Low Silicate GMAW Process

SuperArc XLS & Rapid XLS

The Lincoln Electric Company

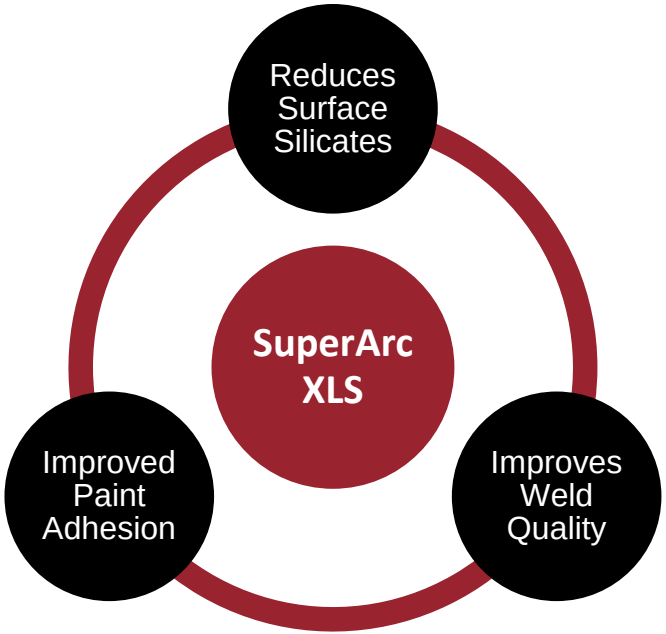
OUTLINE

LINCOLN ELECTRIC

01

INDUSTRY CHALLENGE

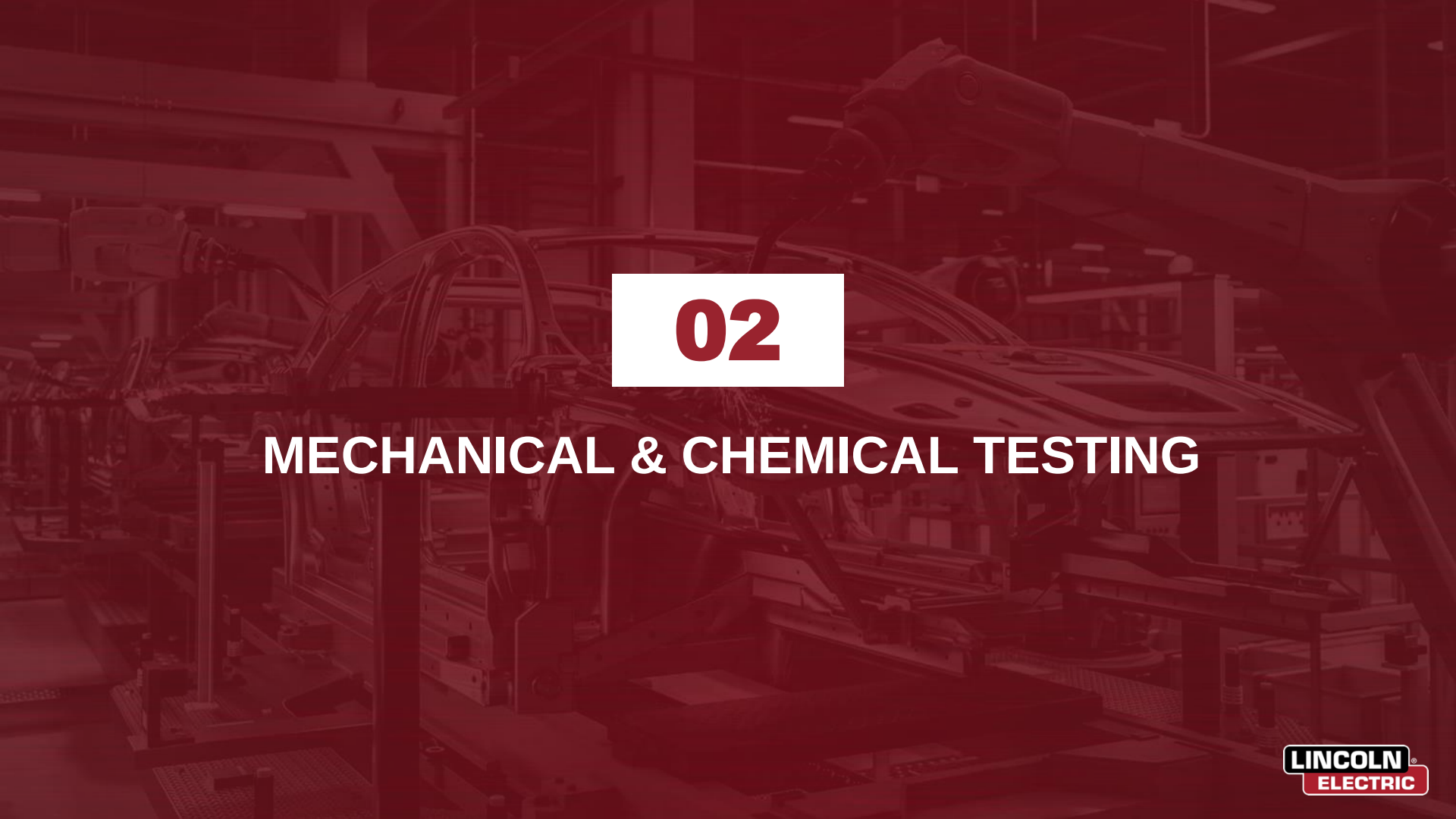
INDUSTRY CHALLENGE



- Improve corrosion life on “under the belt” exposed automotive components
- **Lincoln Electric’s Response: SuperArc® XLS**
  - Reduces surface silicates to near-zero amounts*
  - Improved paint adhesion which improves corrosion life
  - Improves weld quality on Zinc-coated steels as it pertains to porosity

**There may be a resulting surface oxide that has proven to coat (paint)*

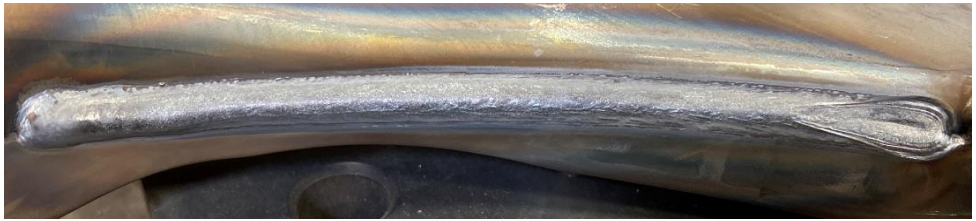
LINCOLN ELECTRIC



02

MECHANICAL & CHEMICAL TESTING

SUPER ARC XLS - LOW SILICATE ELECTRODE CLASSIFICATION



Product	SuperArc XLS	SuperArc XLS
Classification	ER70S-9	G43 M20 Z
Specification	AWS A5.18, ASME SFA-5.18	ISO 14341 A:2010
Date	Oct 20, 2023	July 16,2020

» **Dual Classification:**

- AWS 5.18, ASME SFA-5.18/ Classification ER70S-9
- ISO 14341 A-2010/ Classification G 42 3 M20 Z

SUPER ARC XLS – LOW SILICATE ELECTRODE COMPOSITION

Electrode Composition Weight	ER70S-9 Requirements	Electrode Results
C	0.03 - 0.12	0.08
Mn	1.25 - 2.20	1.65
Si	0.15 max.	0.05
S	0.035 max.	0.005
P	0.025 max.	0.008
Cr	0.15 max.	0.03
Ni	0.50 max.	0.27
Mo	0.15 max.	0.01
V	0.03 max	0.01
Cu (Total)	0.50 max.	0.14
Ti + Zr	0.05 - 0.25	0.12

AWS ER70S-9 Requirements

Electrode Composition Weight	ER70S-6 Requirements	Electrode Results
C	0.06 - 0.15	0.08
Mn	1.40 - 1.85	1.43
Si	0.80 - 1.15	0.89
S	0.035 max.	0.009
P	0.025 max.	0.015
Cr	0.15 max.	0.04
Ni	0.15 max.	0.03
Mo	0.15 max	<0.00
V	0.03 max.	<0.003
Cu (Total)	0.50 max.	0.22

AWS ER70S-6 Requirements

LINCOLN ELECTRIC

SUPER ARC XLS – LOW SILICATE ELECTRODE MECHANICAL PROPERTIES

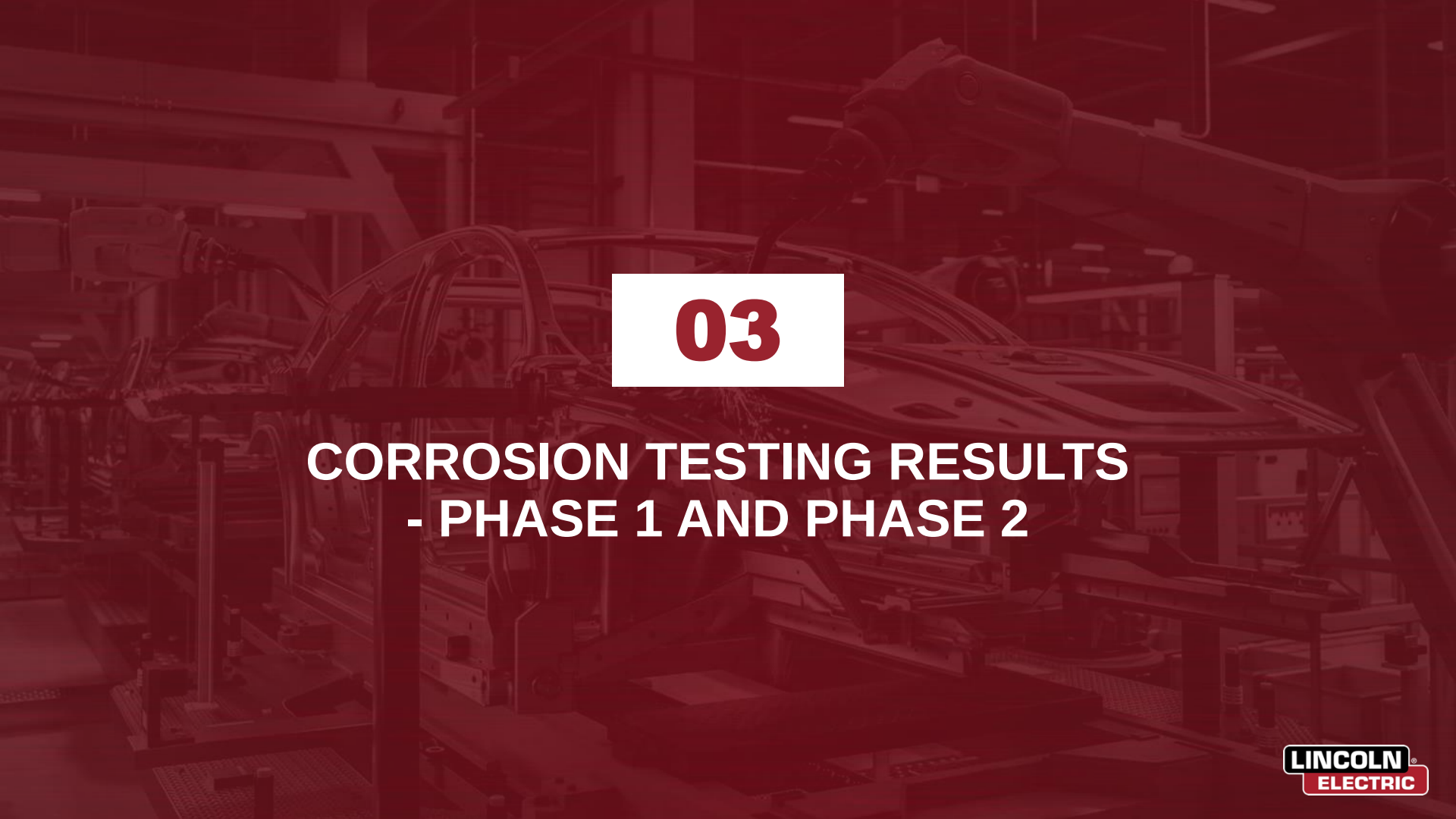
Super Arc XLS AWS ER70S-9

Mechanical Properties of Electrode	ER70S-9 Minimum Requirements	Results	
Tensile Strength, Mpa (ksi)	483 (70)	590 (86)	
Yield Strength, 0.2% Offset, Mpa (ksi)	400 (58)	540 (78)	
Elongation %	152 (22)	27	
Impact Energy Joules @ -29 °C (ft-lbs @ -20 °F)	20 (15)	185, 193, 199 (137, 142, 146)	
		Average	192 (42)
Average Hardness HRB	-	91	

SuperArc L-56 (ER70S-6 / Similar to G3Si 1)

Mechanical Properties of Electrode	ER70S-6 / G3Si 1 Minimum Requirements	Results	
		100% CO^2	98%Ar,2 %O^2
Tensile Strength, Mpa (ksi)	483 (70)	550 (80)	610 (89)
Yield Strength, 0.2% Offset, Mpa (ksi)	400 (58)	420 (62)	500 (72)
Elongation %	22	29	24
Average Impact Energy	20 (15)	75 (55)	76 (56)
Joules @ -29 °C (ft-lbs @ -20 °F)		71, 72, 81 (52, 53, 60)	60, 82, 87 (44,61, 64)
Average Hardness, HRB	-	86	92

LINCOLN ELECTRIC



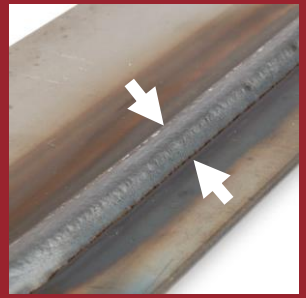
03

CORROSION TESTING RESULTS - PHASE 1 AND PHASE 2

PHASE ONE CORROSION TESTING

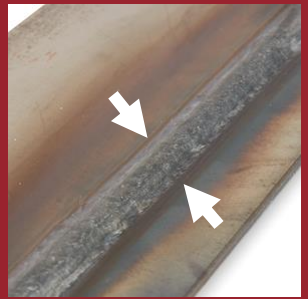
ER70S-6 SuperArc L-59

Silicate formation at weld toes



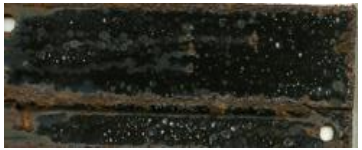
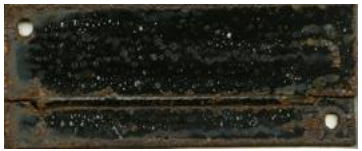
SuperArc XLS

No silicate formation at weld toes



- **Two Lincoln Electric wires:**
  - Modified ER70S-6 for low silicate performance using SuperArc L-59
  - SuperArc XLS
- **Three pretreatments**
- **Two final coating methods**
- **Cyclical Corrosion Test (CCT) intervals:**
  - 25 CCT - Completed
  - 60 CCT - Completed
  - 90 CCT – Completed
  - 120 CCT – Pitting Depth Evaluation - Completed

PHASE ONE CONTROL GROUP

ER70S-3 / G2 Si1			
SuperArc XLS			
Test Standard SAE J-2334	**25** Cycles	**60** Cycles	**90** Cycles

- Alkaline cleaning
- No acid descale
- E-Coat Conditioner

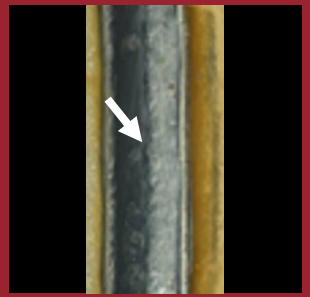
PHASE TWO CORROSION TESTING

ER70S-6

Silicate formation at weld toes

SuperArc XLS

No silicate formation at weld toes

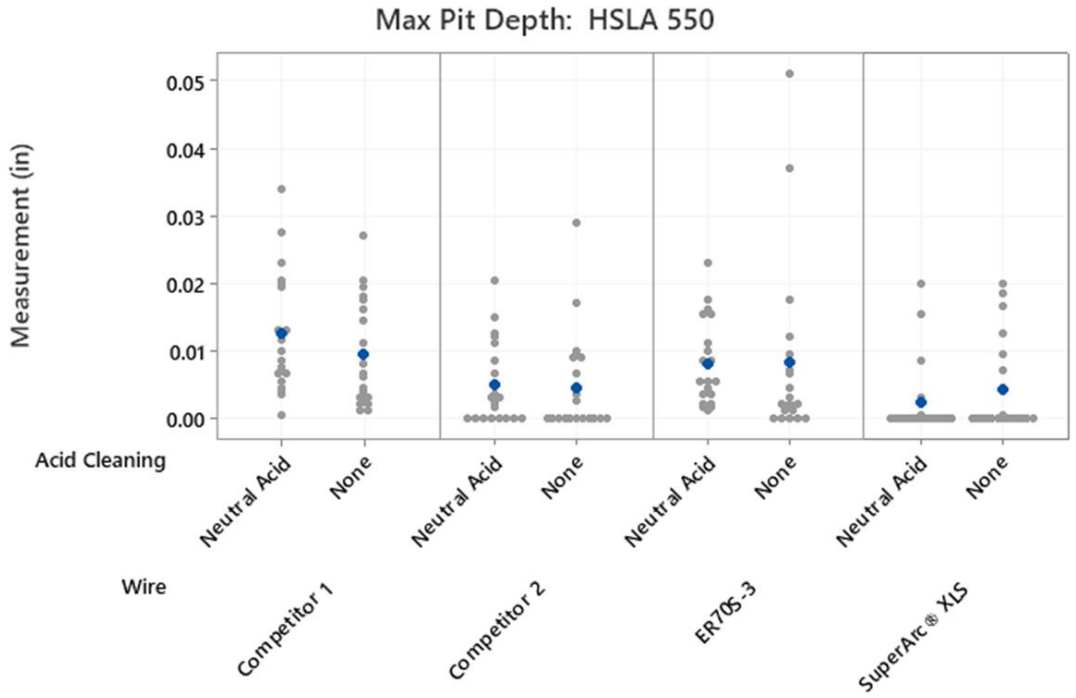


- **Two Lincoln Electric wires:**
  - ER70S-3 (G2Si)
  - SuperArc XLS
- **Standard PPG Chemfos 700 pretreatment**
- **PPG High Edge Electrocoat**
- **Cyclical Corrosion Test (CCT) intervals**
  - **SAE J2334 Standard :**
    - 25 CCT - Completed
    - 60 CCT - Completed
    - 120 CCT – Completed
    - 120 CCT – Pitting Depth Evaluation - Completed

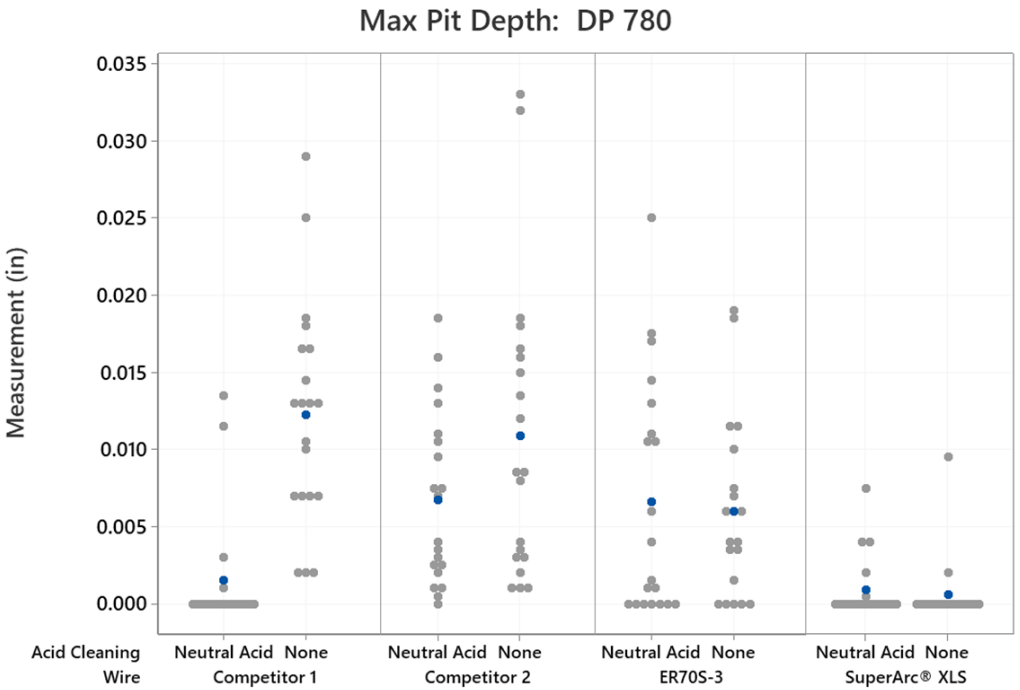
PHASE TWO TESTING –
ZINC-COATED STEELS PERFORMED BY OEM

	Pre-Corrosion	30 Cycles	60 Cycles	120 Cycles
ER70S-3 / G2 Si1				
SuperArc XLS				
Test Standard SAE J-2334				

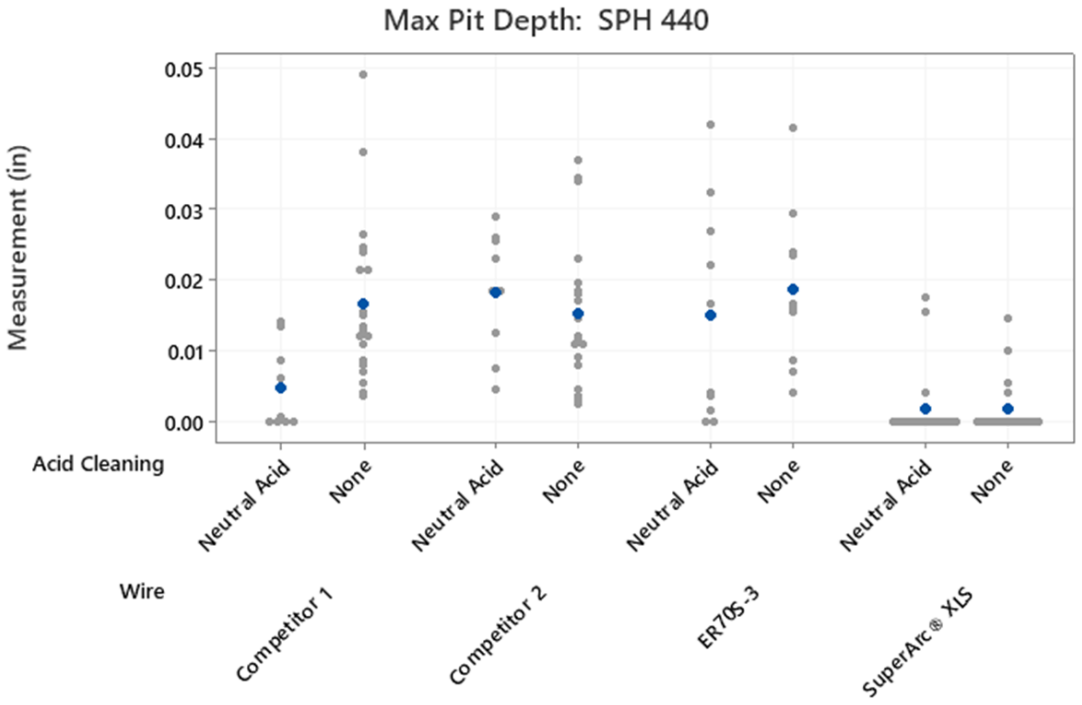
CORROSION PITTING DEPTH AT 120 CCT-HSLA 550



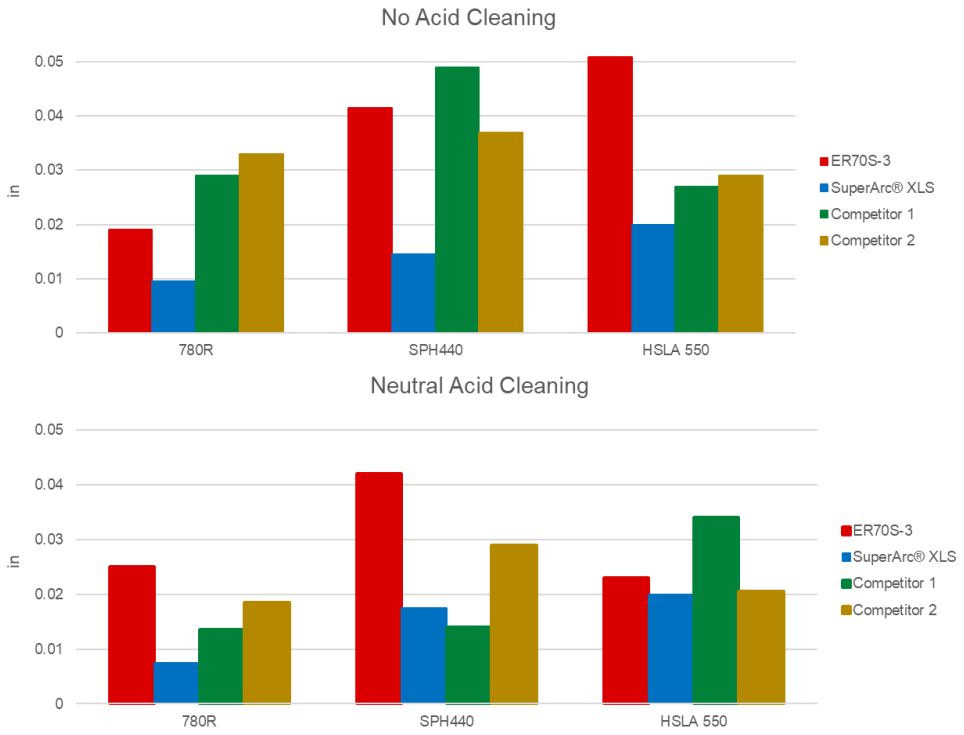
CORROSION PITTING DEPTH AT 120 CCT-DP 780



CORROSION PITTING DEPTH AT 120 CCT- SPH 440



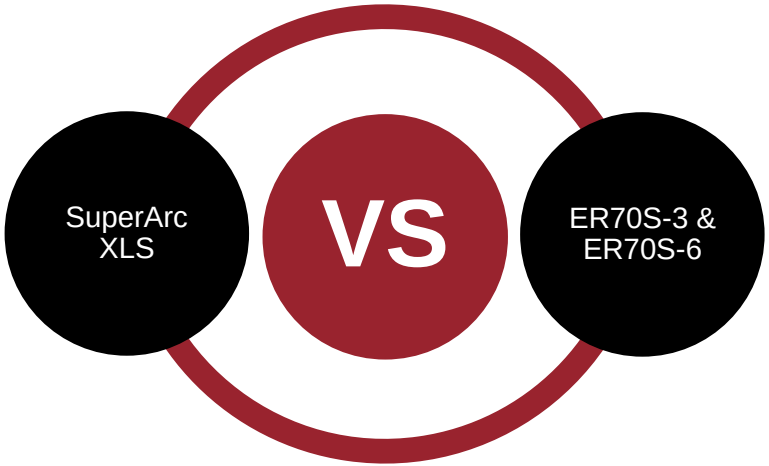
SUMMARY OF CORROSION PITTING DEPTH AT 120 CCT



04

RAPID X LS (LOW SILICATE) WAVEFORM DEVELOPMENT

FUNDAMENTAL
SUPERARC XLS BEHAVIOR VS. ER70S-3 & S-6



- Low silicate wires are less resistive by approximately 30%
  - Requiring about 10-20% higher amperage at lower voltages for proper droplet transfer
  - Rapid X® LS was created with these adaptations to improve arc stability
- 90/10 (Ar/CO2) provides noticeably better droplet transfer than 80/20
- Measurable improvement in porosity performance on zinc-coated steels
  - Up to 40% reduction as compared to standard ER70S wires

LINCOLN ELECTRIC

ADVANCED TECH WAVEFORM – RAPID X LS
KEY FEATURES

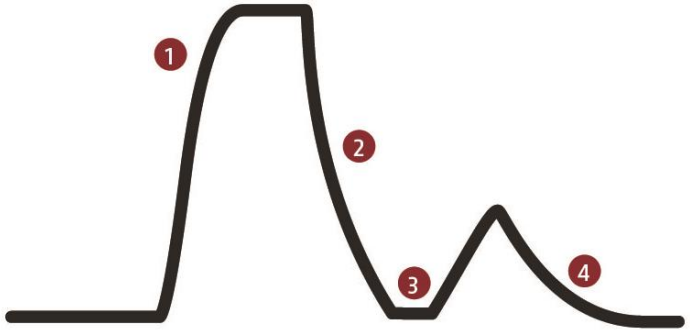
- **Modified Rapid X for Low Silicate Wire**
  - Similar Puddle Repulsion Process
  - Higher Pulse Energy For Droplet Transfer
- **Fixed Frequency**
  - Consistent Droplet Transfer
  - Arc Stability for Zinc-Coated Steels
- **Reduced Spatter from Improved Arc Stability**
- **Best Process For Coated & Uncoated Steel**
  - All Low Silicate wire types

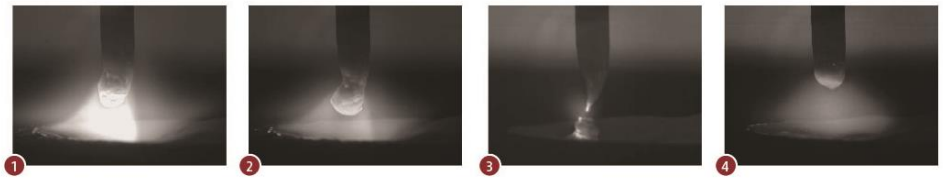
LINCOLN ELECTRIC

ADVANCED TECH WAVEFORM – RAPID X LS

CLICK HERE TO VIEW

https://lered.info/3ZcZXpQ





PULSE RAMP/PEAK
A rapid current increase creates a molten droplet.

TAILOUT
Reduced current relaxes the plasma force as the droplet approaches the puddle.

WET-IN
Proprietary hardware quickly reduces the current at the instant the droplet contacts the puddle, reducing spatter after the droplet detaches.

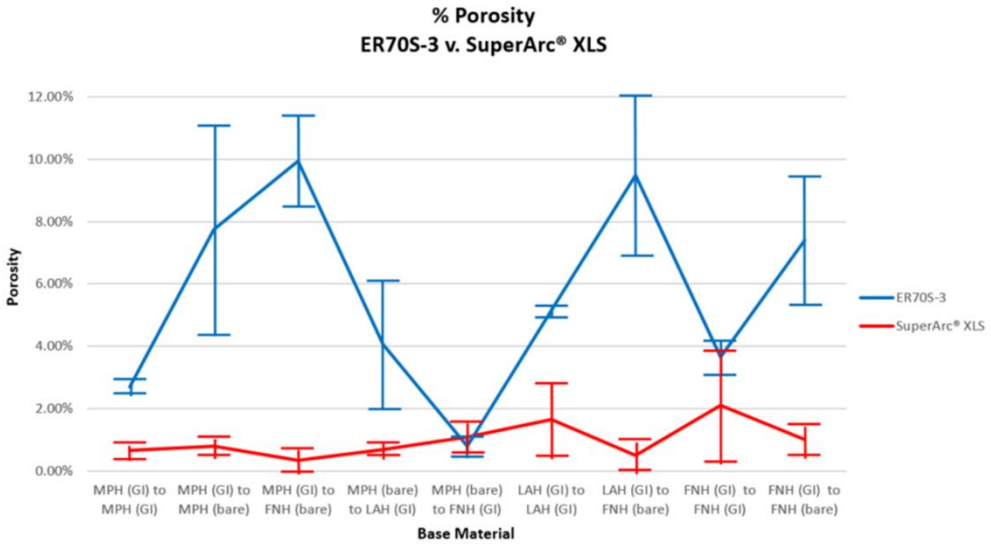
PUDDLE REPULSION
A plasma boost pushes the puddle away, creating separation and a stable rhythm of the weld pool.

LINCOLN ELECTRIC

05

ZINC-COATED MATERIAL SOLUTION

ZINC-COATED STEEL PERFORMANCE



» **Challenges**

- Multiple steel grades
- ER70S-3 vs. SuperArc XLS

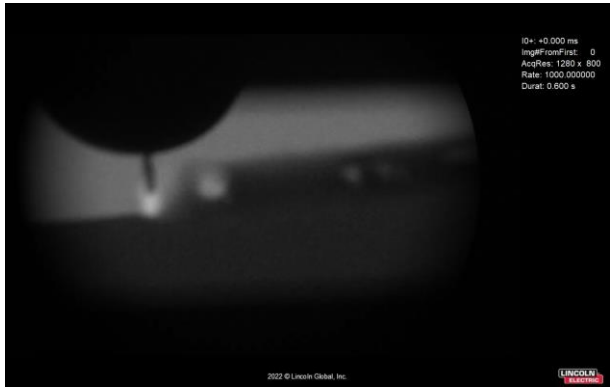
» **Winning Solution**

- SuperArc XLS / Rapid X LS

A MORE REPEATABLE & PREDICTABLE PROCESS

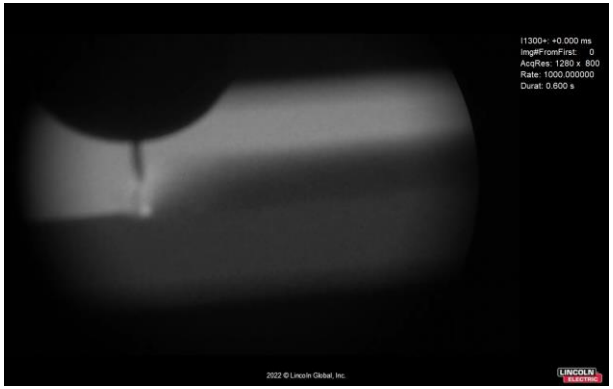
X-RAY COMPARISON - OUTGASSING

ER70S-3



Post-weld X-ray: 10% area porosity

SuperArc XLS



Post-weld X-ray: 1% area porosity

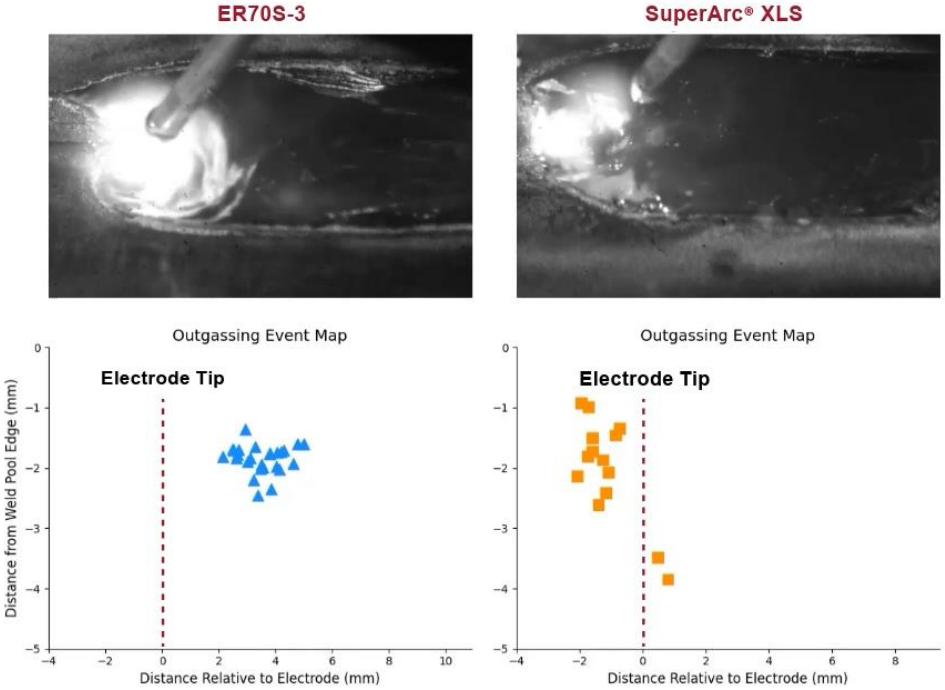
CLICK HERE TO VIEW

https://lered.info/4dwvXsP

https://lered.info/4chUzEC

LINCOLN ELECTRIC

OUTGASSING EVENT MAP COMPARISON

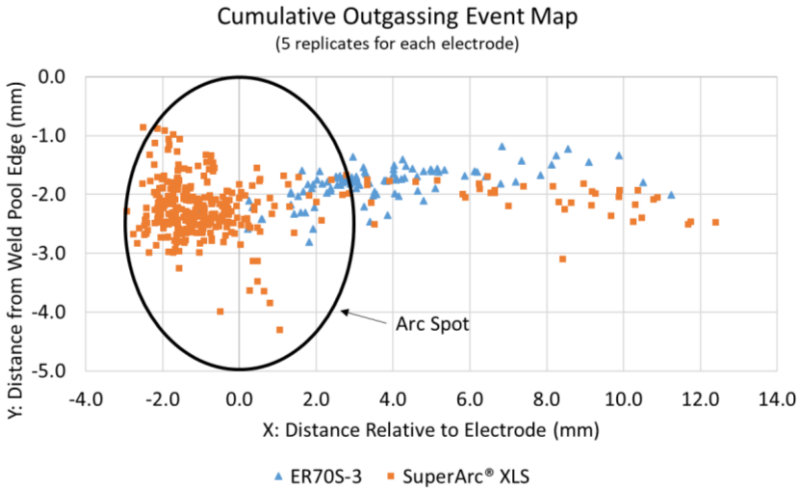


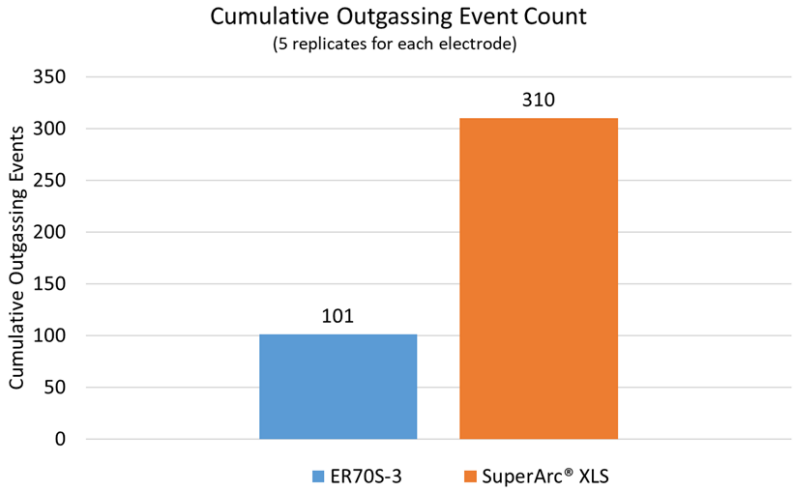
CLICK HERE TO VIEW

https://lered.info/3YAbhfo

LINCOLN ELECTRIC

3X THE OUTGASSING EVENTS WITH SuperArc XLS





40% REDUCTION IN POROSITY DUE TO OUTGASSING EVENTS

06

MARKET ACCEPTANCE

SUPERARC XLS MARKET LAUNCH

Official Product Launch (December 2020)

- Spools and Bulk Packages in
  - 0.035in (0.9 mm)
  - 0.040in (1.0 mm)
  - 0.045in (1.1 mm)
  - 1.2 mm (0.047 in)
- Website Landing Page

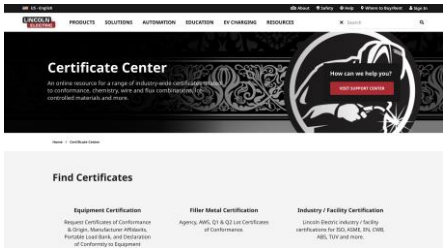
Waveform Development & Application

- Rapid X LS Development – Released Febr. 14, 2022
- Rapid X LS, Weld Process Guide published 7/2022

Chemistry Certification

IMDS Listing, ISO & AWS Certification, Schedule H

- Actual lot chemistry available via www.lincolnelectric.com



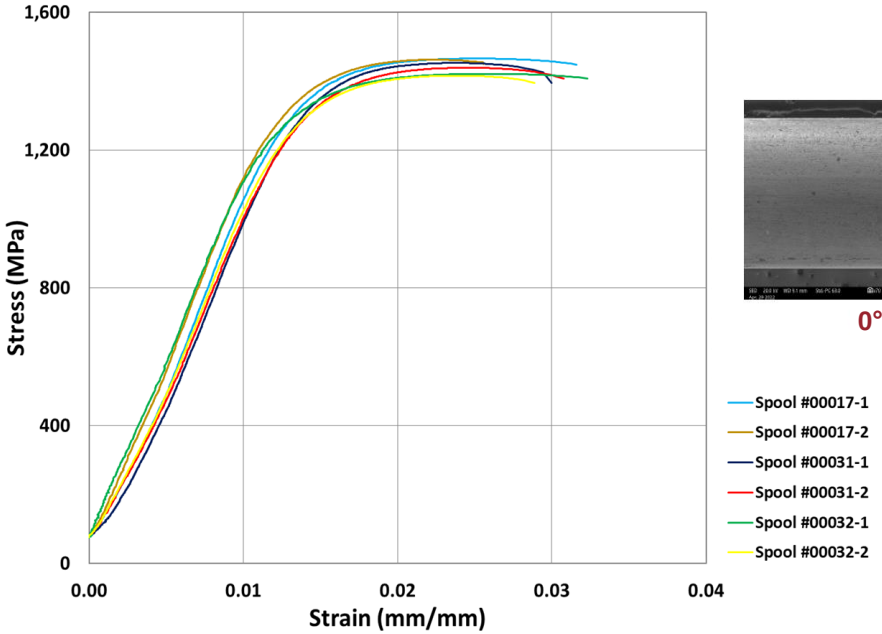
SUPPORTING DOCUMENTATION

- Solution Briefs
- White Papers
- Procedural Guides
- Video Support

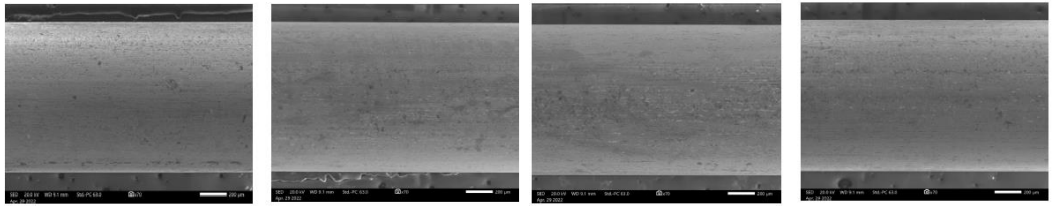
07

THIRD PARTY AUDIT OF SUPERARC XLS

THIRD PARTY AUDIT OF SUPERARC XLS

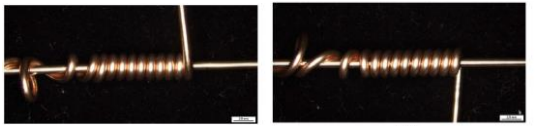


Surface Quality of Wire



0° 90° 180° 270°

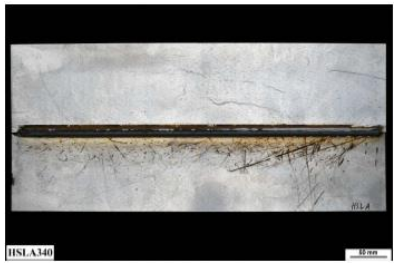
Copper Spalling test



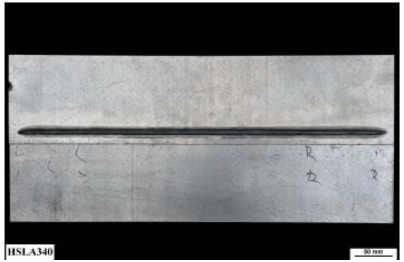
0° 180°

THIRD PARTY AUDIT OF SUPERARC XLS - WELD PANEL VISUAL EXAMINATION & PASSING X-RAY

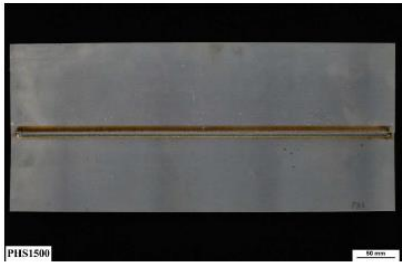
HSLA 340



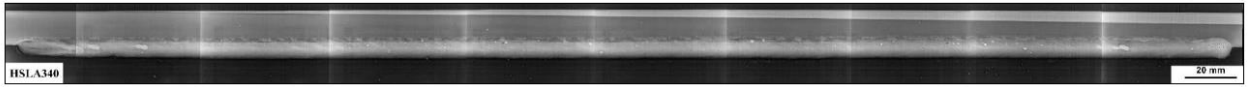
HSLA 340



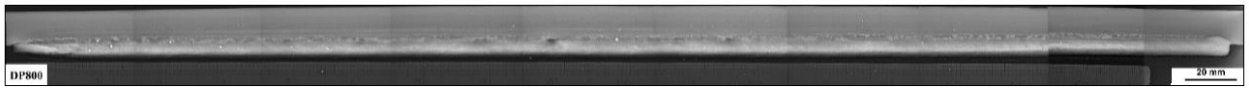
PHS 1500



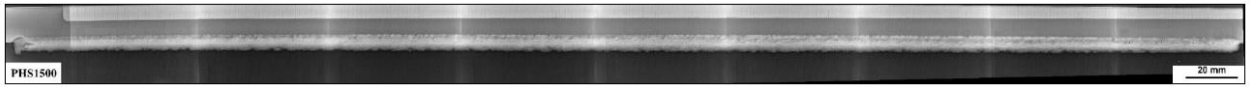
HSLA 340



DP 800

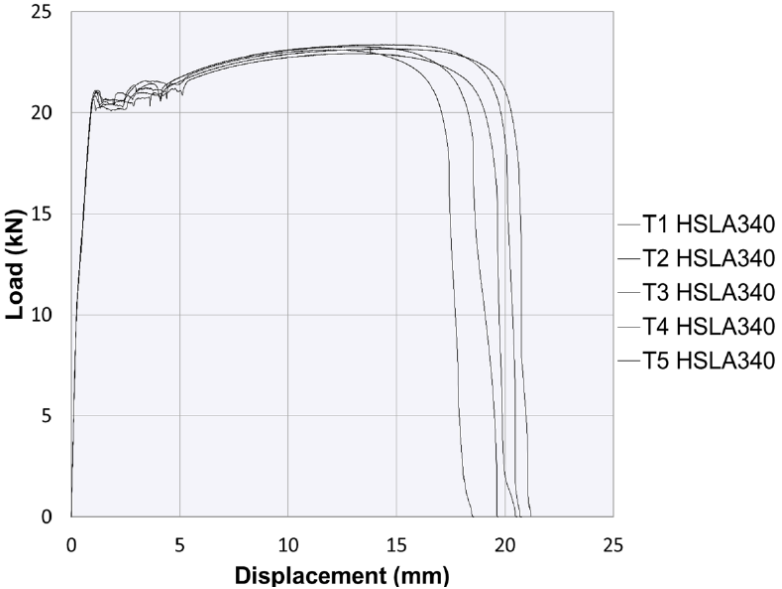


PHS 1500

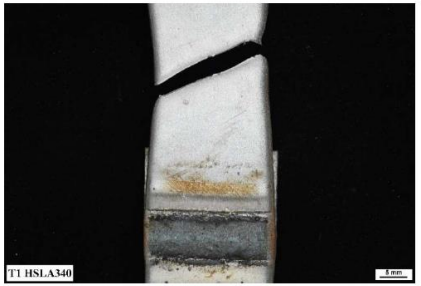


LINCOLN ELECTRIC

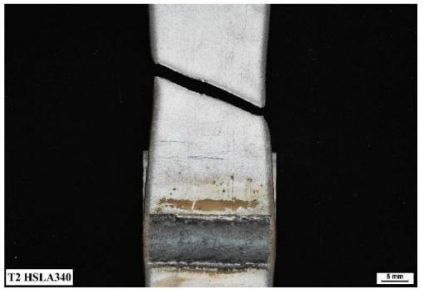
THIRD PARTY AUDIT OF SUPERARC XLS



Material Fracture in HAZ

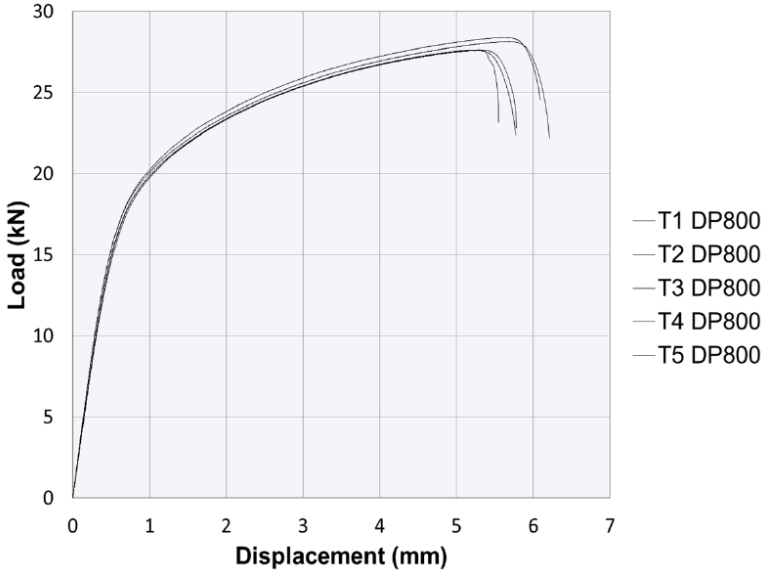


T1 HSLA340

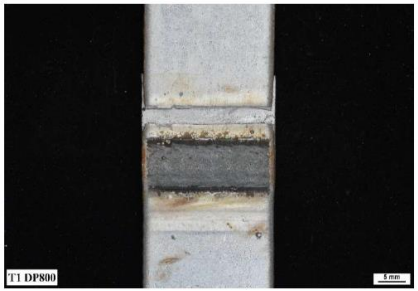


T2 HSLA340

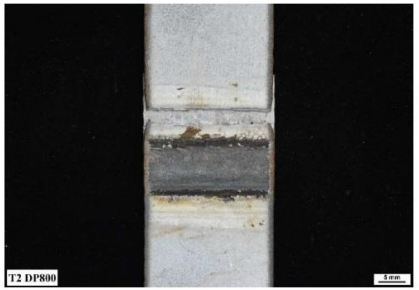
THIRD PARTY AUDIT OF SUPERARC XLS



Material Fracture in HAZ

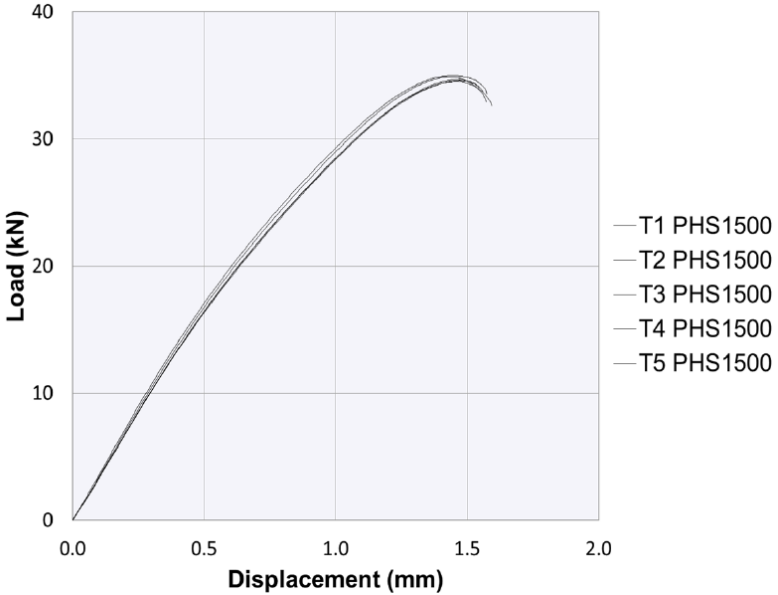


T1 DP800

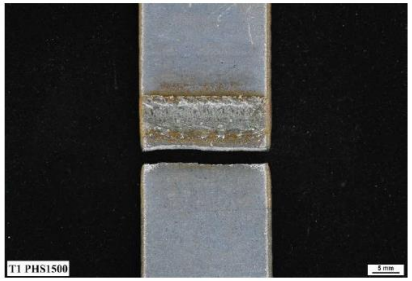


T2 DP800

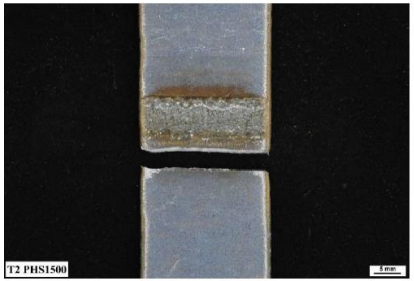
THIRD PARTY AUDIT OF SUPERARC XLS



Material Fracture in HAZ



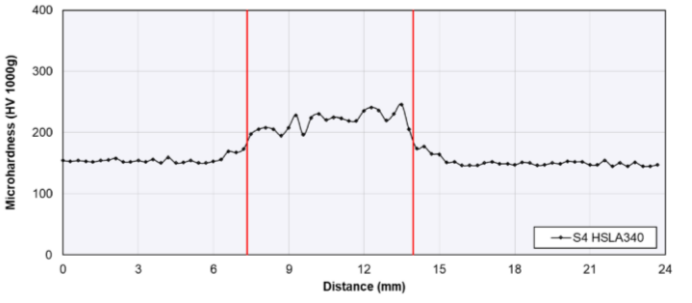
T1 PHS1500



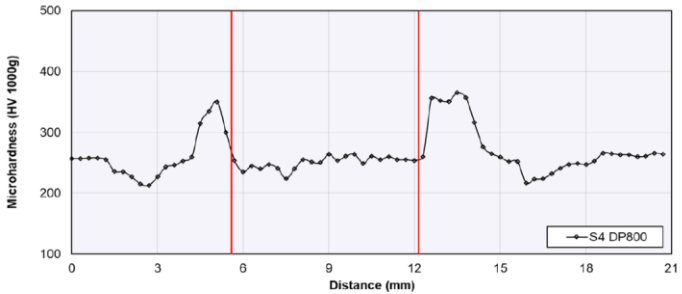
T2 PHS1500

THIRD PARTY AUDIT OF SUPERARC XLS

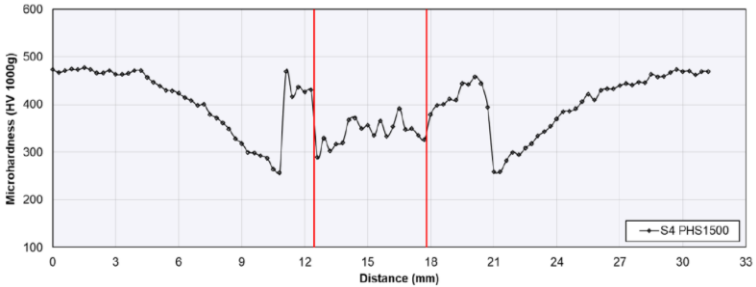
HSLA 340



DP 800



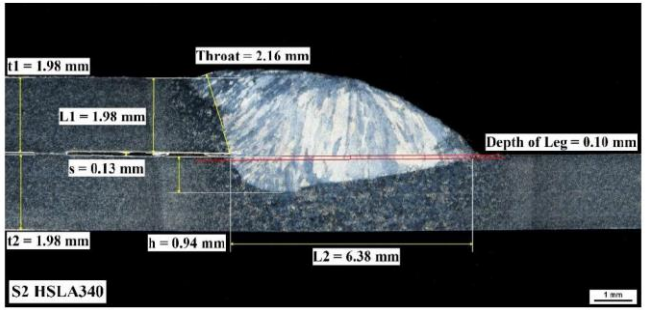
PHS 1500



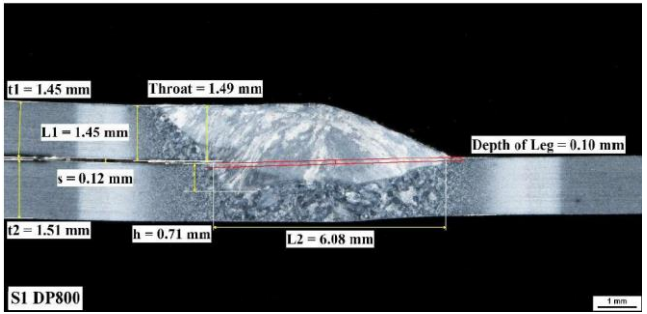
LINCOLN ELECTRIC

THIRD PARTY AUDIT OF SUPERARC XLS

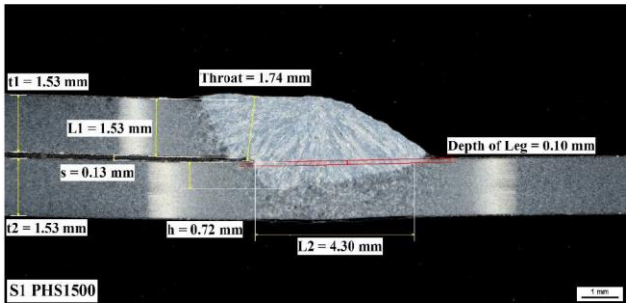
HSLA 340



DP 800



PHS 1500



LINCOLN ELECTRIC

Have Questions?

Visit Lincoln Electric Website

www.lincolnelectric.com

LINCOLN® ELECTRIC

DISCLAIMER - This document may contain links to other third-party websites or content, which are intended to furnish users with general information on matters that they may find to be interested. The information provided in this document does not, and is not intended to constitute any legal advice, or to replace any consultation or service. Information in this document may not be the most up-to-date. Lincoln Electric makes no representation or warranty, express or implied, regarding the accuracy of content of the third-party links, and does not guarantee specific results or outcomes. You should consult with your own professional advisors for advice concerning specific matters before making any decision.

CUSTOMER ASSISTANCE POLICY - The business of Lincoln Electric is manufacturing and selling high quality welding equipment, automated welding systems, consumables, cutting equipment and EV charging systems. Our challenge is to meet the needs of our customers, who are experts in their fields, and to exceed their expectations. On occasion, purchasers may ask Lincoln Electric for information or technical information about their use of our products. Our employees respond to inquiries to the best of their ability based on information and specifications provided to them by the customers and the knowledge they may have concerning the application. Our employees, however, are not in a position to verify the information provided or to evaluate the engineering requirements for the particular weldment, or to provide engineering advice in relation to a specific situation or application. Accordingly, Lincoln Electric does not warrant or guarantee or assume any liability with respect to such information or communications. Moreover, the provision of such information or technical information does not create, expand, or alter any warranty on our products. Any express or implied warranty that might arise from the information or technical information, including any implied warranty of merchantability or any warranty of fitness for any customers' particular purpose or any other equivalent or similar warranty is specifically disclaimed.

Lincoln Electric is a responsive manufacturer, but the definition of specifications, and the selection and use of specific products sold by Lincoln Electric is solely within the control of, and remains the sole responsibility of the customer. Many variables beyond the control of Lincoln Electric affect the results obtained in applying these types of fabrication methods and service requirements.

TEST RESULTS - Test results for deposition rates, mechanical properties, deposit or electrode composition, and diffusible hydrogen levels were obtained from welds produced and tested according to typical codes and standards, and should not be assumed to be the actual results in a particular application or weldment. Data shown is representative of the results achieved for a specific set of welding conditions that may be different than our customers' conditions. Actual results will vary depending on many factors, including, but not limited to, weld procedure, plate chemistry and temperature, weldment design and fabrication methods. Users are cautioned to confirm by qualification testing, or other appropriate means to the relevant industry or project requirements, the suitability of any welding consumable(s) and welding procedure before use in the intended application.

TRADEMARKS - All trademarks and registered trademarks are the property of their respective owners.

SUBJECT TO CHANGE - This information is accurate to the best of our knowledge at the time of printing. Please refer to www.lincolnelectric.com for any updated information.

LINCOLN ELECTRIC