EWI NSRP Welding Technology Panel Project Updates

Jim Hansen, EWI

August 1, 2023

NATIONAL SHIPBUILDING RESEARCH PROGRAM™
Taking Shipbuilding and Repair to the Next Level

GMAW Electrode and Procedure Technology for Silicate-Free Weld Deposition

NSRP Project Manager: Ryan Schneider
NSRP PTR: Paul Hebert

August 1, 2023

NSRP
NATIONAL SHIPBUILDING RESEARCH PROGRAM™
Taking Shipbuilding and Repair to the Next Level

Project Team

- EWI (prime)
  - Jim Hansen (PI), Joe Getgen (Engineering support), Dennis Harwig (Senior Technical Leader)
  - Steve Blevins (PM), Mark Schimming (VP Govt Business)
- ATI PM
  - Ryan Schneider
- NSRP Program Technical Representative (PTR)
  - Paul Hebert
- Participant
  - HII-Ingalls – John Walks, Kevin Roossinck
  - NSWCCD – Matt Sinfield

Background

- In GMAW of shipbuilding steels, silicates (small slag islands) form on the weld deposit surface and must be removed prior to multipass welding and before structural painting
  - A new reduced-silicate wire has been developed by ESAB for lean CO_2 shielding
    - This wire has produced sound deposits in industrial fillet welding evaluations
  - Need to evaluate, apply, and / or modify silicate free electrodes for multi-pass groove welding to improve shipbuilding productivity and affordability

Goals

- Develop silicate-free GMAW technology mitigating the need for multipass weld interpass cleaning

- Explore & demonstrate (if possible) use with existing procedures, classify within existing Tech Pub 248 groupings, and expedite impact across shipyards using existing procedures

Technical Objectives

- Develop a matrix of welding procedures for tandem GMAW (T-GMAW) process at minimum and maximum heat inputs for two HSLA-65 steel plate thicknesses
  - Min / max heat inputs based on existing Ingalls T-GMAW procedures
- Evaluate the T-GMAW properties using representative procedure qualification tests per MIL-STD-271 and Tech Pub 248
  - Coordinate with NSWCCD to identify requirements for MIL-Spec classification
  - Compare qualification results to MIL-70S-6 weld wire
- Determine next steps to drive transition of the silicate-free wire technology into NSRP member shipyards
  - Silicate-free T-GMAW Demonstration & Transition workshop at EWI

Status to date

- Material Acquisition
  - ESAB's reduced-silicate wire is being shipped from their development facility in Sweden
  - Ingalls is in the process of prepping 0.5-in and 1-in thick HSLA-65 plate to be sent to EWI
- Develop procedure matrix at min / max heat inputs for two HSLA-65 steel plate thicknesses – In Process
- Benchmark metal transfer and silicate island formation of legacy ER70S-6 electrode – In Process
  - EWI's high speed video system will be used to understand metal transfer characteristics of both the legacy and reduced-silicate wire

Next Generation Double Electrode GMAW Processes for Precision Fillet Welding

NSRP Project Manager: Ryan Schneider
NSRP PTR: Paul Hebert

NSRP Weld Panel Meeting – August 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

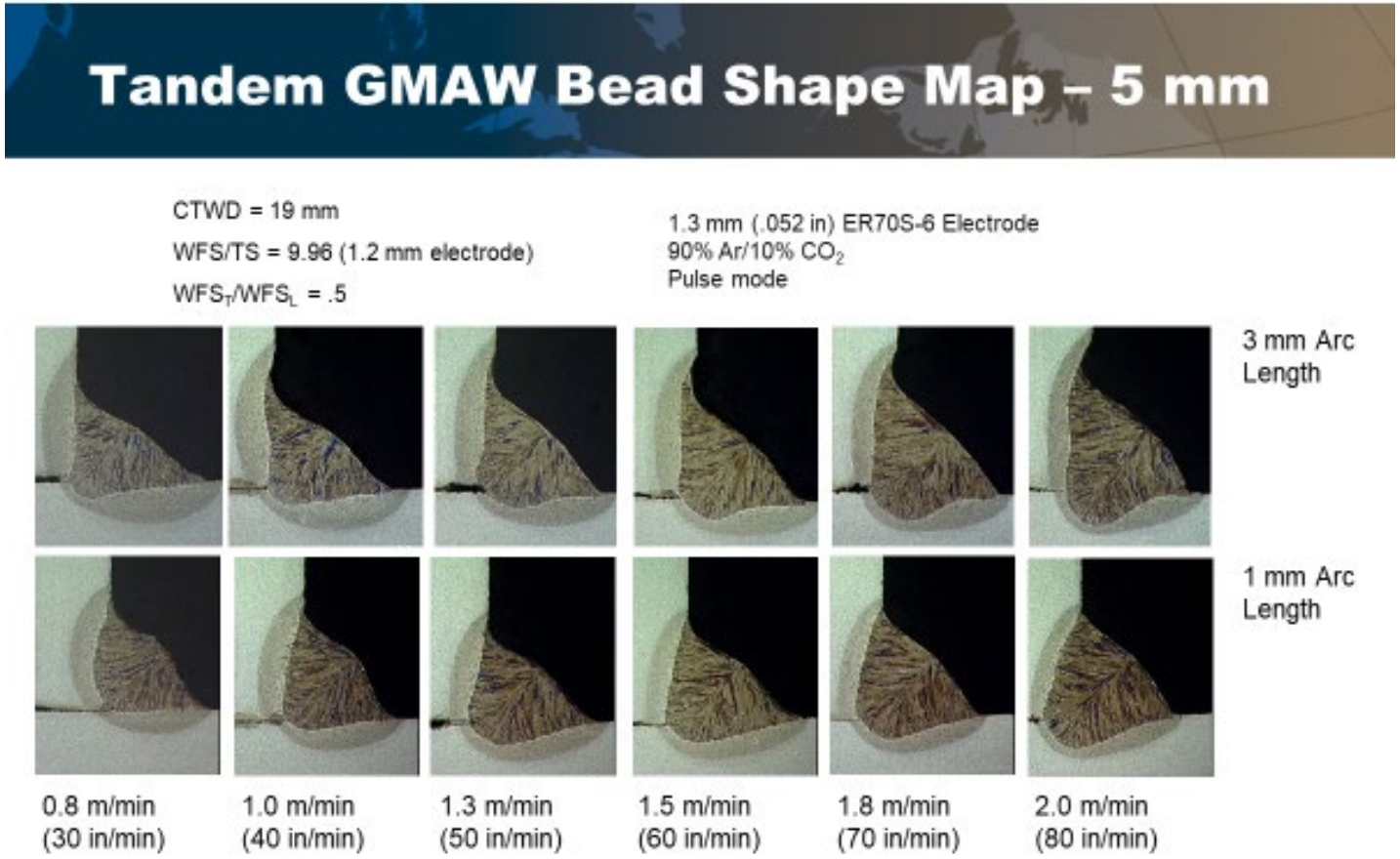
- Double electrode gas metal arc welding (GMAW) processes, such as tandem and twin, typically provide two to three times the productivity of single electrode GMAW and flux cored arc welding (FCAW) processes.
- Need high productivity process for 4-mm precision fillet welds
  - Thin panel stiffener welding
  - 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 HyperFillTM)
  - 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.



Arcwise Bead Shape Map Example

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 – Complete
- Task 4 – Precision Fillet Weld Operational Windows, Bead Shape Maps, and Productivity Analysis - In Process
- Task 5 – DE-GMAW Process Benchmarking and Productivity Analysis - In Process
- Task 6 – Next Generation DE-GMAW Technology Workshop - In Process

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
    - Fronius
    - Miller
    - Select Arc

Market Survey

COMPANY	POCs	TECHNOLOGY	DEPOSITION
LINCOLN ELECTRIC	Steve Peters	HyperFill	24-Lb/Hr
Miller	Steve Massey	Hercules	30-Lb/Hr
Fronius	Shaun Relyea	tps/i TWIN	35-Lb/Hr
CLOOS	Mike Moore	Tandem Synergy Pro	35-Lb/Hr
ESAB	Nate Lott		
OTC DAIHEN Inc.	Larry Barley	SyncroFeed	18-Lb/Hr
		Buried Arc	Not Applicable
SELECT ARC INC.	Ben Kahut	Consumables	
HOBART FILLER METALS	Kim Francis	Consumables	Not Applicable
ABICOR BINZEL	Tom Graham	SpinArc	Not Applicable
D MIG TIG	Steve Moerke	Tandem Torch	Not Applicable

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 was performed at two arc lengths using the ARCWISE method. This method used systematic tests to develop operational windows, assess bead shape, and determine productivity for weld joint applications.
  - For feasibility tests, all assessments were made using only visual, dimensional, and weld surface quality data.
  - Up to three preferred processes were selected for detailed ARCWISE testing in Task 4.

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

Down selected

COMPANY	POCs	TECHNOLOGY	DEPOSITION
LINCOLN ELECTRIC	Steve Peters	HyperFill	24-Lb/Hr
Miller	Steve Massey	Hercules	30-Lb/Hr
Fronius	Shaun Relyea	tps/i TWIN	35-Lb/Hr
CLOOS	Mike Moore	Tandem Synergy Pro	35-Lb/Hr
SELECT ARC INC.	Ben Kahut	Consumables	
ABICOR BINZEL	Tom Graham	SpinArc	Not Applicable
DV MIG TIG	Steve Moerke	Tandem Torch	Not Applicable

Down selection into Task 4

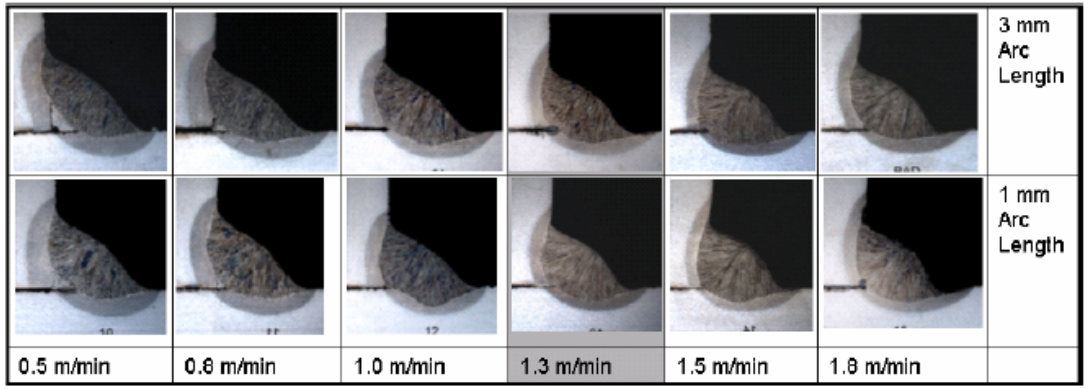
- Recommendations are to move forward:
  - Miller Hercules
  - Fronius tps/i TWIN
  - Cloos Tandem Synergy Pro.

- Select Arc 70C-10 should also be considered when additional bead wetting is needed.

Task 4 – Precision Fillet Weld Operational Windows, Bead Shape Maps, and Productivity Analysis

- Each process in Task 3 can run independently from each other.
- Systematic ARCWISE tests will be performed on up to three process combinations from Task 3.
  - For each process combination, a series of constant deposit area (WFS/TS ratio) tests will be performed at two arc lengths.
  - The tests will be performed over a full range of travel speeds (for example 0.25 to 2 m/min) to determine the minimum speed needed for fusion, the range of acceptable welding conditions, and the maximum speed to process failure.
  - Each test will be examined using visual and dimensional methods.
  - Metallographic sections will be removed from each test to characterize bead shape dimensions and quality.

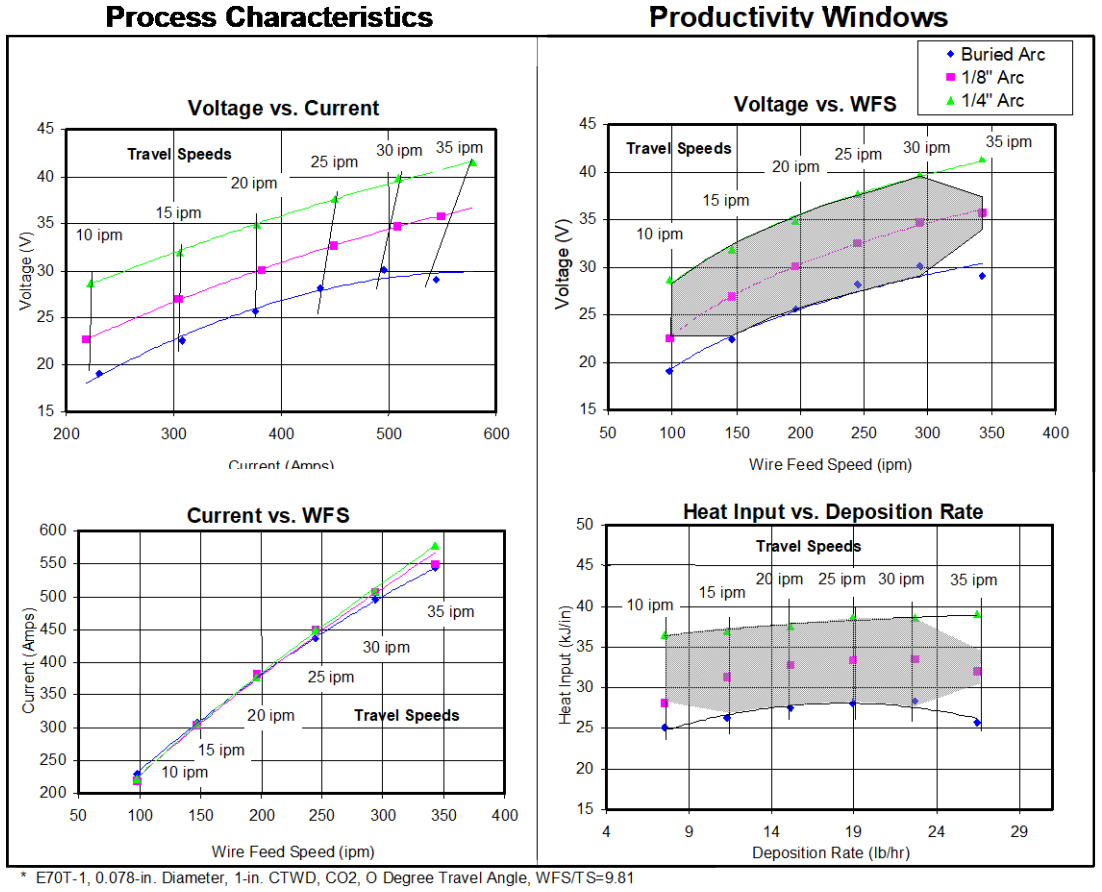
**Dierksheide



- TS range 0.25 to 2.0 m/min?
- Arc Lengths 1-mm and 3-mm?

Task 5 – DE-GMAW Process Benchmarking and Productivity Analysis

- This task will analyze all the 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 versus deposition rate; and bead shape relationships.
- Recommended welding procedures will be determined from the operational windows for making precision 4-mm fillets.



* E70T-1, 0.078-in. Diameter, 1-in. CTWD, CO2, O Degree Travel Angle, WFS/TS=9.81

**Harwig

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 in September to demonstrate the preferred process processes and review performance data with U.S. shipyards.

Questions?

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Old slides from all panel meeting

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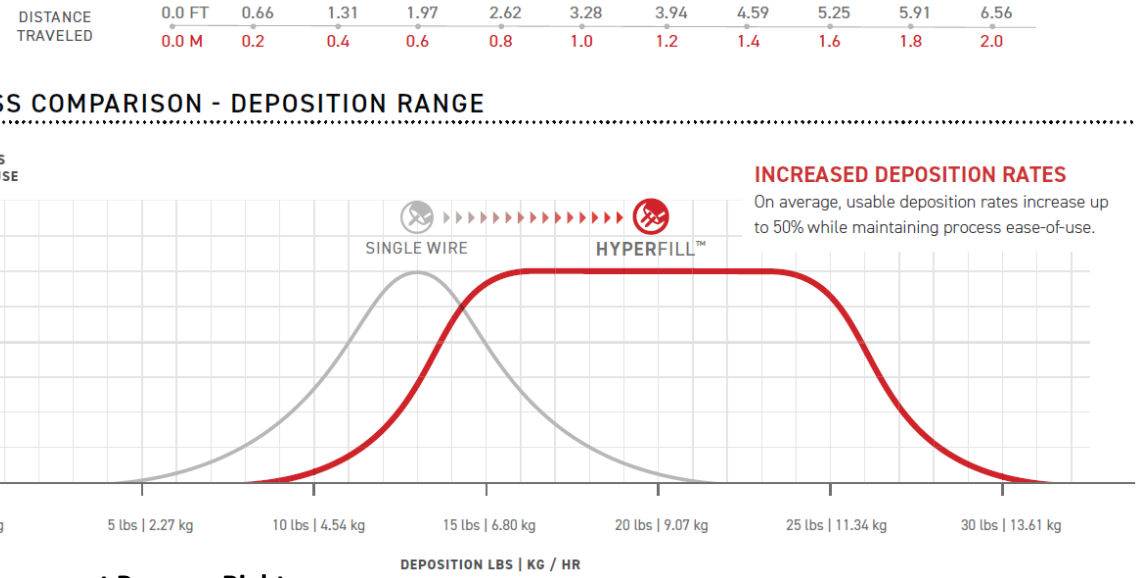
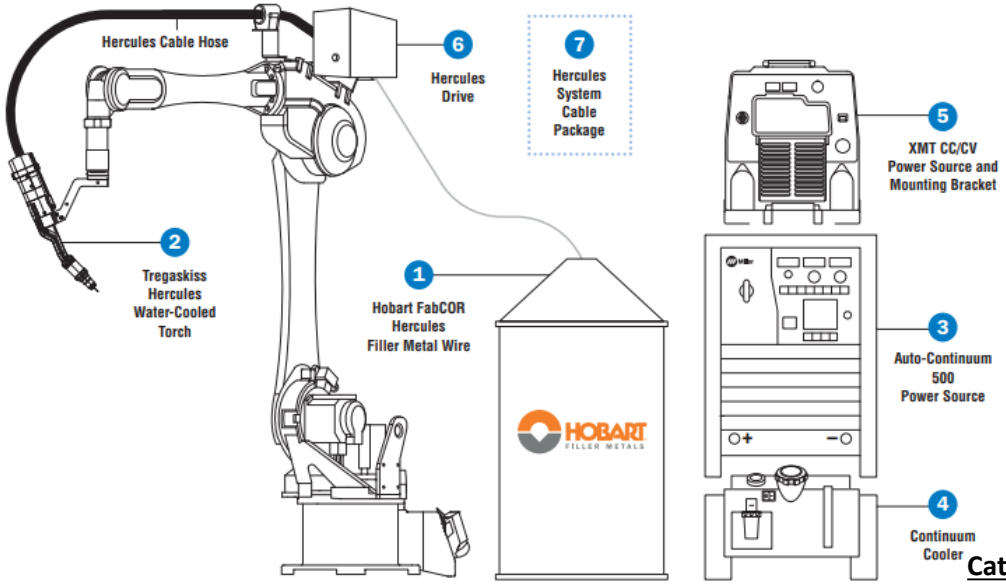
Lincoln HyperFill

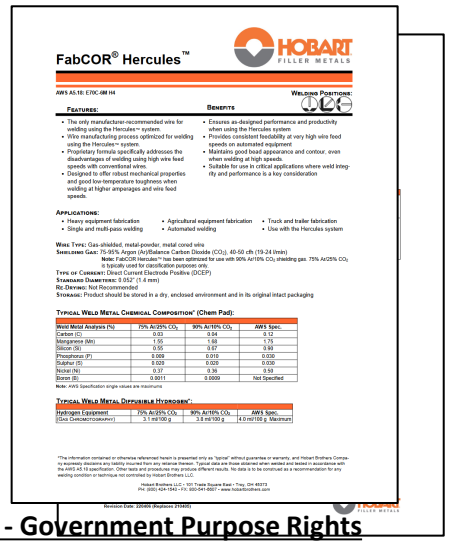
- Twin-wire GMAW solution
- Designed for semiautomatic and automatic applications
- Deposition rates above 18 lbs/hr (24+ lbs/hr robotically
- Ease-of-use (one power supply/feeder)
- Not direction dependent

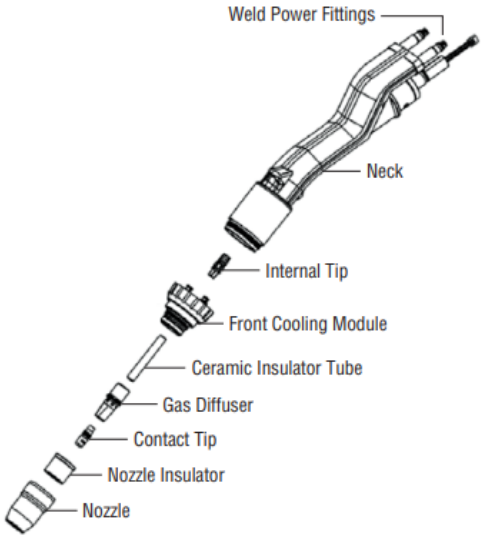


Miller Hercules

- 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





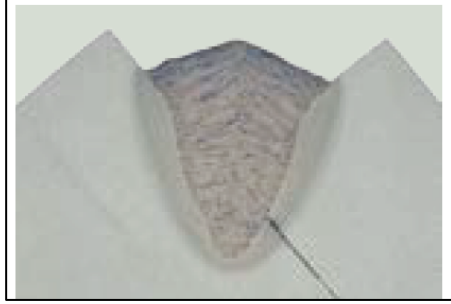


Fronius TPSi TWIN

- 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

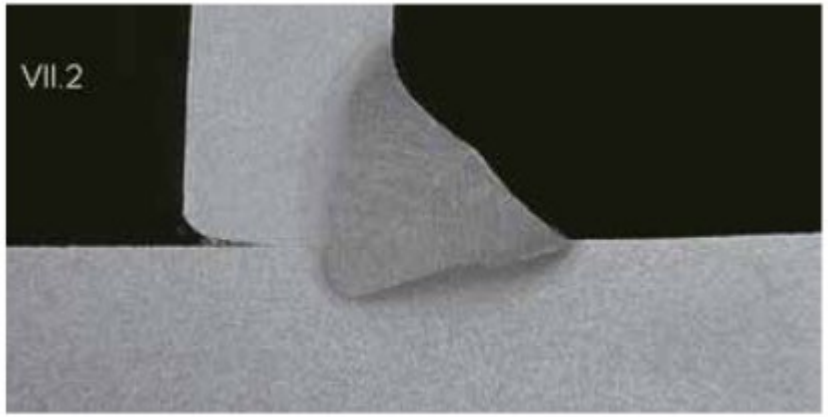
One welding pass is all it takes. Thanks to the high deposition rate of the TWIN system, welds that needed to be welded in multiple passes are a thing of the past.

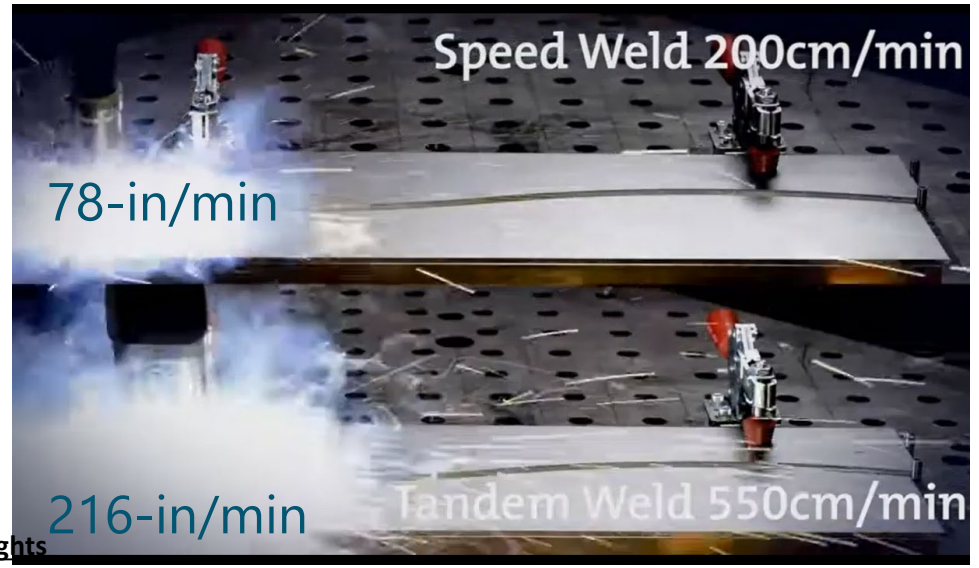


Parameters	
vs [cm/min]:	4.72 in/min
Dep. rate =	55.33 lb/h
Contact tip angle =	0°
Lead Vd =	PMC 106.29 in/min
Trail Vd =	PMC 78.74 in/min
a-dimension =	0.21
Penetration =	0.15 in

CLOOS Tandem

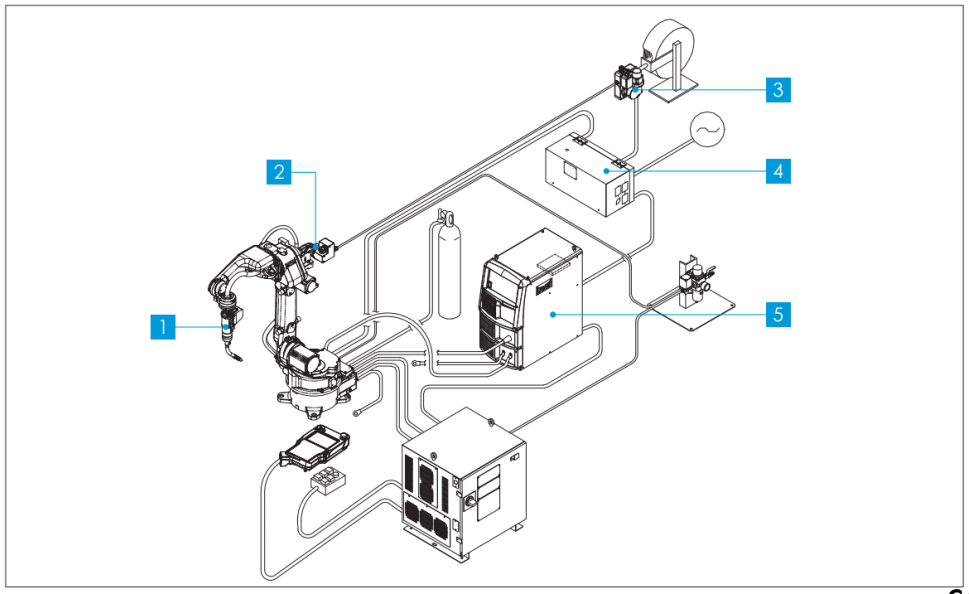
- Two-wire GMAW solution
- Designed for semiautomatic and automatic applications
- Deposition rates above 35 lbs/hr (robotically)
- Two separate welding systems
- Direction dependent





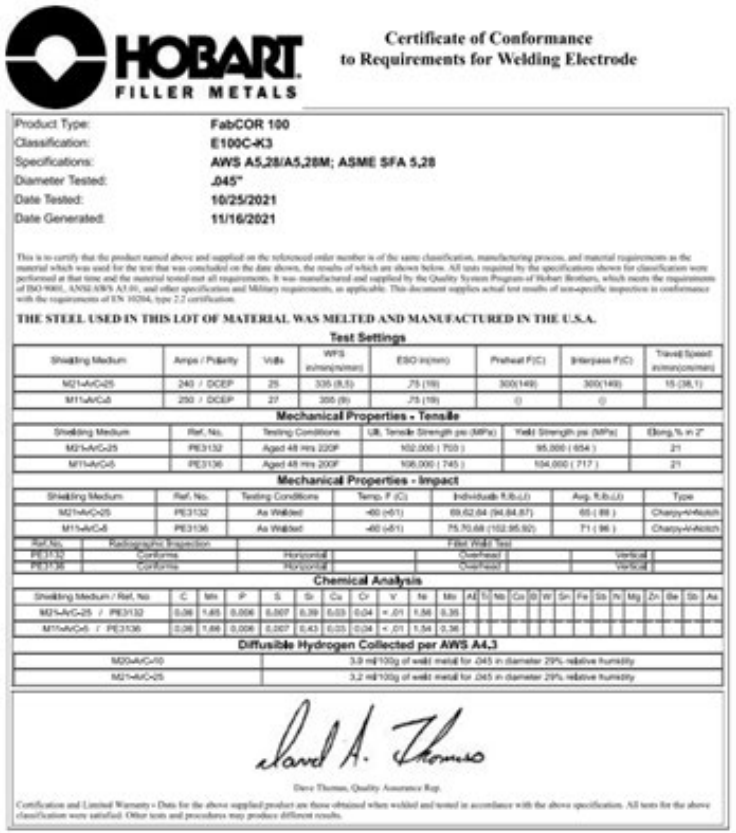
OTC

- 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



HOBART FILLER METALS

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 concluded 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(m/min)	ESO in(mm)	Preheat F(C)	Interpass F(C)	Travel Speed in/min(cm/min)
M21-ArC-25	240 / DCEP	25	335 (8.5)	.75 (19)	300(149)	300(149)	15 (38.1)
M11-ArC-5	250 / DCEP	27	355 (9)	.75 (19)	()	()	

Mechanical Properties - Tensile

Shielding Medium	Ref. No.	Testing Conditions	Ult. Tensile Strength psi (MPa)	Yield Strength psi (MPa)	Elong.% in 2"
M21-ArC-25	PE3132	Aged 48 Hrs 220F	102,000 (703)	95,000 (654)	21
M11-ArC-5	PE3136	Aged 48 Hrs 200F	108,000 (745)	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
M21-ArC-25	PE3132	As Welded	-60 (-51)	69,62,64 (94,84,87)	65 (88)	Charpy-V-Notch
M11-ArC-5	PE3136	As Welded	-60 (-51)	75,70,68 (102,95,92)	71 (96)	Charpy-V-Notch

Ref.No.	Radiographic Inspection	Fillet Weld Test					
PE3132	Conforms	Horizontal :		Overhead :		Vertical :	
PE3136	Conforms	Horizontal :		Overhead :		Vertical :	

Chemical Analysis

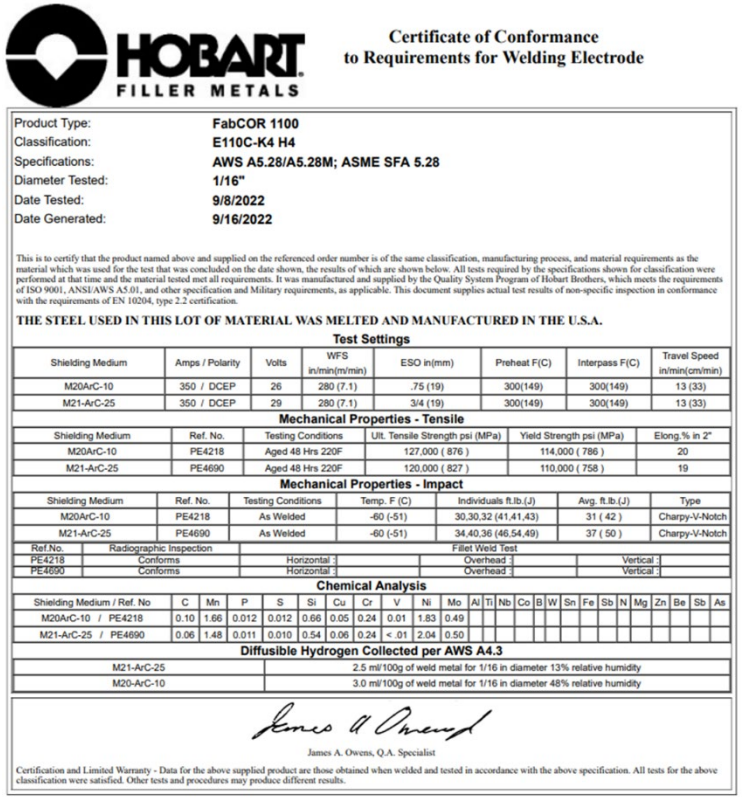
Shielding Medium / Ref. No	C	Mn	P	S	Si	Cu	Cr	V	Ni	Mo	Al	Ti	Nb	Co	B	W	Sn	Fe	Sb	N	Mg	Zn	Be	Sb	As
M21-ArC-25 / PE3132	0.06	1.65	0.008	0.007	0.39	0.03	0.04	< .01	1.58	0.35															
M11-ArC-5 / PE3136	0.06	1.66	0.008	0.007	0.43	0.03	0.04	< .01	1.54	0.36															

Diffusible Hydrogen Collected per AWS A4.3

M20-ArC-10	3.0 ml/100g of weld metal for .045 in diameter 29% relative humidity
M21-ArC-25	3.2 ml/100g of weld metal for .045 in diameter 29% relative humidity

Dave 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.



HOBART FILLER METALS

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 concluded 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(m/min)	ESO in(mm)	Preheat F(C)	Interpass F(C)	Travel Speed in/min(cm/min)
M20ArC-10	350 / DCEP	26	280 (7.1)	.75 (19)	300(149)	300(149)	13 (33)
M21-ArC-25	350 / DCEP	29	280 (7.1)	3/4 (19)	300(149)	300(149)	13 (33)

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
M21-ArC-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
M21-ArC-25	PE4690	As Welded	-60 (-51)	34,40,36 (46,54,49)	37 (50)	Charpy-V-Notch

Ref.No.	Radiographic Inspection	Fillet Weld Test					
PE4218	Conforms	Horizontal :		Overhead :		Vertical :	
PE4690	Conforms	Horizontal :		Overhead :		Vertical :	

Chemical Analysis

Shielding Medium / Ref. No	C	Mn	P	S	Si	Cu	Cr	V	Ni	Mo	Al	Ti	Nb	Co	B	W	Sn	Fe	Sb	N	Mg	Zn	Be	Sb	As
M20ArC-10 / PE4218	0.10	1.66	0.012	0.012	0.66	0.05	0.24	0.01	1.83	0.49															
M21-ArC-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

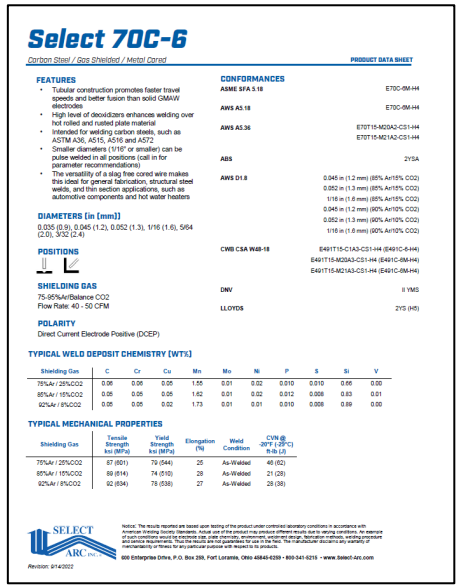
M21-ArC-25	2.5 ml/100g of weld metal for 1/16 in diameter 13% relative humidity
M20-ArC-10	3.0 ml/100g of weld metal for 1/16 in diameter 48% relative humidity

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 rusted plate material
- Intended for welding carbon steels, such as ASTM A36, A515, A516 and A572
- Smaller diameters (1/16" or smaller) can be pulse welded in all positions (call in for parameter recommendations)
- The versatility of a slag free cored wire makes this ideal for general fabrication, structural steel welds, and thin section applications, such as automotive components and hot water heaters

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

SHIELDING GAS

75-95%Ar/Balance CO2
Flow Rate: 40 - 50 CFM

POLARITY

Direct Current Electrode Positive (DCEP)

CONFORMANCES

ASME SFA 5.18	E70C-6M-H4
AWS A5.18	E70C-6M-H4
AWS A5.36	E70T15-M20A2-CS1-H4 E70T15-M21A2-CS1-H4
ABS	3YSA
AWS D1.8	0.045 in (1.2 mm) (85% Ar/15% CO2) 0.052 in (1.3 mm) (85% Ar/15% CO2) 1/16 in (1.6 mm) (85% Ar/15% CO2) 0.045 in (1.2 mm) (90% Ar/10% CO2) 0.052 in (1.3 mm) (90% Ar/10% CO2) 1/16 in (1.6 mm) (90% Ar/10% CO2)
CWB CSA W48-18	E491T15-C1A3-CS1-H4 (E491C-6-H4) E491T15-M20A3-CS1-H4 (E491C-6M-H4) E491T15-M21A3-CS1-H4 (E491C-6M-H4)
DNV	II YMS
LLOYDS	2YS (H5)

TYPICAL WELD DEPOSIT CHEMISTRY [WT%]

Shielding Gas	C	Cr	Cu	Mn	Mo	Ni	P	S	Si	V
75%Ar / 25%CO2	0.06	0.06	0.05	1.55	0.01	0.02	0.010	0.010	0.66	0.00
85%Ar / 15%CO2	0.05	0.05	0.05	1.62	0.01	0.02	0.012	0.008	0.83	0.01
92%Ar / 8%CO2	0.05	0.05	0.02	1.73	0.01	0.01	0.010	0.008	0.89	0.00

TYPICAL MECHANICAL PROPERTIES

Shielding Gas	Tensile Strength ksi (MPa)	Yield Strength ksi (MPa)	Elongation (%)	Weld Condition	CVN @ -20°F (-29°C) ft-lb (J)
75%Ar / 25%CO2	87 (601)	79 (544)	25	As-Welded	46 (62)
85%Ar / 15%CO2	89 (614)	74 (510)	26	As-Welded	21 (28)
92%Ar / 8%CO2	92 (634)	76 (538)	27	As-Welded	28 (38)

SELECT ARC INC.

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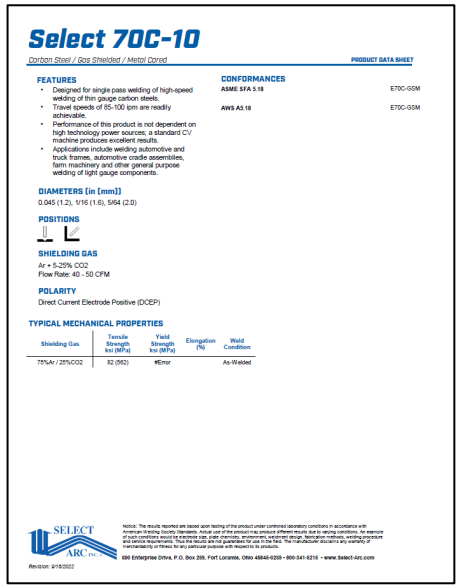

Select 70C-10

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 85-100 ipm are readily achievable.
- Performance of this product is not dependent on high technology power sources; a standard CV machine produces excellent results.
- Applications include welding automotive and truck frames, automotive cradle assemblies, farm machinery and other general purpose welding of light gauge components.

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)

CONFORMANCES

ASME SFA 5.18	E70C-GSM
AWS A5.18	E70C-GSM

TYPICAL MECHANICAL PROPERTIES

Shielding Gas	Tensile Strength ksi (MPa)	Yield Strength ksi (MPa)	Elongation (%)	Weld Condition
75%Ar / 25%CO2	82 (562)	#Error		As-Welded

SELECT ARC INC.

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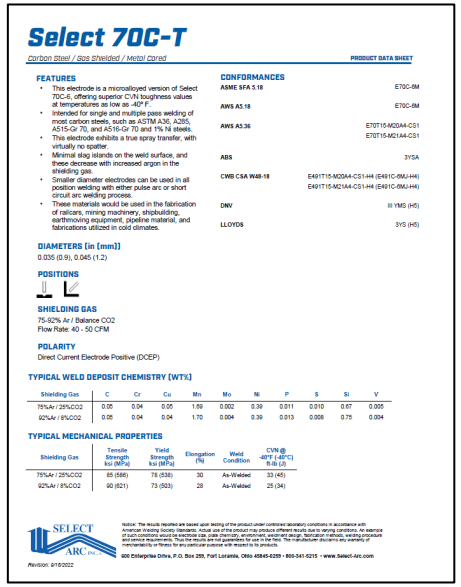

Select 70C-T

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, A285, A515-Gr 70, and A516-Gr 70 and 1% Ni steels.
- This electrode exhibits a true spray transfer, with virtually no spatter.
- Minimal slag islands 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 pulse arc or short circuit arc welding process.
- These materials would be used in the fabrication of railcars, mining machinery, shipbuilding, earthmoving equipment, pipeline material, and fabrications utilized in cold climates.

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)

CONFORMANCES

ASME SFA 5.18	E70C-6M
AWS A5.18	E70C-6M
AWS A5.36	E70T15-M20A4-CS1 E70T15-M21A4-CS1
ABS	3YSA
CWB CSA W48-18	E491T15-M20A4-CS1-H4 (E491C-6MJ-H4) E491T15-M21A4-CS1-H4 (E491C-6MJ-H4)
DNV	III YMS (H5)
LLOYDS	3YS (H5)

TYPICAL WELD DEPOSIT CHEMISTRY [WT%]

Shielding Gas	C	Cr	Cu	Mn	Mo	Ni	P	S	Si	V
75%Ar / 25%CO2	0.05	0.04	0.05	1.69	0.002	0.39	0.011	0.010	0.67	0.005
92%Ar / 8%CO2	0.05	0.04	0.04	1.70	0.004	0.39	0.013	0.008	0.75	0.004

TYPICAL MECHANICAL PROPERTIES

Shielding Gas	Tensile Strength ksi (MPa)	Yield Strength ksi (MPa)	Elongation (%)	Weld Condition	CVN @ -40°F (-40°C) ft-lb (J)
75%Ar / 25%CO2	85 (586)	78 (538)	30	As-Welded	33 (45)
92%Ar / 8%CO2	90 (621)	73 (503)	28	As-Welded	25 (34)

SELECT ARC INC.

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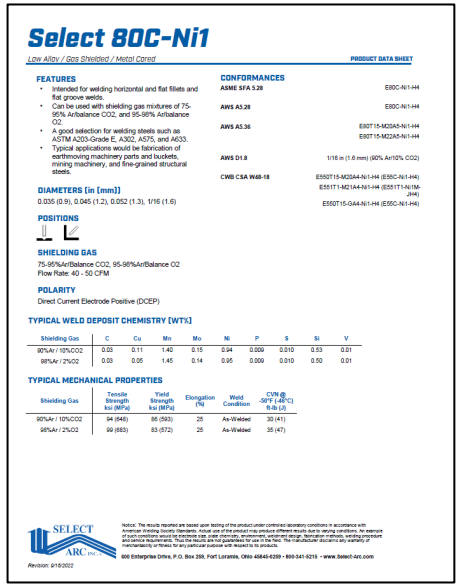

Select 80C-Ni1

Low Alloy / Gas Shielded / Metal Cored — PRODUCT DATA SHEET

FEATURES

- Intended for welding horizontal and flat fillets and flat groove welds.
- Can be used with shielding gas mixtures of 75-95% Ar/balance CO2, and 95-98% Ar/balance O2.
- A good selection for welding steels such as ASTM A203-Grade E, A302, A575, and A633.
- Typical applications would be fabrication of earthmoving machinery parts and buckets, mining machinery, and fine-grained structural steels.

DIAMETERS [in (mm)]

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

POSITIONS

SHIELDING GAS

75-95%Ar/Balance CO2, 95-98%Ar/Balance O2
Flow Rate: 40 - 50 CFM

POLARITY

Direct Current Electrode Positive (DCEP)

CONFORMANCES

ASME SFA 5.28	E80C-Ni1-H4
AWS A5.28	E80C-Ni1-H4
AWS A5.36	E80T15-M20A5-Ni1-H4 E80T15-M22A5-Ni1-H4
AWS D1.8	1/16 in (1.6 mm) (90% Ar/10% CO2)
CWB CSA W48-18	E550T15-M20A4-Ni1-H4 (E55C-Ni1-H4) E551T1-M21A4-Ni1-H4 (E551T1-Ni1M-JH4) E550T15-GA4-Ni1-H4 (E55C-Ni1-H4)

TYPICAL WELD DEPOSIT CHEMISTRY [WT%]

Shielding Gas	C	Cu	Mn	Mo	Ni	P	S	Si	V
90%Ar / 10%CO2	0.03	0.11	1.40	0.15	0.94	0.009	0.010	0.53	0.01
98%Ar / 2%O2	0.03	0.05	1.45	0.14	0.95	0.009	0.010	0.50	0.01

TYPICAL MECHANICAL PROPERTIES

Shielding Gas	Tensile Strength ksi (MPa)	Yield Strength ksi (MPa)	Elongation (%)	Weld Condition	CVN @ -50°F (-45°C) ft-lb (J)
90%Ar / 10%CO2	94 (648)	86 (593)	25	As-Welded	30 (41)
98%Ar / 2%O2	99 (683)	83 (572)	25	As-Welded	35 (47)

SELECT ARC INC.

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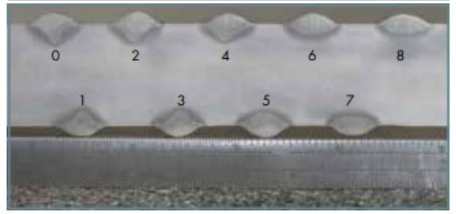
Revision: 9/15/2022

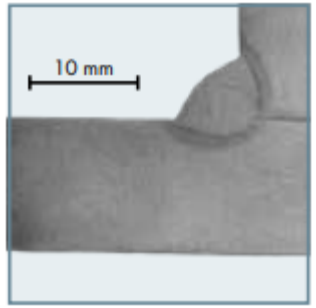
Abicor Binzel

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



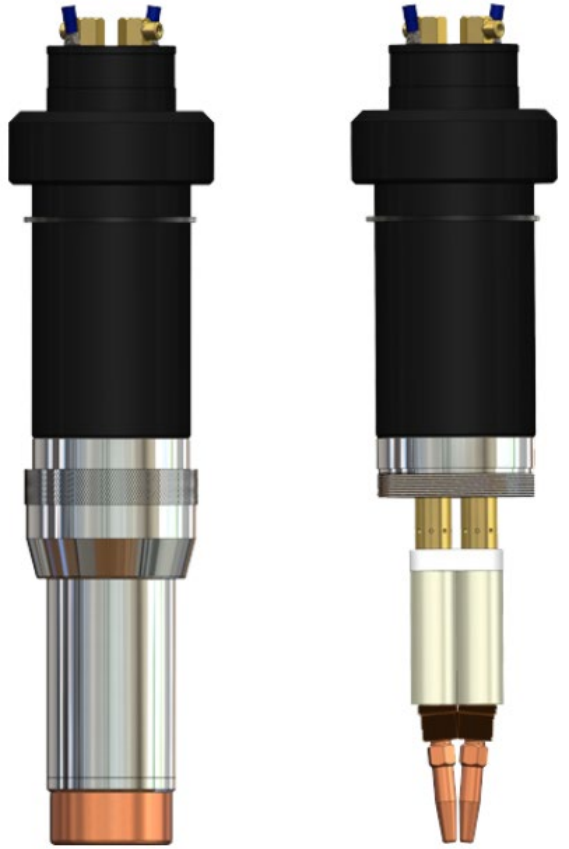
- Tool free spin diameter adjustability
- Digital motor control circuit for precise spin speed control
- Contact tip extensions for deep, narrow, grooved welds
- Automated and robotic applications



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.