

Next Generation Double Electrode GMAW Processes for Precision Fillet Welding

NSRP Project Manager: Ryan Schneider
NSRP PTR: Paul Hebert

NSRP All Panel Meeting – March 28, 2023

Project Team

- EWI (prime)
 - Michael Carney (PI), Dennis Harwig (Senior Technical Leader)
 - Katie Hardin (PM), Mark Schimming (VP Govt Business)
- Government POC
 - Matt Sinfield, NSWCCD
- Participant
 - Cody Whiteley - NASSCO
 - Steve Scholler, John Walks - INGALLS

Background

- Double electrode gas metal arc welding (GMAW) processes, such as tandem and twin, typically provide two to three times the productivity of single electrode GMAW and flux cored arc welding (FCAW) processes.
- Need high productivity process for 4-mm precision fillet welds
 - Thin panel stiffener welding
 - Significantly reduce panel distortion and rework
- Assess precision welding processes - equipment, apparatus, control technology, and consumables
- Double electrode processes also offer maximum productivity for both small, 4 mm, and large fillets.
 - Tandem GMAW widely used for larger (5-7 mm) fillet welds.
- Modern double electrode GMAW processes can also provide higher deposition rates, better deposit bead shape and quality, and more robustness than existing shipyard processes.

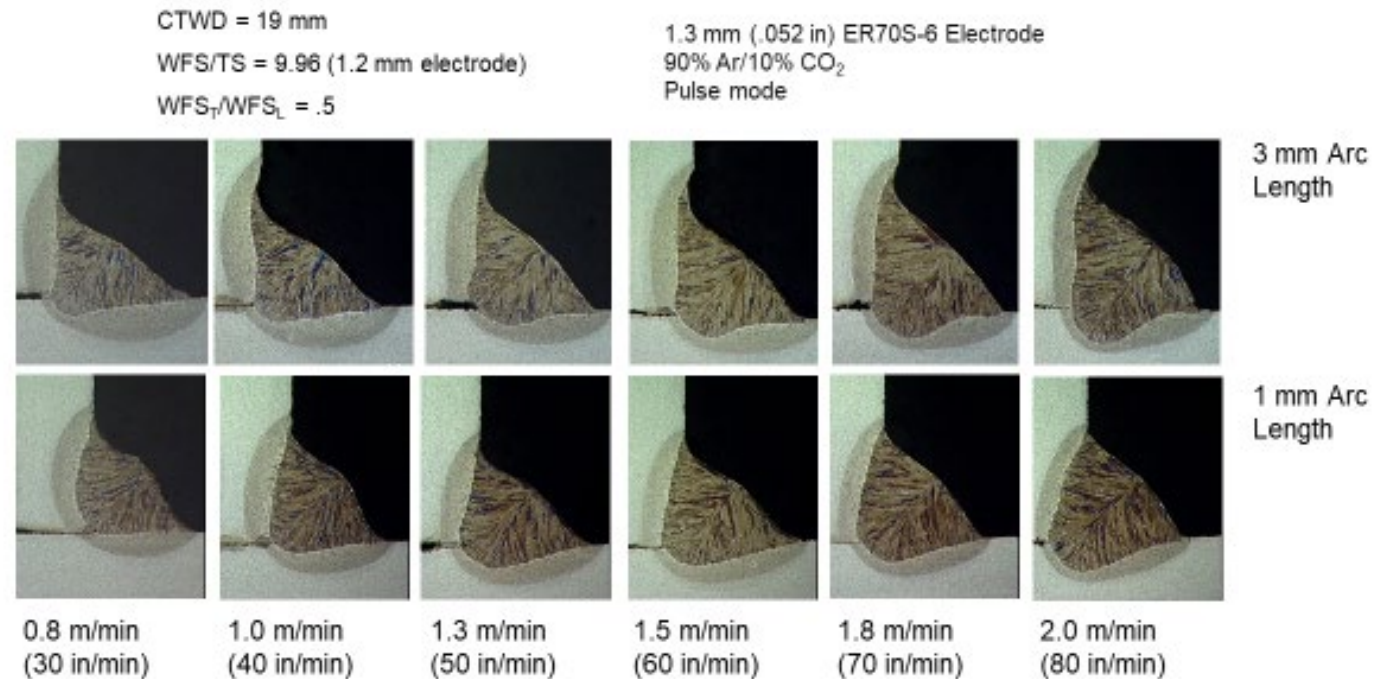
Objectives

- Evaluate and benchmark advanced double electrode GMAW processes and consumables for high-speed (4-mm) fillet welding.
- Survey industry, screen candidate processes, and select preferred process variants for feasibility testing. Candidate processes for feasibility testing include:
 - Twin (i.e., Lincoln HyperFill™)
 - Hot wire tandem (Lincoln)
 - Tandem (Cloos)
 - Tandem CMT/Pulse-CMT (Fronius)
 - Adjustable configuration tandem (D&F Specialty Torch)
 - Advanced consumables for tandem (advanced metal core electrodes for high-speed performance)
- Downselect and develop ARCWISE windows & bead shape maps for up to three variants.
 - Target application: 4-mm horizontal fillet welds
- Provide technology transfer and demonstration workshop upon project completion

Process Comparison Conditions

- Material Thickness
 - 4 - 5 mm
 - Sand blasted/de-scaled
- DH/EH36 Grade
- ER70S-6
- Fit-up
 - 0 to 1.5 mm (1/16 in.) gap
- Shielding Gas
 - Typical FCAW
 - 94Ar/6CO₂
 - Panel Lines
 - 100CO₂
- Tack Size
 - Leg Size
 - 3-mm target
 - Length
 - 1 in.

Tandem GMAW Bead Shape Map – 5 mm



Arcwise Bead Shape Map Example

Optimum













Tasks

- Task 1 – Project Initiation and Kickoff Meeting – **Complete**
- Task 2 – Survey Suppliers for Next Generation Double Electrode GMAW Technology – **Complete**
- Task 3 – Feasibility Testing of Next Generation DE-GMAW Processes – **In Process**
- Task 4 – Precision Fillet Weld Operational Windows, Bead Shape Maps, and Productivity Analysis
- Task 5 – DE-GMAW Process Benchmarking and Productivity Analysis
- Task 6 – Next Generation DE-GMAW Technology Workshop

Task 2 – Survey Suppliers for Next Generation Double Electrode GMAW Technology

- Survey of welding equipment and consumable suppliers
- Identify the next generation equipment, consumables, and apparatus that can be used to deposit 4 mm and larger fillet welds to support panel line assembly.
 - Equipment suppliers will be consulted on recommended setups and parameters for twin, hot wire tandem, adjustable configuration tandem, and advanced consumables for high-speed precision fillet welding.
 - Supplier “in-kind” benchmarking support welcome to maximize project data

Market Survey

COMPANY	POCs	TECHNOLOGY	DEPOSITION
	Steve Peters	HyperFill	24-Lb/Hr
	Steve Massey	Hercules	30-Lb/Hr
	Shaun Relyea	tps/i TWIN	35-Lb/Hr
	Mike Moore	Tandem Synergy Pro	35-Lb/Hr
	Nate Lott		
	Larry Barley	SyncroFeed	18-Lb/Hr
		Buried Arc	Not Applicable
	Ben Kahut	Consumables	
	Kim Francis	Consumables	Not Applicable
	Tom Graham	SpinArc	Not Applicable
	Steve Moerke	Tandem Torch	Not Applicable

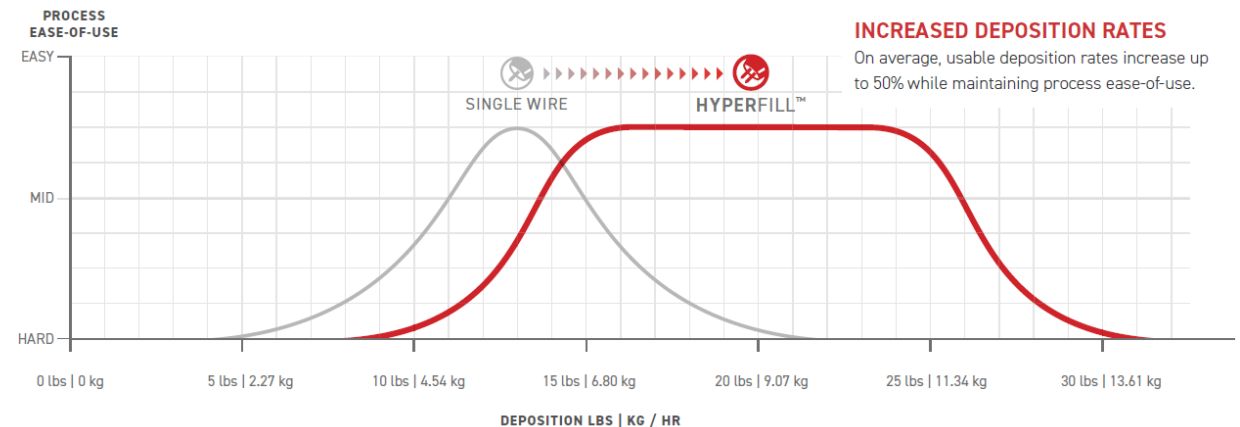
Lincoln HyperFill

- Twin-wire GMAW solution
- Designed for semiautomatic and automatic applications
- Deposition rates above 18 lbs/hr (24+ lbs/hr robotically)
- Ease-of-use (one power supply/feeder)
- Not direction dependent



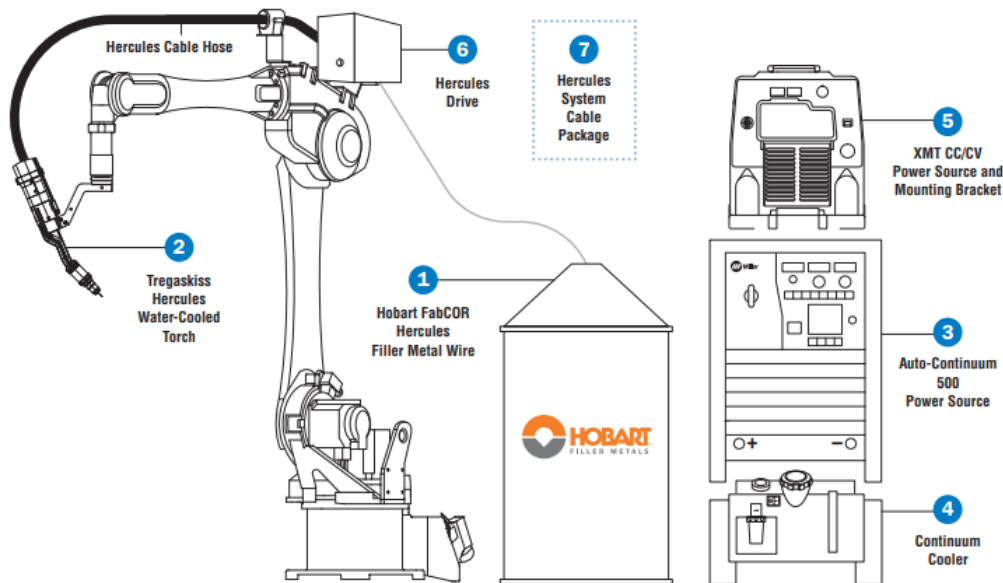
DISTANCE TRAVELED	0.0 FT	0.66	1.31	1.97	2.62	3.28	3.94	4.59	5.25	5.91	6.56
	0.0 M	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0

PROCESS COMPARISON - DEPOSITION RANGE



Miller Hercules

- Single-wire GMAW solution
- Designed for semiautomatic and automatic applications
- Deposition rates above 30.5 lbs/hr robotically
- Ease-of-use (one power supply/feeder)
- Not direction dependent
- Customer wire (FabCOR) tailored to Hercules process



FabCOR® Hercules™

AWR AS-18-ETC-08-14 Welding Position:

FEATURES		BENEFITS	
• The only manufacturer recommended wire for welding using the Hercules™ system.	• Wire manufacturing process optimized for welding using the Hercules™ system.	• Ensures as-designed performance and productivity when using the Hercules system.	• Provides consistent fluidity at very high wire feed speeds on automated equipment.
• High purity formula specifically performs the disadvantages of welding using high wire feed speeds with conventional wires.	• Designed to offer robust mechanical properties and good low temperature toughness when welding at higher amperages and wire feed speeds.	• Maintains good fluid appearance and control, even when welding at high speeds.	• Suitable for use in critical applications where weld quality and performance is a key consideration.

APPLICATIONS:

- Heavy equipment fabrication
- Single and multi-pass welding
- Agricultural equipment fabrication
- Automated welding
- Tank and trailer fabrication
- Use with the Hercules system

Weld Type: Gas-shielded, metal-powder, metal-cored wire
Sensitized Gas: 75-95% Argon (Arg/Balance Carbon Dioxide (CO₂), 40-60 lbs (19-24 liter))
Note: FabCOR Hercules™ has been optimized for use with 90% Argon/CO₂ mixtures gas 75% Argon/CO₂.

Type of Connection: Contact Electrode Position (CEP) is typically used for gasification and spooling.

Shielding Gas Inlets: 0.50" (12.7 mm)
BC Device: Not Recommended
Storage: Product should be stored in a dry, uncooled environment and in its original intact packaging.

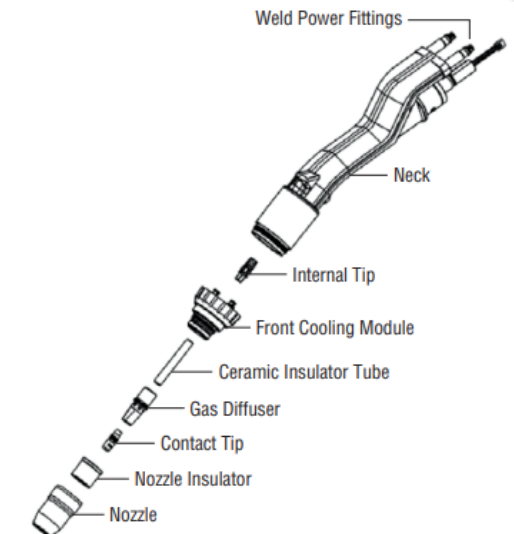
TYPICAL WELD METAL CHEMICAL COMPOSITION* (Chem Pad):

Weld Metal Analysis (%)	75% Argon/CO ₂	80% Argon/CO ₂	90% Argon/CO ₂	AWR 500
Carbon (C)	0.01	0.04	0.03	0.03
Manganese (Mn)	1.50	0.50	1.50	1.50
Silicon (Si)	0.05	0.07	0.05	0.05
Phosphorus (P)	0.008	0.008	0.008	0.008
Sulfur (S)	0.009	0.008	0.009	0.009
Nitrogen (N)	0.011	0.008	0.008	0.008
Boron (B)	0.0011	0.0009	Not Specified	Not Specified

TYPICAL WELD METAL DEPENDENT PROPERTIES*:

Hydrogen Equivalent	75% Argon/CO ₂	80% Argon/CO ₂	90% Argon/CO ₂	AWR 500
(Cm) (mg/100g)	3.1 (0.078)	3.1 (0.078)	3.1 (0.078)	3.1 (0.078)

*This information is provided as a reference. Actual test results may vary. For a complete list of properties and analysis, and Miller Technical Center, or contact your nearest Miller distributor for more information. Analysis and test results are based on Miller's standard test procedures and may vary from actual production. Analysis and test results are based on Miller's standard test procedures and may vary from actual production. © 2015 Miller Electric Mfg. Co. Miller Electric Mfg. Co. 2015 Miller Electric Mfg. Co. 2015 Miller Electric Mfg. Co. 2015 Miller Electric Mfg. Co. 2015 Miller Electric Mfg. Co.



Fronius TPSi TWIN

- Two-wire GMAW solution
- Designed for semiautomatic and automatic applications
- Deposition rates above 35 lbs/hr (robotically)
- Two separate welding systems
- Direction dependent
- CMT/PMT/GMA combinations



High deposition rate

One welding pass is all it takes. Thanks to the high deposition rate of the TWIN system, welds that needed to be welded in multiple passes are a thing of the past.

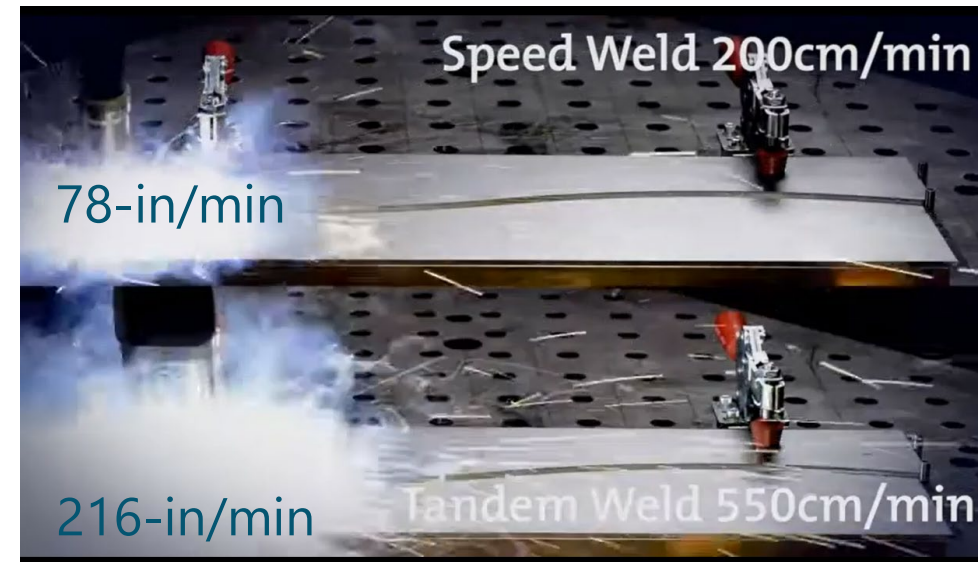
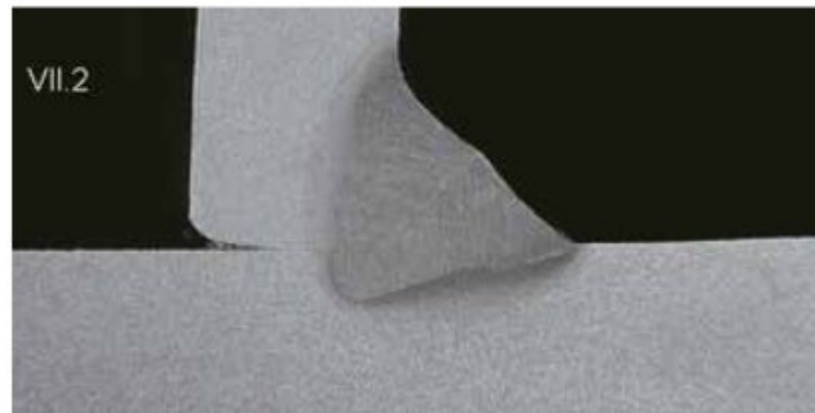


Parameters	
vs [cm/min]:	4.72 in/min
Dep. rate =	55.33 lb/h
Contact tip angle =	0°
Lead Vd =	PMC 106.29 in/min
Trail Vd =	PMC 78.74 in/min
a-dimension =	0.21
Penetration =	0.15 in



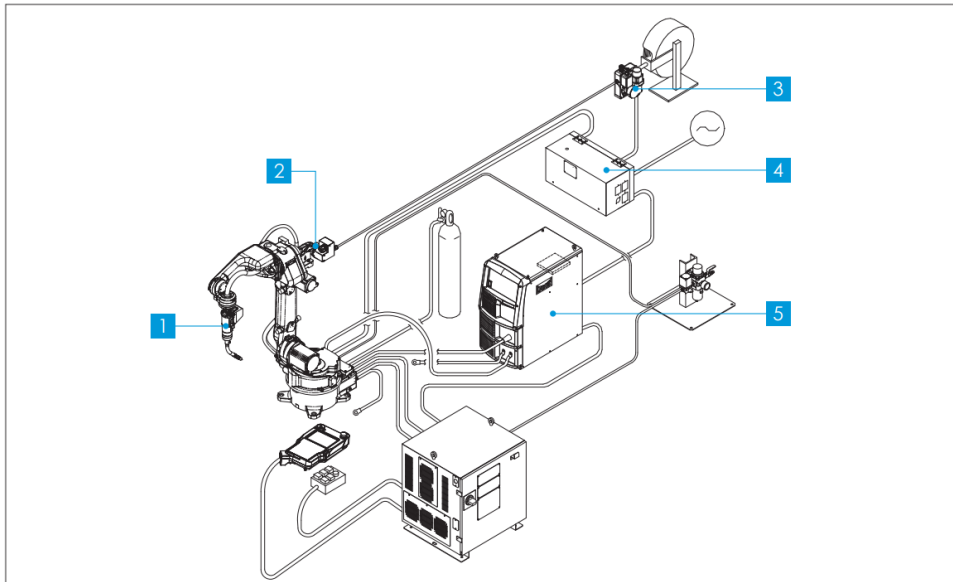
CLOOS Tandem

- Two-wire GMAW solution
- Designed for semiautomatic and automatic applications
- Deposition rates above 35 lbs/hr (robotically)
- Two separate welding systems
- Direction dependent



OTC

- OTC discontinued all double electrode processes in 2008
- Using their Syncrofeed system the max deposition rate is 18 lbs/hr
- Single-wire GMAW solution
- Designed for semiautomatic and automatic applications



Hobart

- Only off the shelf options



Certificate of Conformance to Requirements for Welding Electrode

Product Type: **FabCOR 100**
 Classification: **E100C-K3**
 Specifications: **AWS A5.28/A5.28M; ASME SFA 5.28**
 Diameter Tested: **.045"**
 Date Tested: **10/25/2021**
 Date Generated: **11/16/2021**

This is to certify that the product named above and supplied on the referenced order number is of the same classification, manufacturing process, and material requirements as the material which was used for the test that was conducted on the date shown, the results of which are shown below. All tests required by the specifications shown for classification were performed at that time and the material tested met all requirements. It was manufactured and supplied by the Quality System Program of Hobart Brothers, which meets the requirements of ISO 9001, ANSI/AWS A3.0, and other specifications and Military requirements, as applicable. This document supplies actual test results of non-specific inspection in conformance with the requirements of EN 10204, type 2.2 certification.

THE STEEL USED IN THIS LOT OF MATERIAL WAS MELTED AND MANUFACTURED IN THE U.S.A.

Test Settings						
Shielding Medium	Amps / Polarity	Volts	WFS in/min(mm/min)	ESD in(mm)	Preheat F(C)	Interpass F(C)
M21ArC25	240 / DCEP	25	335 (8.3)	75 (19)	300(149)	300(149)
M11ArC6	250 / DCEP	27	300 (8)	75 (19)	0	0

Mechanical Properties - Tensile					
Shielding Medium	Ref. No.	Testing Conditions	Ult. Tensile Strength psi (MPa)	Yield Strength psi (MPa)	Elong. % in 2"
M21ArC25	PE3132	Aged 48 Hrs 220F	102,000 (703)	95,000 (654)	21
M11ArC6	PE3136	Aged 48 Hrs 200F	106,000 (743)	104,000 (717)	21

Mechanical Properties - Impact						
Shielding Medium	Ref. No.	Testing Conditions	Temp. F (C)	Individuals ft.lb.(J)	Avg. ft.lb.(J)	Type
M21ArC25	PE3132	As Welded	-60 (-51)	69.62/84 (94.84/8.7)	65 (88)	Charpy-V-Notch
M11ArC6	PE3136	As Welded	-60 (-51)	75.70/68 (102.95/92)	71 (96)	Charpy-V-Notch

Ref. No.	Radiographic Inspection	Horizontal	Vertical
PE3132	Conforms	Horizontal	Vertical
PE3136	Conforms	Horizontal	Vertical

Chemical Analysis													
Shielding Medium / Ref. No.	C	Mn	P	S	Si	Cu	Cr	V	Ni	Mo	Al	Ti	Nb
M21ArC25 / PE3132	0.08	1.45	0.006	0.007	0.39	0.03	0.04	<.01	1.56	0.30			
M11ArC6 / PE3136	0.08	1.48	0.006	0.007	0.43	0.03	0.04	<.01	1.54	0.30			

Diffusible Hydrogen Collected per AWS A4.3

M20ArC-10	3.9 ml/100g of weld metal for .045 in diameter 20% relative humidity
M21ArC-25	3.2 ml/100g of weld metal for .045 in diameter 20% relative humidity

David A. Thomas
 David Thomas, Quality Assurance Rep.

Certification and Limited Warranty - Data for the above supplied product are those obtained when welded and tested in accordance with the above specification. All tests for the above classification were satisfied. Other tests and procedures may produce different results.



Certificate of Conformance to Requirements for Welding Electrode

Product Type: **FabCOR 1100**
 Classification: **E110C-K4 H4**
 Specifications: **AWS A5.28/A5.28M; ASME SFA 5.28**
 Diameter Tested: **1/16"**
 Date Tested: **9/8/2022**
 Date Generated: **9/16/2022**

This is to certify that the product named above and supplied on the referenced order number is of the same classification, manufacturing process, and material requirements as the material which was used for the test that was conducted on the date shown, the results of which are shown below. All tests required by the specifications shown for classification were performed at that time and the material tested met all requirements. It was manufactured and supplied by the Quality System Program of Hobart Brothers, which meets the requirements of ISO 9001, ANSI/AWS A5.01, and other specification and Military requirements, as applicable. This document supplies actual test results of non-specific inspection in conformance with the requirements of EN 10204, type 2.2 certification.

THE STEEL USED IN THIS LOT OF MATERIAL WAS MELTED AND MANUFACTURED IN THE U.S.A.

Test Settings						
Shielding Medium	Amps / Polarity	Volts	WFS in/min(mm/min)	ESD in(mm)	Preheat F(C)	Interpass F(C)
M20ArC-10	350 / DCEP	26	280 (7.1)	.75 (19)	300(149)	300(149)
M21ArC-25	350 / DCEP	29	280 (7.1)	3/4 (19)	300(149)	300(149)

Mechanical Properties - Tensile					
Shielding Medium	Ref. No.	Testing Conditions	Ult. Tensile Strength psi (MPa)	Yield Strength psi (MPa)	Elong. % in 2"
M20ArC-10	PE4218	Aged 48 Hrs 220F	127,000 (876)	114,000 (786)	20
M21ArC-25	PE4690	Aged 48 Hrs 220F	120,000 (827)	110,000 (758)	19

Mechanical Properties - Impact						
Shielding Medium	Ref. No.	Testing Conditions	Temp. F (C)	Individuals ft.lb.(J)	Avg. ft.lb.(J)	Type
M20ArC-10	PE4218	As Welded	-60 (-51)	30.30/32 (41.41/43)	31 (42)	Charpy-V-Notch
M21ArC-25	PE4690	As Welded	-60 (-51)	34.40/36 (46.54/49)	37 (50)	Charpy-V-Notch

Ref. No.	Radiographic Inspection	Horizontal	Vertical
PE4218	Conforms	Horizontal	Vertical
PE4690	Conforms	Horizontal	Vertical

Chemical Analysis													
Shielding Medium / Ref. No.	C	Mn	P	S	Si	Cu	Cr	V	Ni	Mo	Al	Ti	Nb
M20ArC-10 / PE4218	0.10	1.66	0.012	0.012	0.66	0.05	0.24	0.01	1.83	0.49			
M21ArC-25 / PE4690	0.06	1.48	0.011	0.010	0.54	0.06	0.24	<.01	2.04	0.50			

Diffusible Hydrogen Collected per AWS A4.3

M21ArC-25	2.5 ml/100g of weld metal for 1/16 in diameter 13% relative humidity
M20ArC-10	3.0 ml/100g of weld metal for 1/16 in diameter 48% relative humidity

James A. Owens
 James A. Owens, Q.A. Specialist

Certification and Limited Warranty - Data for the above supplied product are those obtained when welded and tested in accordance with the above specification. All tests for the above classification were satisfied. Other tests and procedures may produce different results.

Select-Arc

- A few options that are off the shelf tailored to high-speed welding (automotive)
- If project needs willing to tailor custom electrodes

Select 70C-6

Carbon Steel / Gas Shielded / Metal Cored

PRODUCT DATA SHEET

FEATURES

- Tubular construction promotes faster travel speeds and better fusion than solid GMAW electrodes
- High level of deoxidizers enhances welding over hot rolled and casted pipe material
- Intended for single and multiple pass welding of most carbon steels, such as ASTM A36, A307, A516 and A572
- Smaller diameters (1/16" or smaller) can be pipe welded in all positions (call for parameter recommendations)
- The versatility of a slag free cored wire makes this ideal for general fabrication, structural steel work, and thin section applications, such as automotive components and hot water heaters

CONFORMANCES

AMSE SFA 5.18	E70C-6M-H
AWS A5.18	E70C-6M-H
AWS A5.36	E70T15-M20A4-C51-H4
AWS A5.18	E70T15-M21A4-C51-H4
ABS	2Y5A
AWS D1.8	0.045 in (1.2 mm) (80% Ar/19% CO ₂) 0.050 in (1.3 mm) (80% Ar/19% CO ₂) 1/16 in (1.6 mm) (80% Ar/19% CO ₂) 0.045 in (1.2 mm) (80% Ar/19% CO ₂) 0.050 in (1.3 mm) (80% Ar/19% CO ₂) 1/16 in (1.6 mm) (80% Ar/19% CO ₂)

DIAMETERS [in (mm)]

0.035 (0.9), 0.045 (1.2), 0.052 (1.3), 1/16 (1.6), 5/64 (2.0), 3/32 (2.4)

POSITIONS

CWB CSA W48-18 E49T15-C1A3-C51-H4 (E491C-E444)
E49T15-M20A3-C51-H4 (E491C-6M-H4)
E49T15-M21A3-C51-H4 (E491C-6M-H4)

SHIELDING GAS

75-95%Ar/Balance CO₂ II YMS
Flow Rate: 40 - 50 CFM
LLOYDS 2Y5 (M5)

POLARITY

Direct Current Electrode Positive (DCEP)

TYPICAL WELD DEPOSIT CHEMISTRY (WT%)

Shielding Gas	C	Cr	Cu	Mn	Mo	Ni	P	S	Si	V
75%Ar/25%CO ₂	0.06	0.00	0.00	1.80	0.01	0.02	0.010	0.010	0.05	0.00
85%Ar/15%CO ₂	0.06	0.00	0.00	1.62	0.01	0.02	0.012	0.008	0.03	0.01
92%Ar/8%CO ₂	0.06	0.00	0.02	1.73	0.01	0.01	0.010	0.008	0.09	0.00

TYPICAL MECHANICAL PROPERTIES

Shielding Gas	Tensile Strength ksi (MPa)	Yield Strength ksi (MPa)	Elongation (%)	Weld Condition	CVN @ 50°F (J)
75%Ar/25%CO ₂	87 (601)	70 (484)	25	As-Welded	49 (35)
85%Ar/15%CO ₂	89 (614)	74 (515)	25	As-Welded	21 (25)
92%Ar/8%CO ₂	92 (634)	78 (538)	27	As-Welded	28 (38)

SELECT-ARC
Revision: 01/2022

Note: The results reported are based upon testing of the product under controlled laboratory conditions in accordance with American Society for Testing and Materials (ASTM) and other applicable standards. Actual use of the product may present different results due to varying conditions. For example, the results reported herein are based upon testing of the product under controlled laboratory conditions. The actual results may vary depending on the specific application and the conditions of use. The results reported herein are for informational purposes only and do not constitute a warranty. The results reported herein are for informational purposes only and do not constitute a warranty.

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Select 70C-10

Carbon Steel / Gas Shielded / Metal Cored

PRODUCT DATA SHEET

FEATURES

- Designed for single pass welding of high-speed welding of thin gauge carbon steels
- Travel speeds of 60-100 ipm are readily achievable
- Performance of this product is not dependent on high technology power sources, a standard C/V machine produces excellent results
- Applications include welding automotive and truck frames, automotive trailer assemblies, farm machinery and other general purpose welding of light gauge components.

CONFORMANCES

AMSE SFA 5.18	E70C-50M
AWS A5.18	E70C-50M

DIAMETERS [in (mm)]

0.045 (1.2), 1/16 (1.6), 5/64 (2.0)

POSITIONS

SHIELDING GAS
Ar + 5-25% CO₂
Flow Rate: 40 - 50 CFM

POLARITY

Direct Current Electrode Positive (DCEP)

TYPICAL MECHANICAL PROPERTIES

Shielding Gas	Tensile Strength (ksi) (MPa)	Yield Strength (ksi) (MPa)	Elongation (%)	Weld Condition
75%Ar/25%CO ₂	82 (561)	65 (450)	25	As-Welded

SELECT-ARC
Revision: 01/2022

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Select 70C-T

Carbon Steel / Gas Shielded / Metal Cored

PRODUCT DATA SHEET

FEATURES

- This electrode is a microalloyed version of Select 70C-6, offering superior CVN toughness values at temperatures as low as -40° F.
- Intended for single and multiple pass welding of most carbon steels, such as ASTM A36, A307, A575-70, and A516-70 and 18 1/8 steels.
- This electrode exhibits a true spray transfer, with virtually no spatter
- Minimal slag inclusions on the weld surface, and these decrease with increased argon in the shielding gas
- Smaller diameter electrodes can be used in all position welding with either pulsed arc or short circuit arc welding process.
- These materials would be used in the fabrication of railcars, mining machinery, shipbuilding, engineering equipment, pipeline material, and fabrications utilized in cold climates.

CONFORMANCES

AMSE SFA 5.18	E70C-6M
AWS A5.18	E70C-6M
AWS A5.36	E70T15-M20A4-C51
AWS A5.18	E70T15-M21A4-C51
ABS	3Y5A
CWB CSA W48-18	E49T15-M20A4-C51-H4 (E491C-6M-H4) E49T15-M21A4-C51-H4 (E491C-6M-H4)
DNV	II YMS (M5)
LLOYDS	3Y5 (M5)

DIAMETERS [in (mm)]

0.035 (0.9), 0.045 (1.2)

POSITIONS

SHIELDING GAS
75-92%Ar/Balance CO₂
Flow Rate: 40 - 50 CFM

POLARITY

Direct Current Electrode Positive (DCEP)

TYPICAL WELD DEPOSIT CHEMISTRY (WT%)

Shielding Gas	C	Cr	Cu	Mn	Mo	Ni	P	S	Si	V
75%Ar/25%CO ₂	0.06	0.04	0.00	1.60	0.002	0.00	0.011	0.010	0.07	0.000
92%Ar/8%CO ₂	0.06	0.04	0.04	1.70	0.004	0.00	0.013	0.008	0.10	0.004

TYPICAL MECHANICAL PROPERTIES

Shielding Gas	Tensile Strength ksi (MPa)	Yield Strength ksi (MPa)	Elongation (%)	Weld Condition	CVN @ 50°F (J)
75%Ar/25%CO ₂	85 (588)	70 (538)	30	As-Welded	33 (45)
92%Ar/8%CO ₂	90 (621)	73 (503)	28	As-Welded	25 (34)

SELECT-ARC
Revision: 01/2022

Note: The results reported are based upon testing of the product under controlled laboratory conditions in accordance with American Society for Testing and Materials (ASTM) and other applicable standards. Actual use of the product may present different results due to varying conditions. For example, the results reported herein are based upon testing of the product under controlled laboratory conditions. The actual results may vary depending on the specific application and the conditions of use. The results reported herein are for informational purposes only and do not constitute a warranty. The results reported herein are for informational purposes only and do not constitute a warranty.

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Select 80C-Ni1

Low Alloy / Gas Shielded / Metal Cored

PRODUCT DATA SHEET

FEATURES

- Intended for welding horizontal and flat fillets and full groove welds
- Can be used with shielding gas mixtures of 75-92% Argon/Inert Gas and 95-98% Argon/Balance CO₂
- A good selection for welding steels such as ASTM A203-Grade E, A302, A575, and A633
- Typical applications would be fabrication of automotive machinery parts and buckets, mining machinery, and fine-grained structural steels.

CONFORMANCES

AMSE SFA 5.28	E80C-N1-H4
AWS A5.28	E80C-N1-H4
AWS A5.36	E80T15-M20A4-N1-H4
AWS A5.18	E80T15-M21A4-N1-H4
CWB CSA W48-18	E50T15-M20A4-N1-H4 (E50C-N1-H4) E50T15-M21A4-N1-H4 (E50C-N1-H4) E50T15-M21A4-N1-H4 (E50C-N1-H4)

DIAMETERS [in (mm)]

0.035 (0.9), 0.045 (1.2), 0.052 (1.3), 1/16 (1.6)

POSITIONS

SHIELDING GAS
75-92%Ar/Balance CO₂, 95-98%Ar/Balance CO₂
Flow Rate: 40 - 50 CFM

POLARITY

Direct Current Electrode Positive (DCEP)

TYPICAL WELD DEPOSIT CHEMISTRY (WT%)

Shielding Gas	C	Cr	Cu	Mn	Mo	Ni	P	S	Si	V
80%Ar/20%CO ₂	0.03	0.11	1.40	0.15	0.04	0.000	0.010	0.03	0.01	
88%Ar/12%CO ₂	0.03	0.05	1.45	0.14	0.05	0.000	0.010	0.00	0.01	

TYPICAL MECHANICAL PROPERTIES

Shielding Gas	Tensile Strength ksi (MPa)	Yield Strength ksi (MPa)	Elongation (%)	Weld Condition	CVN @ 50°F (J)
80%Ar/20%CO ₂	84 (583)	69 (482)	25	As-Welded	30 (41)
88%Ar/12%CO ₂	89 (621)	73 (503)	25	As-Welded	30 (41)

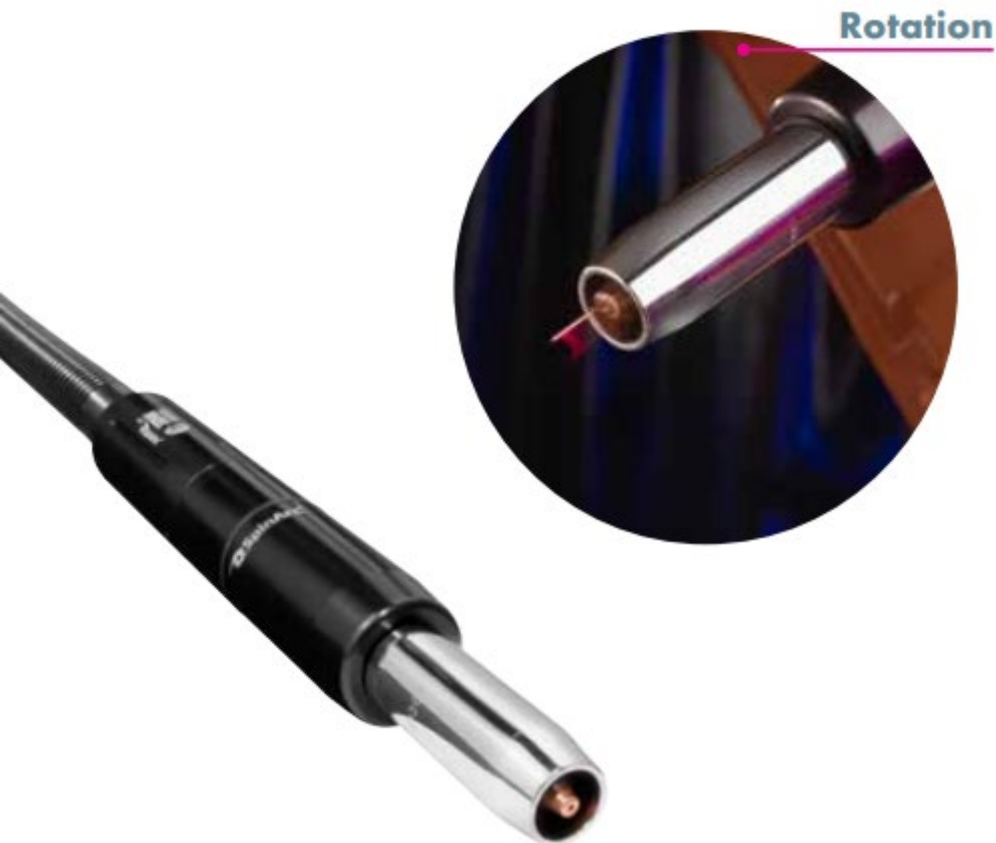
SELECT-ARC
Revision: 01/2022

Note: The results reported are based upon testing of the product under controlled laboratory conditions in accordance with American Society for Testing and Materials (ASTM) and other applicable standards. Actual use of the product may present different results due to varying conditions. For example, the results reported herein are based upon testing of the product under controlled laboratory conditions. The actual results may vary depending on the specific application and the conditions of use. The results reported herein are for informational purposes only and do not constitute a warranty. The results reported herein are for informational purposes only and do not constitute a warranty.

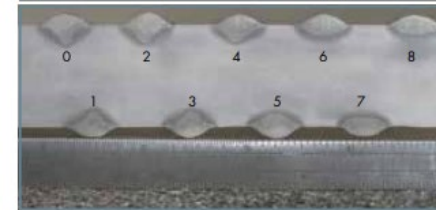
600 Enterprise Drive, P.O. Box 206, Fort Lorain, Ohio 45644-0206 • 800-541-6215 • www.Select-Arc.com

Abicor Binzel

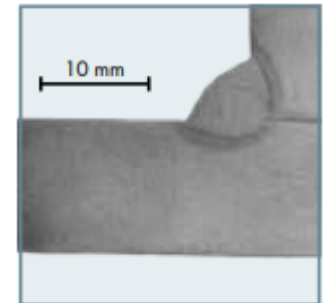
SpinArc® Automatic MIG Gun



Pos.	Setting scale	Rotation diameter
0	-	no spin
1	1	1.0 mm
2	2	2.0 mm
3	3	3.0 mm
4	4	4.0 mm
5	5	5.0 mm
6	6	6.0 mm
7	7	7.0 mm
8	8	8.0 mm



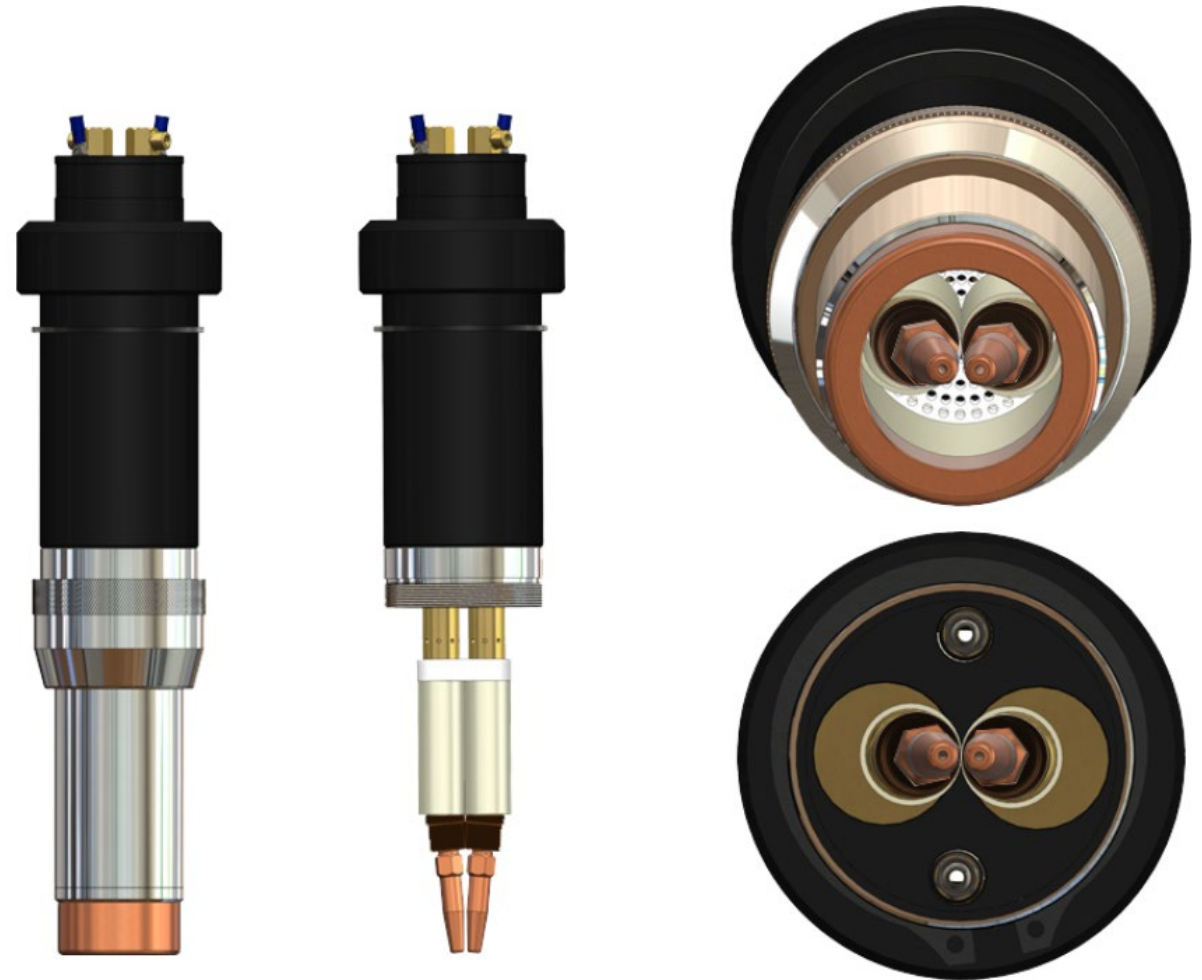
- Tool free spin diameter adjustability
- Digital motor control circuit for precise spin speed control
- Contact tip extensions for deep, narrow, grooved welds
- Automated and robotic applications



Fillet weld:
increase travel speeds by 25 to 50% with ideal penetration profile

D/F Specialties

- 850 Amps @ 100% Duty
- Max 1700 Amps
- The distance between the tandem contact tips (the wires) can vary by removing the body screws of one or both inner bodies. This allows rotation of each inner body increasing or decreasing the distance between the two welding wires.
- The D/F Tandem Barrel inner bodies can be either straight or bent to desired degrees to help achieve different center-point distances between the two tandem contact tips and are easily changeable.



Wenglor








- Regarding reflective surfaces, given the history of using profile sensors in many different industries Wenglor has tools/filters and algorithms built into the sensors to handle reflection. Wenglor also offers red and blue lasers from 2M to 3B power of lasers.
- Using the fastest travel of 2 meters per minute (2000 mm per minute/33mm/second) there would be a look ahead distance of at least 0.44 mm.



Task 3 – Feasibility Testing of Next Generation DE-GMAW Processes

- Candidate double electrode process variants will be evaluated with feasibility tests.
 - For each process combination, a series of constant deposit area (constant wire feed speed/travel speed ratio) tests will be performed at two arc lengths using the ARCWISE method. This method uses systematic tests to develop operational windows, assess bead shape, and determine productivity for weld joint applications.
 - For feasibility tests, all assessments will be made using only visual, dimensional, and weld surface quality data.
 - Up to three preferred processes will be selected for detailed ARCWISE testing in Task 4.

Task 3 – Feasibility Testing of Next Generation DE-GMAW Processes

COMPANY	POCs	TECHNOLOGY	DEPOSITION
	Steve Peters	HyperFill	24-Lb/Hr
	Steve Massey	Hercules	30-Lb/Hr
	Shaun Relyea	tps/i TWIN	35-Lb/Hr
	Mike Moore	Tandem Synergy Pro	35-Lb/Hr
	Ben Kahut	Consumables	
	Tom Graham	SpinArc	Not Applicable
	Steve Moerke	Tandem Torch	Not Applicable

Next Steps

- Task 4 – Precision Fillet Weld Operational Windows, Bead Shape Maps, and Productivity Analysis
 - Systematic ARCWISE tests will be performed on up to three process combinations from Task 3.
- Task 5 – DE-GMAW Process Benchmarking and Productivity Analysis
 - Analyze test data from Task 4
 - Operational windows will be used to determine process tolerance.
 - The ARCWISE data set will include the operational windows and plots that characterize the relationship between voltage, current and wire feed speed; heat input vs deposition rate; and the bead shape relationships.
 - Recommended welding procedures will be determined from operational windows making precision 4-mm fillets.
- Task 6 – Next Generation DE-GMAW Technology Workshop
 - One-day workshop at the end of the project to demonstrate the preferred process processes and review performance data with U.S. shipyards.

Questions?

