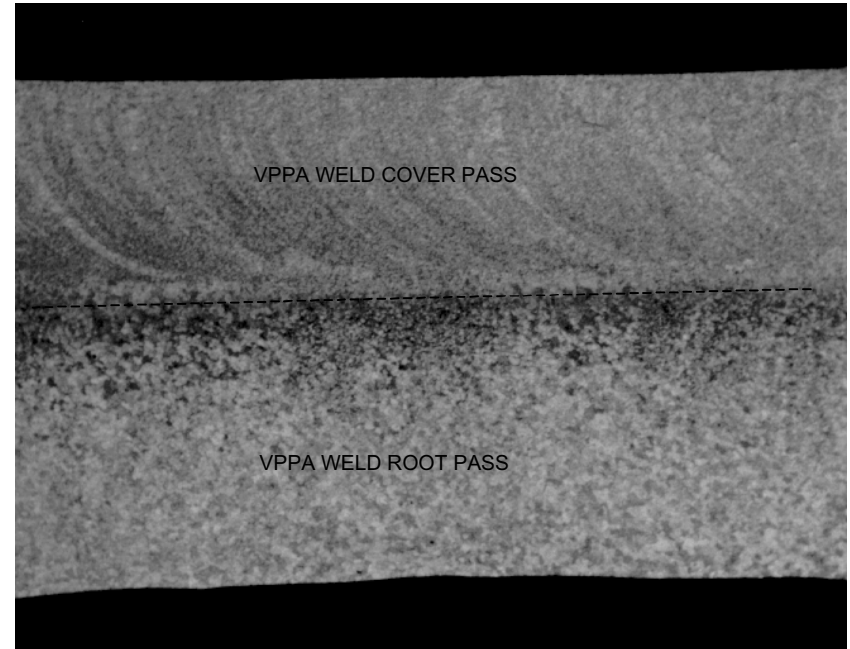
# 2195 Fusion Welding Improvements with New Filler Wire

## B218 VPPA Weld Grain Structure

0.200t 2195 PLATE TO 2195 PLATE VPPAW



10X Original Magnification



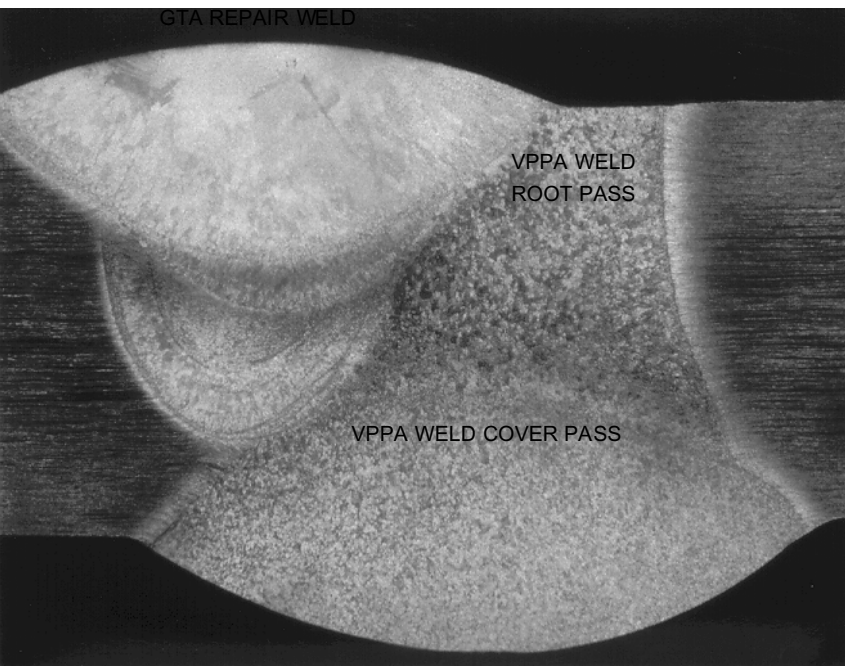
10X Original Magnification



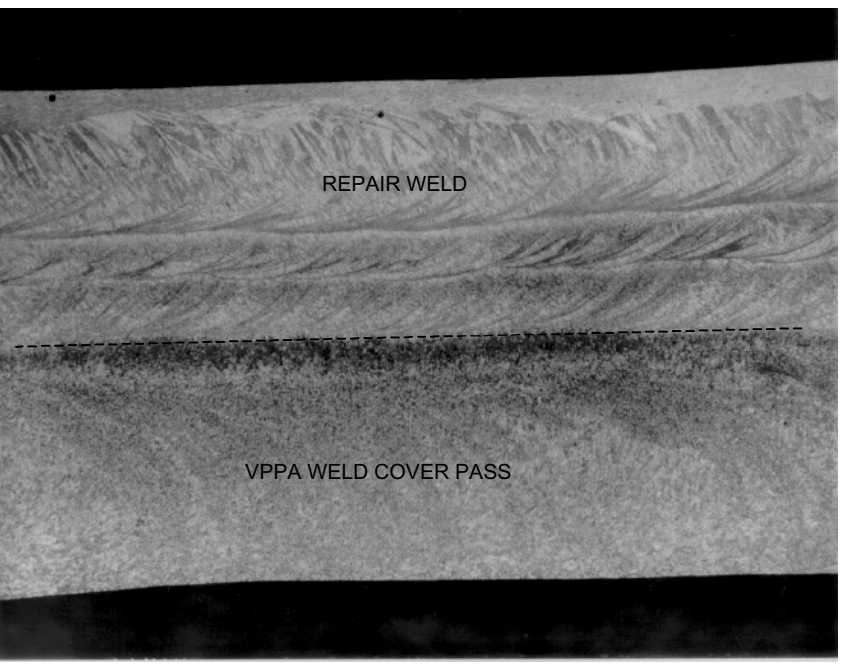
# 2195 Fusion Welding Improvements with New Filler Wire

## B218 GTA Repair Weld Grain Structure

### R1 GTA Repair 0.200t 2195 PLATE TO 2195 PLATE VPPAW



10X Original Magnification



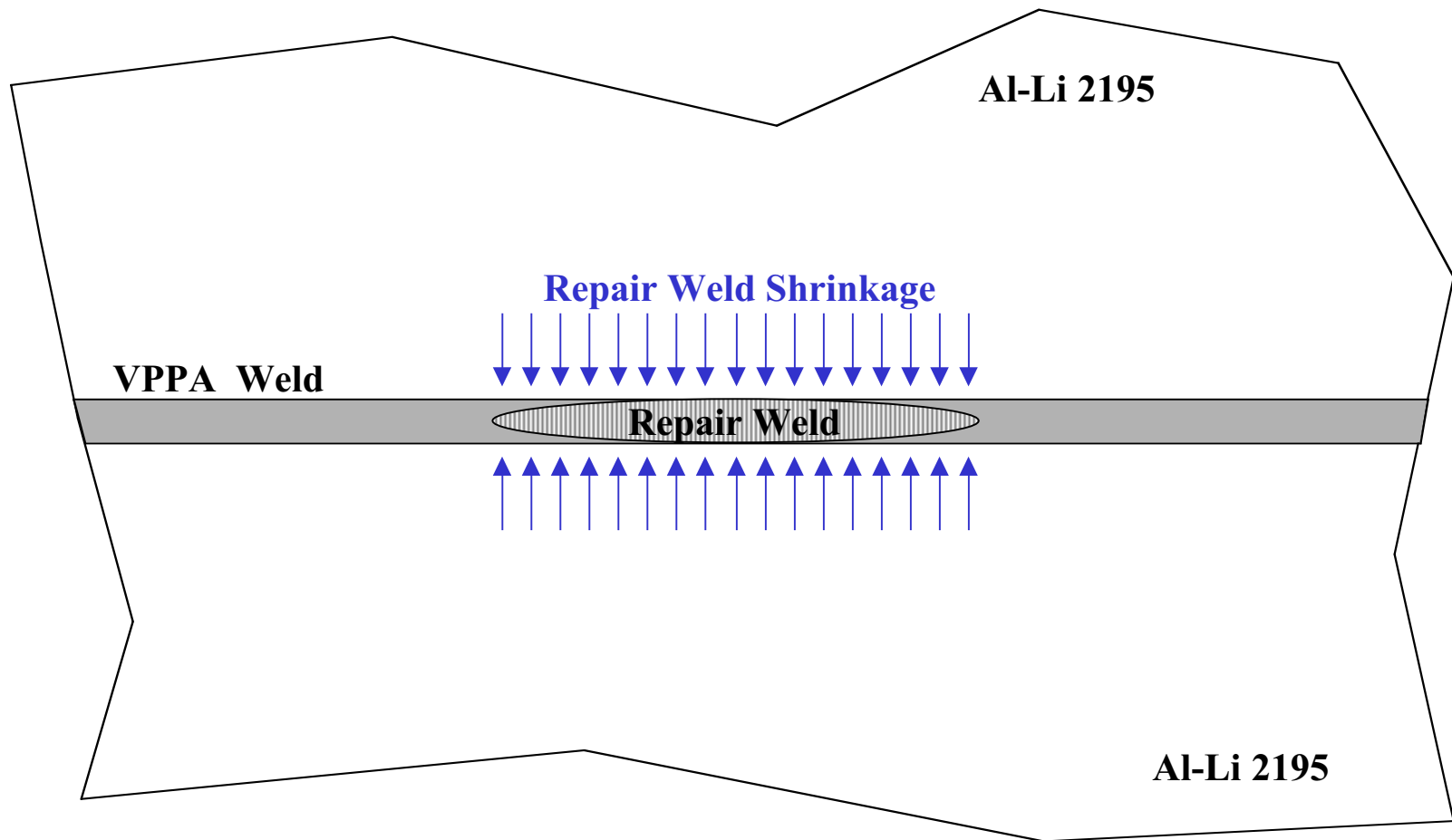
10X Original Magnification





## 2195 Fusion Welding Improvements with New Filler Wire

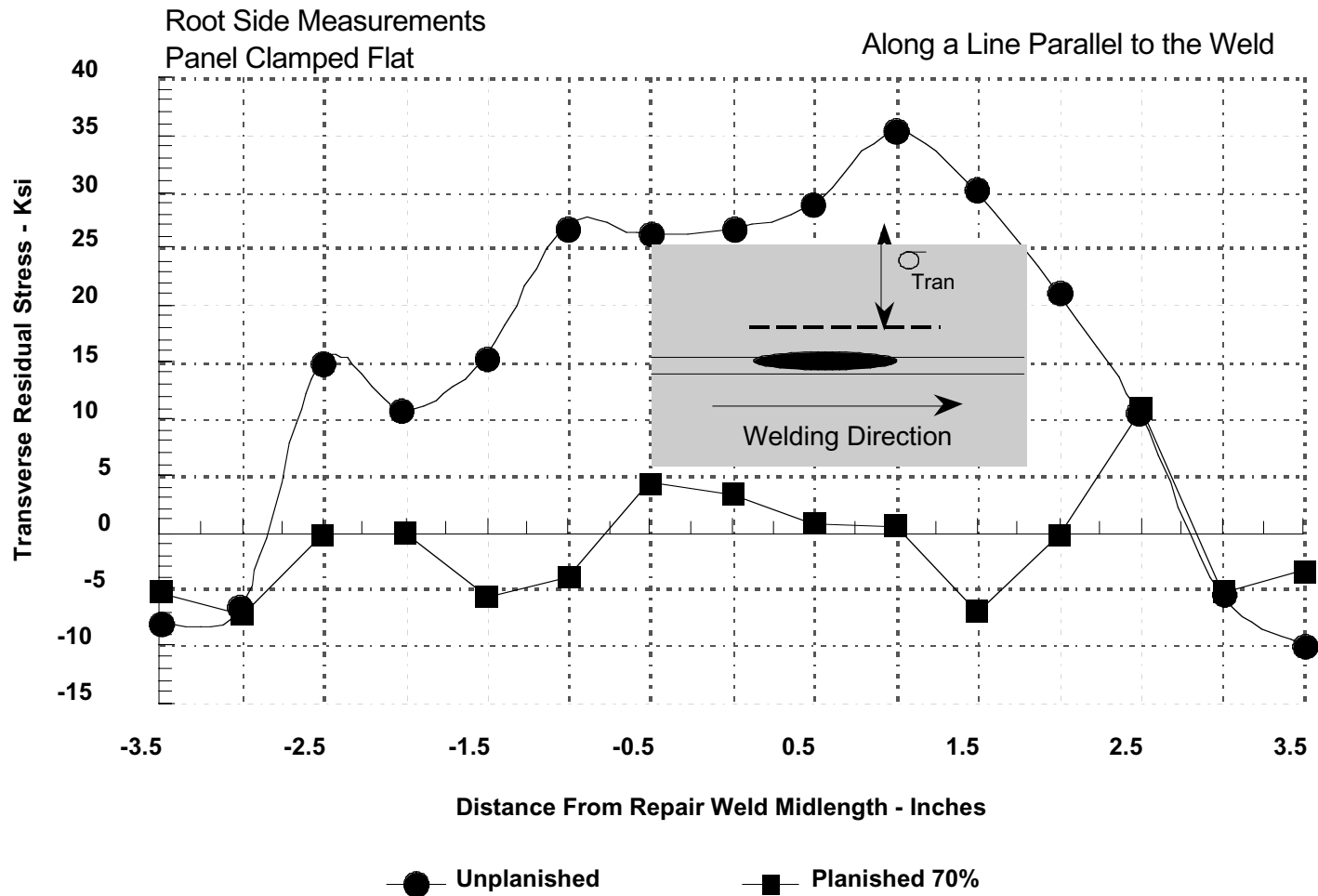
### 2195 Repair Weld Residual Stresses





# 2195 Fusion Welding Improvements with New Filler Wire

## 2195 Repair Weld Residual Stresses





## 2195 Fusion Welding Improvements with New Filler Wire

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### 2195 Repair Weld Residual Stresses

R5 GTA Repair 0.200t 2195 PLATE TO 2195 PLATE VPPAW

**Photostress of Unplanished Repair Weld**



**Photostress of Planished Repair Weld**





## **2195 Fusion Welding Improvements with New Filler Wire**

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### **Objective**

- **Assess B218 weld filler wire for Super Lightweight External Tank production, which could improve current production welding and repair productivity.**

### **Approach**

- **Perform a repair weld quick look evaluation between 4043/B218 and B218/B218 weld filler wire combinations. Evaluate tensile properties for planished and unplanished conditions.**
- **Perform repair weld evaluation on structural simulation panel using 4043/B218 and B218/B218 weld filler wire combinations. Evaluate tensile and simulated service fracture properties for planished and unplanished conditions.**



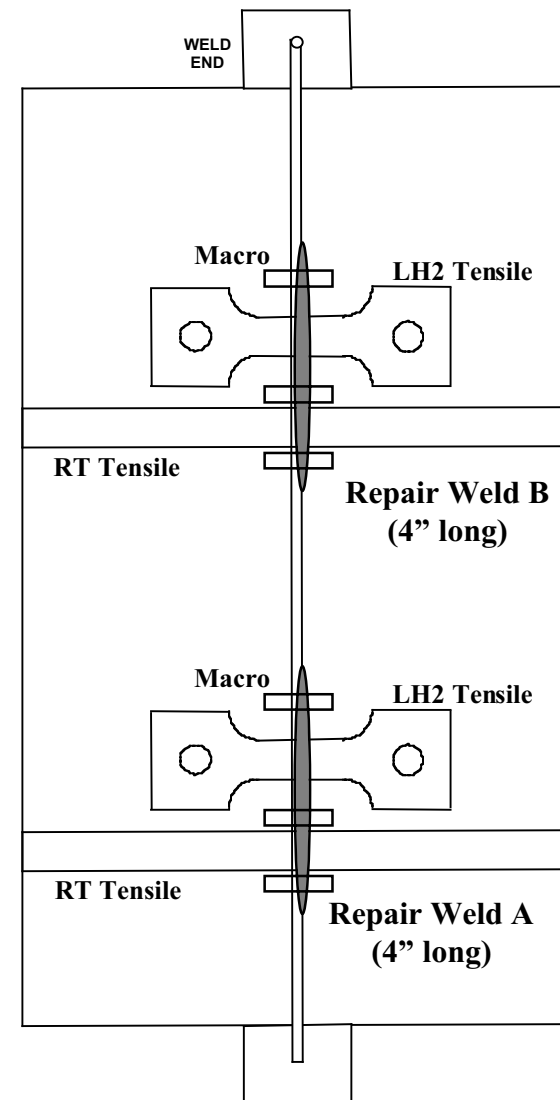
## 2195 Fusion Welding Improvements with New Filler Wire

### VPPA/GTA Repair Weld Quick Look

- 14" X 24" Standard Repair Weld Panel



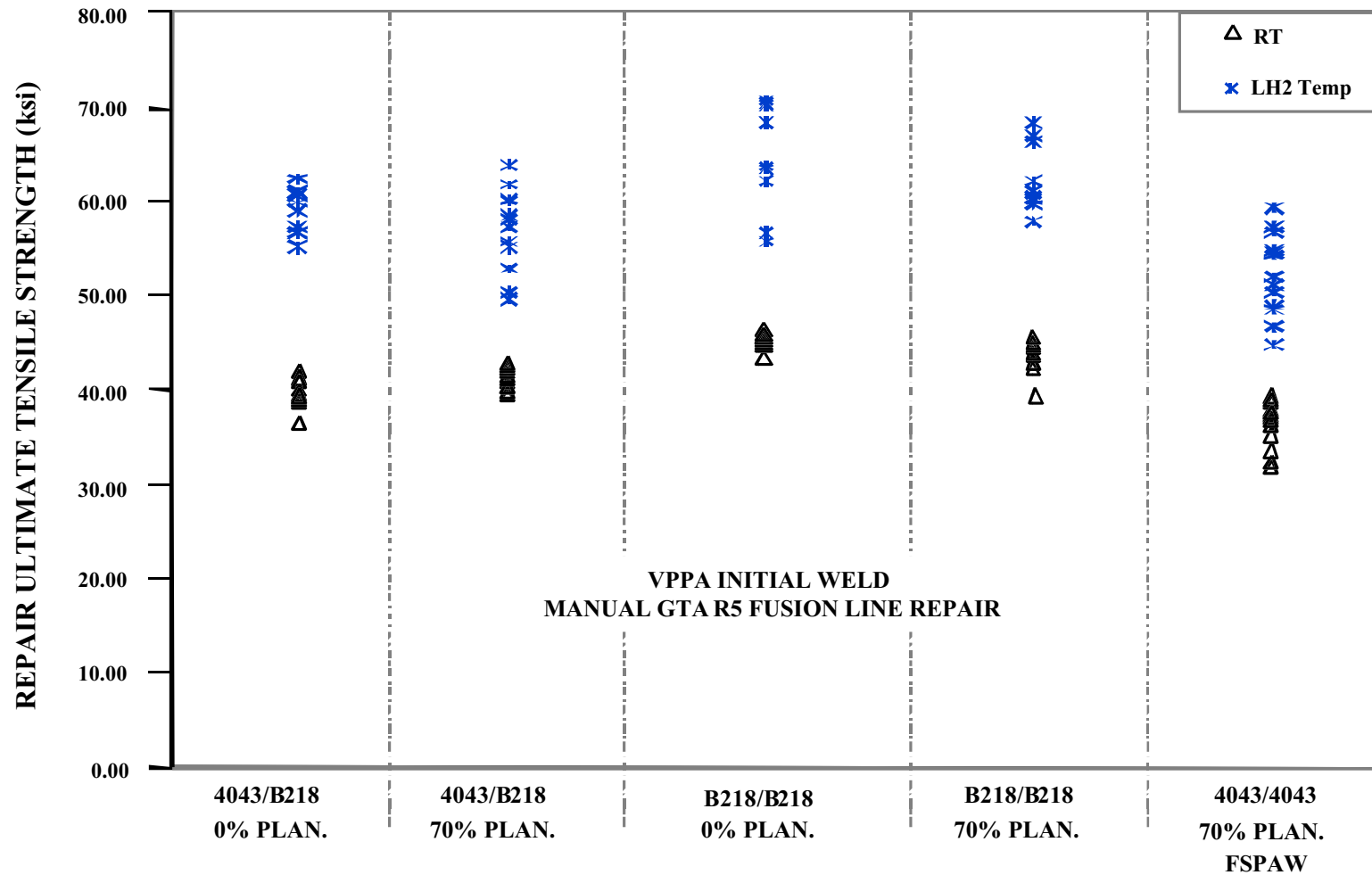
Manual GTA Repair Welding





## 2195 Fusion Welding Improvements with New Filler Wire

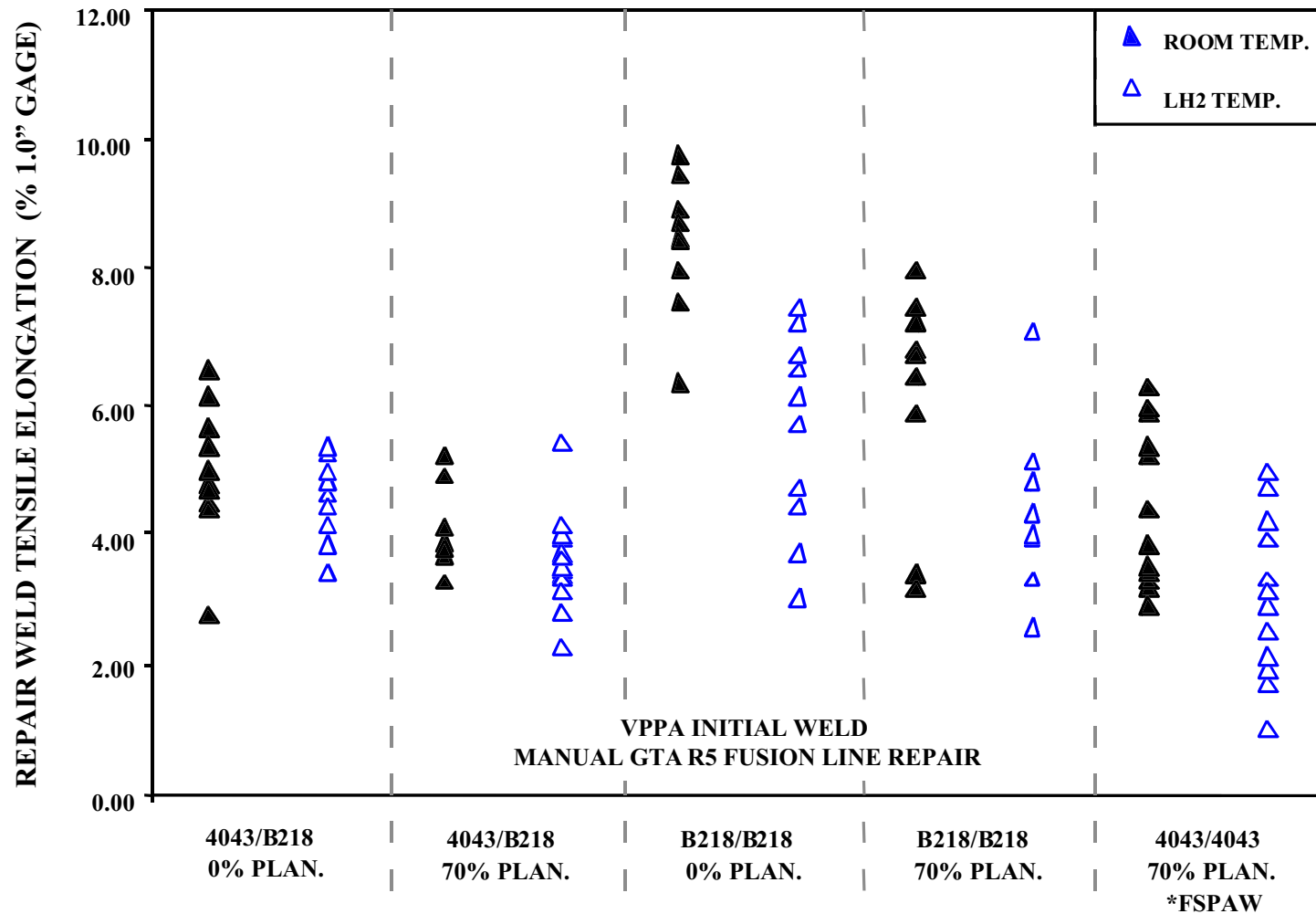
### 0.200"t 2195T8M4 Repair Weld Ultimate Tensile Strength -Coupon Level





## 2195 Fusion Welding Improvements with New Filler Wire

### 0.200"t 2195T8M4 Repair Weld Ultimate Tensile Elongation - Coupon Level



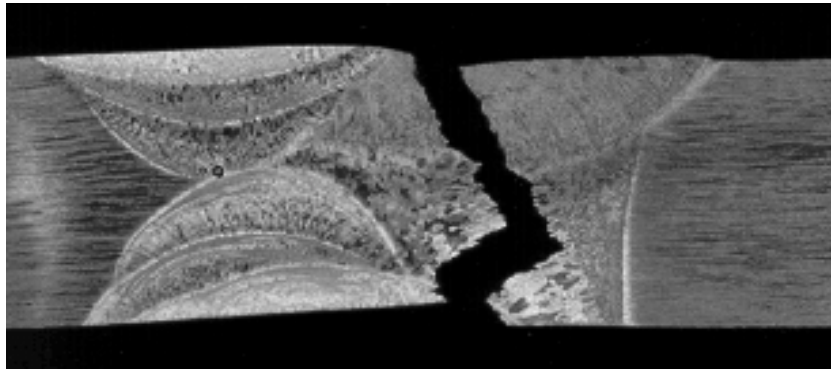


## 2195 Fusion Welding Improvements with New Filler Wire

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### 0.200t 2195T8M4 VPPA/ GTA Repair Weld Metallography

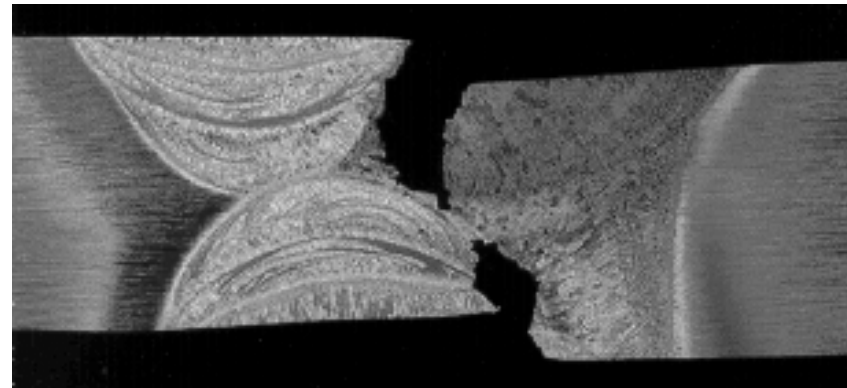
- 4043/B218 0% Planished



7X Original Magnification

**C008-RT02**  
**RT Tensile Test**  
**36.2 ksi / 2.74%El. 1" gage**

**C009-CT01**  
**LH2 Temp. Tensile Test**  
**62.5 ksi / 3.4%El. 1" gage**



7X Original Magnification



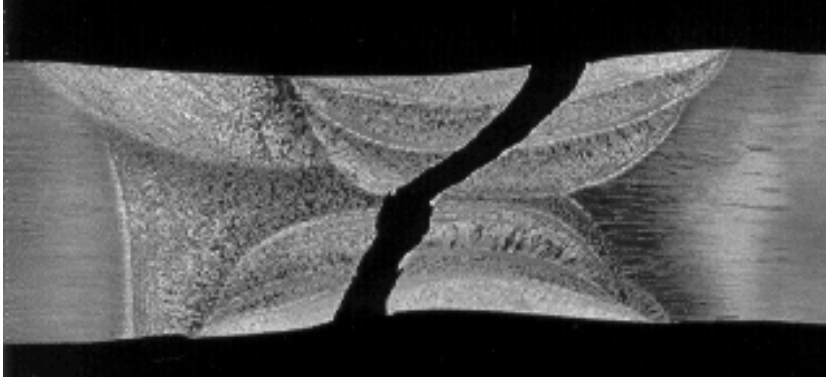


## 2195 Fusion Welding Improvements with New Filler Wire

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### 0.200t 2195T8M4 VPPA/ GTA Repair Weld Metallography

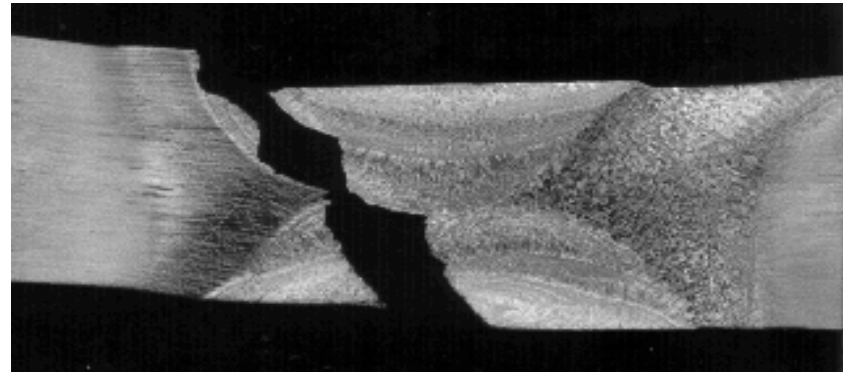
- B218/B218 0% Planished



7X Original Magnification

**C080-RT01**  
**RT Tensile Test**  
**45.2 ksi / 9.75%El. 1" gage**

**C080-CT01**  
**LH2 Temp. Tensile Test**  
**68.1 ksi / 7.40%El. 1" gage**



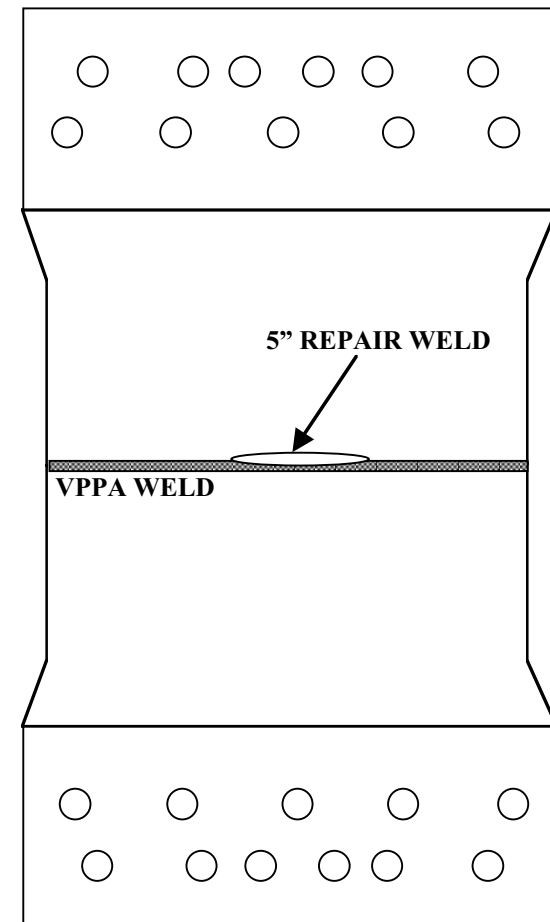
7X Original Magnification



## 2195 Fusion Welding Improvements with New Filler Wire

### VPPA/ GTA Repair Weld Structural Simulation Panel Evaluation

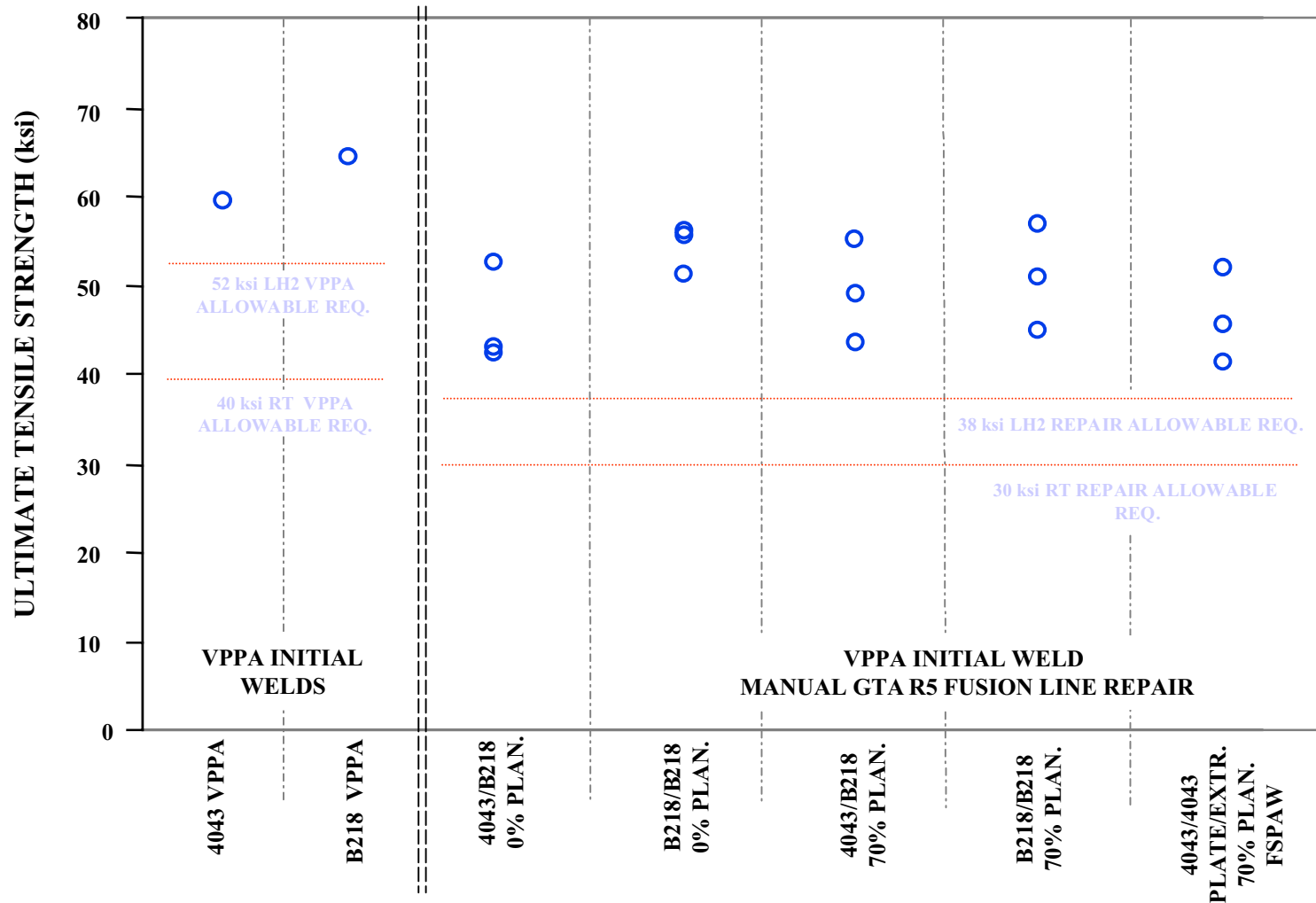
- 19" X 48" Repair Weld Wide Panel





# 2195 Fusion Welding Improvements with New Filler Wire

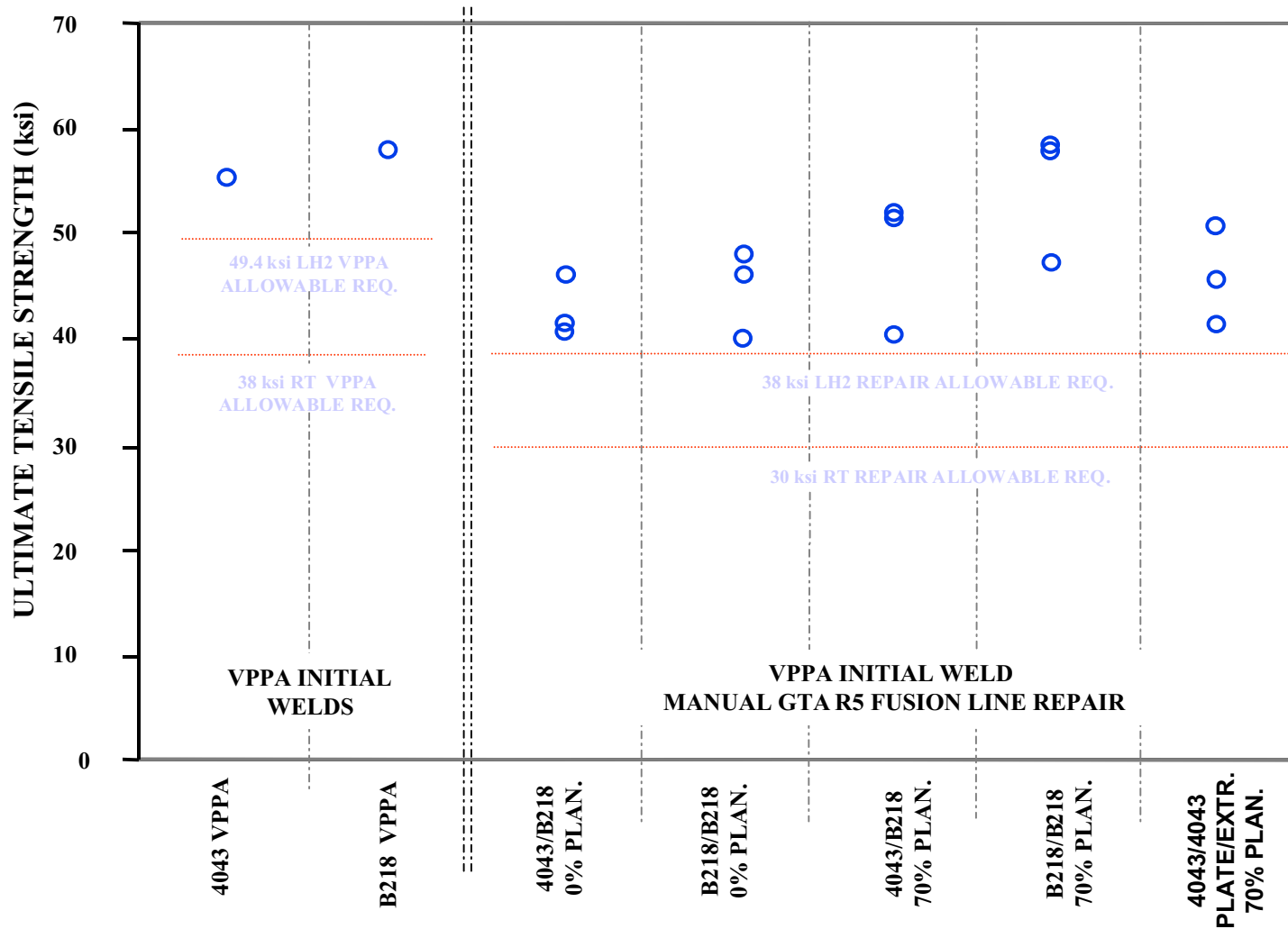
## 0.200t 2195T8M4 Structural Simulation Panel Weld Tensile Strength (-423°F)





## 2195 Fusion Welding Improvements with New Filler Wire

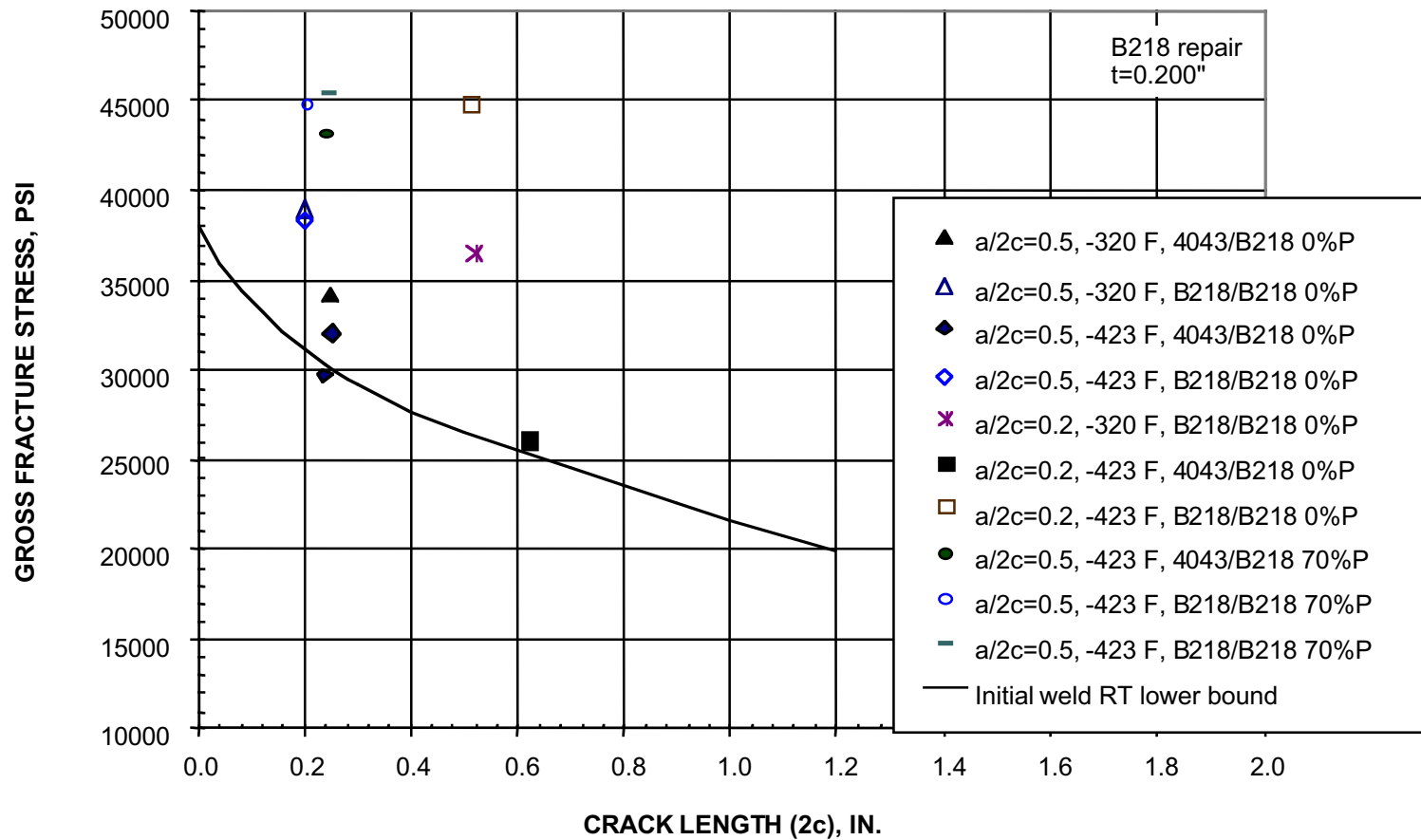
### 0.320t 2195T8M4 Structural Simulation Panel Weld Tensile Strength (-423°F)





## 2195 Fusion Welding Improvements with New Filler Wire

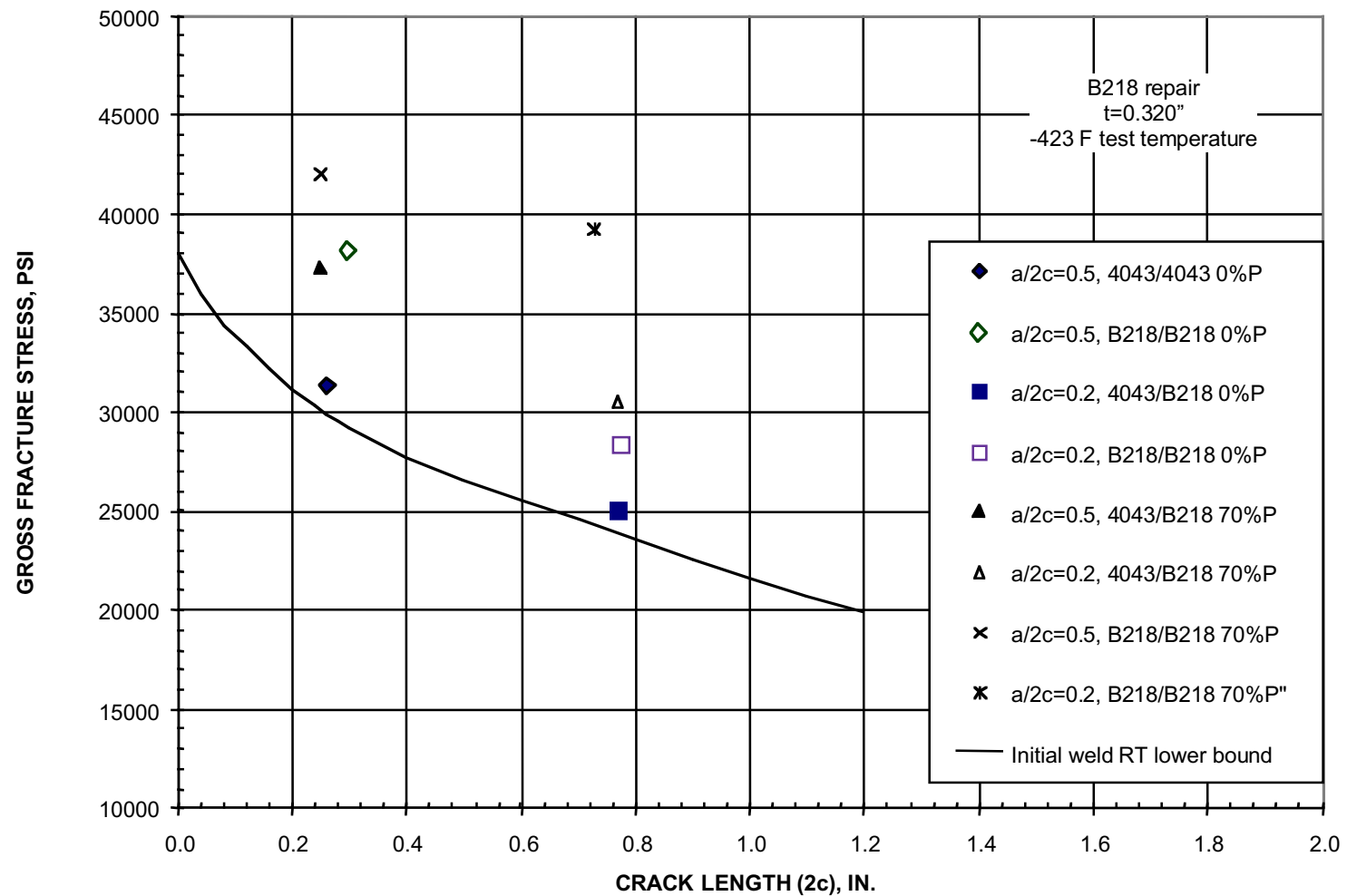
### 0.200t 2195T8M4 VPPA/GTA Repair Weld Simulated Service Fracture Toughness





## 2195 Fusion Welding Improvements with New Filler Wire

### 0.320t 2195T8M4 VPPA/GTA Repair Weld Simulated Service Fracture Toughness





## **2195 Fusion Welding Improvements with New Filler Wire**

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### **Conclusions**

- **B218 weld filler wire displayed higher repair weld tensile strength and ductility compared to 4043.**
- **Unplanished and planished B218 repair welds exceeded the current SLWT 4043 repair weld tensile strength requirement.**
- **B218 repair weld simulated service results surpassed 4043 repair welds and were comparable to 2195 initial welds made with 4043.**
- **B218 displays a high potential for improving SLWT production through increased repair weldability and the reduction/elimination of planishing for the removal of repair weld residual stresses.**