

# SPECIFYING WIRE FEEDSTOCKS

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*ANSI & America Makes AMSC  
Feedstock Standardization*



# Additive Manufacturing and Weld Metal

## Drama

- » Additive Manufacturing
  - Many material types and forms
  - Parts are “builds”
  - Proprietary

## Boring

- » Welding
  - Just metal and wire
  - Parts are “welds”
  - Weld buildups have been around for decades

April 14, 1925.

R. BAKER

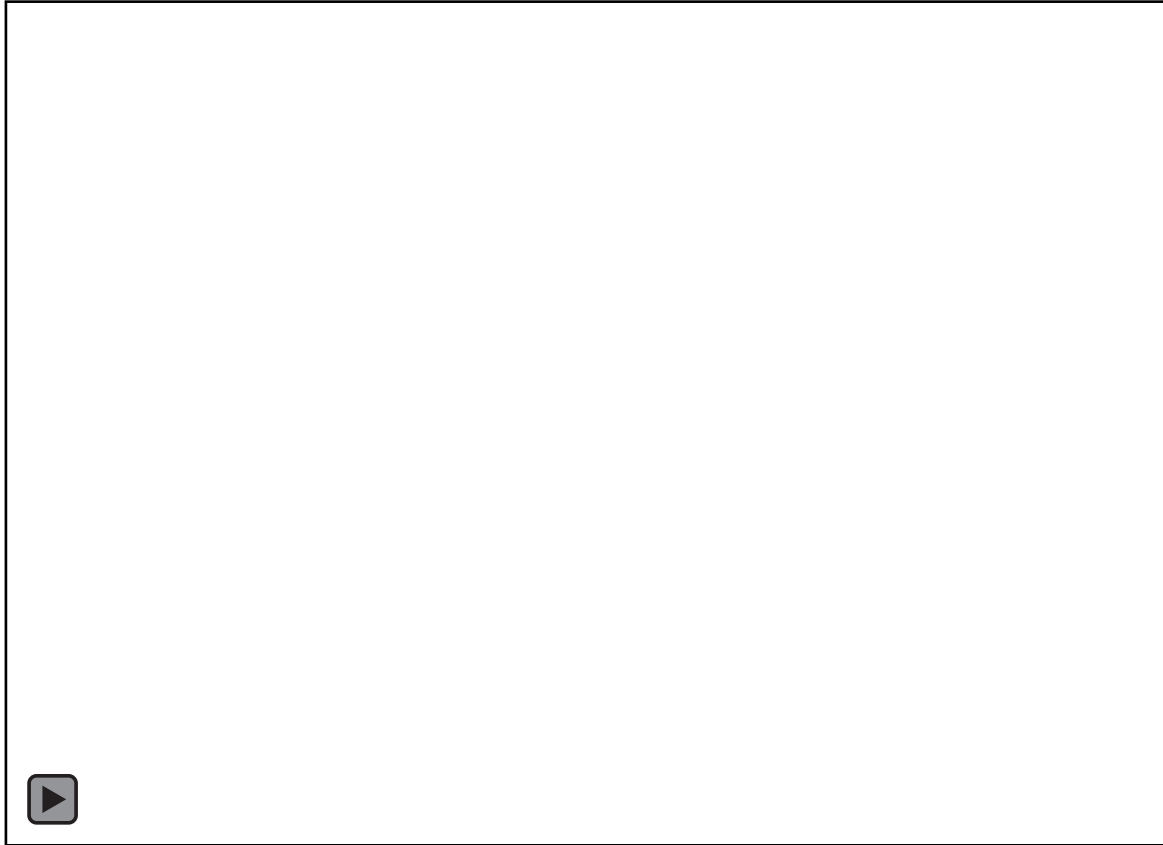
1,533,300

METHOD OF MAKING DECORATIVE ARTICLES

Filed Nov. 12, 1920



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## Weld Metal

- To be practical, it has to be big
- Software to create weld deposit strategy
- Process is automated
- The rest is welding
- Additive/Subtractive

*Hollow-blade propeller –  
2 meter diameter*



# Simple Wire Delivery System



Drive Rolls to push the wire at a controlled rate

Large Format Package

Contact Tip to transfer current to the wire



# Thick Layers/Few Interfaces

- Each layer is fully melted. Inter-layer defects less likely because high energy melts top of prior layer.
- Layer thickness example:
  - 50  $\mu\text{m}$  with powder
  - 5000  $\mu\text{m}$  with GMAW
- Surface is machined



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# Well Understood Properties

- The American Welding Society is >100 years old
- Welding consumables specifications exist for >90 years
- >2 billion pounds of GMAW metal deposited per year
- Used in nuclear power plants, bridges, offshore rigs, pipelines and other safety-related applications
- Standards are updated often to keep up with changes in welding practices, new alloy types and service conditions



# Method for specifying wire feedstock

AWS A5.01M/A5.01:2019  
(ISO 14344:2010 MOD)  
An American National Standard

**Welding  
and Brazing  
Consumables—  
Procurement of  
Filler Metals  
and Fluxes**

- AWS A5.01M/A5.01
- ASME II-C SFA-5.01
- ISO14344

## Procurement Guidelines



- Scope
- Normative References
- Terms and Definitions
- **Lot Class**
- **Level of Testing**
- Annex A (Normative)—Quality Assurance



# AWS A5.01 Scope

- “Identifies various information necessary for communication between a purchaser and a supplier of welding or brazing consumables.”
- Provides a method for preparing specific details for consumable procurement.
  - *the welding or brazing consumable classification (selected from the pertinent AWS/ASME, ISO, or other applicable welding or brazing consumable standard)*
  - *the lot class (selected from Clause 4 of A5.01)*
  - *the testing schedule (selected from Clause 5 of A5.01)*
- Selection of these three items will depend upon the requirements of the application for which the consumable is being procured.

# AWS A5.01 Terms and Definitions

- Heat
- Lot
- Production Schedule
- Reports
  - Certificate of Compliance
  - Certificate of Conformance
  - Certified Material Test Report (CMTR)
  - Material Test Report (MTR)
  - Typical Test Report (“Typical”)

## *Vary by Product Type*

- » **Fully Metallic Solid Consumables**
- » Tubular Cored Electrodes and Rods
- » Covered Electrodes
- » Fluxes for Submerged Arc and Electroslag Welding

# Lot Classifications

- **Lot Class S1.** The quantity of fully metallic solid welding or brazing consumables not exceeding the manufacturer's standard lot, as defined in the manufacturer's quality assurance program.
- **Lot Class S2.** The quantity not exceeding 45 000 kg [100 000 lb] of one fully metallic solid welding or brazing consumable classification, size, form, and temper produced in 24 hours of consecutively scheduled production (i.e., consecutive normal work shifts) from one heat as defined in 3.4 or from controlled chemical composition material as defined in 3.5.2.
- **Lot Class S3.** The quantity of one fully metallic solid welding or brazing consumable classification and one size produced in one production schedule as defined in 3.7 from one heat as defined in 3.4.
- **Lot Class S4.** The quantity not exceeding 45 000 kg [100 000 lb] of one fully metallic solid welding or brazing consumable classification, size, form, and temper produced under one production schedule as defined in 3.7 from one heat as defined in 3.4 or from controlled chemical composition material as defined in 3.5.2.

# Testing Schedules

Schedule	Requirements	<i>Minimum Inspection Document Type</i>
1 or F	The manufacturer's standard testing schedule	2.2
2 or G	Classification tests from product manufactured within 12 months preceding the date of the purchase order	2.2
<b>3 or H</b>	<b>Chemical analysis of the specific lot</b>	<b>3.1</b>
4 or I	Tests called for by Table 2, for the specific lot	3.1
5 or J	All tests prescribed for classification in the AWS, ISO, or other applicable welding or brazing consumable standard, for the specific lot	3.1
6 or K	All tests specified by the purchaser for the specific lot	3.1

# A5.01 Annexes

Table B.7

Example of Use of the Procurement Detail Form for Bare Solid Aluminum Electrodes and Rods

	Example 5	Example 6
<b>I. General</b>		
A. Quality	400 lbs	1000 lbs
B. AWS Specification	A5.10	A5.10
C. AWS Classification	R4043	ER4043
D. Diameter	3/32 in	3/64 in
E. Length	36 in	—
F. Unit Package Type and Weight		
1. Spool	—	4 in, 1 lb
2. Coil with Support	—	—
3. Coil without Support	—	—
4. Rim (reel)	—	—
5. Drum	—	—
6. Straight	5 lbs	—
<b>II. Certification and Testing</b>		
A. Lot Classification	Class S2	Class S2
B. Level of Testing	Schedule 4 or I	Schedule 4 or I
<b>III. Other Requirements</b>	None	None

- Quality assurance requirements are detailed in mandatory annex
- Examples and sample forms are provided in non-mandatory annex



# A5.01 Examples

On a purchase order:

- » 1.2mm AWS A5.9 ER316L, lot class S2, Schedule H testing
- » 0.035" AWS A5.10 ER4043, lot class S2, Schedule H testing
- » 1/16" AWS A5.18 ER70S-6, lot class S2, Schedule H testing

From the specifying AWS A5.xx code:

- » Test Methods
- » Certification
- » Size and shape
- » Packaging
- » Winding
- » Labelling



# AWS A5.01 in Practice

- A5.01 / ISO 14344 are widely used
- Most consumables suppliers stock products to various “lot class” and “testing” requirements
- Alloy (stainless steel, nickel-alloy, aluminum, titanium) consumables are generally supplied by the heat and with chemical composition CMTR.
- Mild and low alloy steel consumables are often stocked to S2 lot class with composition and often weld metal mechanical properties tests.
- Test requirements and referee methods for testing (chemical composition, etc) are contained in the AWS A5.xx specifications.





# Certification in A5 Specifications

By affixing the AWS specification and classification designations to the packaging or the classification to the product, the manufacturer certifies that the product meets the requirements of this specification.

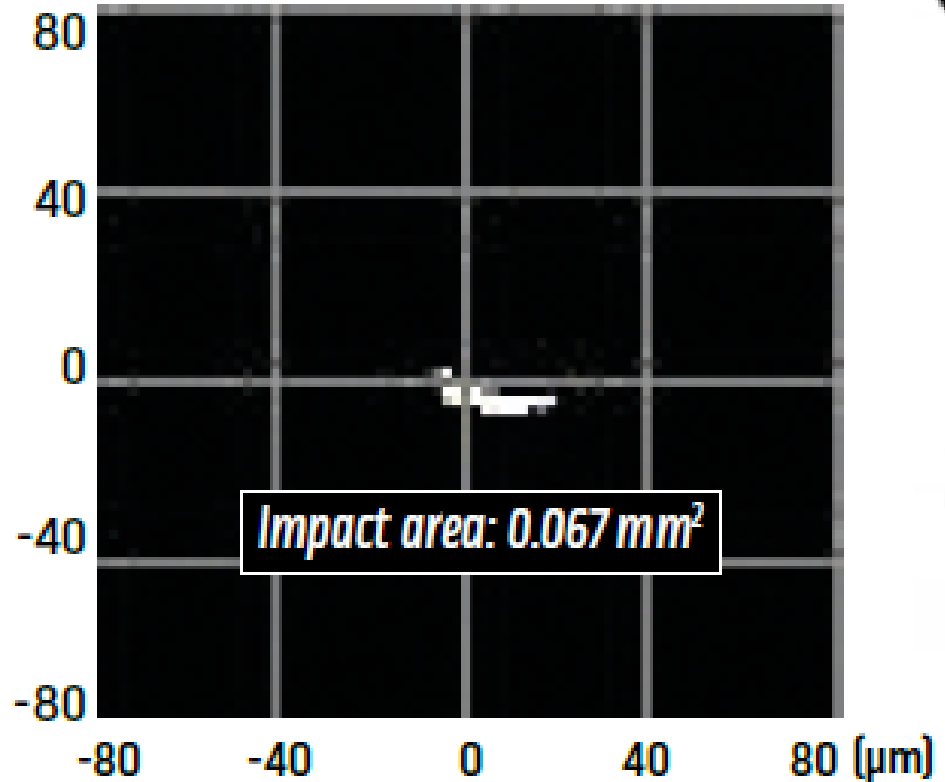
*Unique to AWS A5.xx specifications*



# Proprietary Aspects

- » Room in specifications for some proprietary content
- » Those properties that are difficult to measure in finished components are the most closely regulated
- » -G for chemical composition (although some is still regulated)
- » Operability
  - Adjustments for arc stability and arc transfer
  - Surface finish for feeding and contact tip life
- » Consistency
  - Target specific limits of composition for consistency
  - Dimensional tolerance and winding for placement consistency

# Wire Placement



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# >100 Years and Still Learning

- » Assigns responsibility
- » Goes into supplier's QA system
- » Sets a minimum acceptance that others can add to and audit (nuclear, military, shipbuilding)
- » Clearly define lot classification and testing schedules
- » Consumable specifications set testing requirements and methods
- » Regulate what is less inspectable in a final component
- » Leaves room for proprietary forms and compositions, but suppliers can't hide under them
- » Updated regularly

# Questions / Discussion



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