



DEPARTMENT OF THE NAVY  
NAVAL SEA SYSTEMS COMMAND  
1333 ISAAC HULL AVE SE  
WASHINGTON NAVY YARD DC 20376-0001

IN REPLY REFER TO  
9074  
Ser 05P/285  
3 Oct 24

From: Commander, Naval Sea Systems Command (SEA 05P)  
To: Program Executive Officer, Strategic Submarines

Subj: PROJECT PECULIAR DOCUMENT FOR METAL ADDITIVE MANUFACTURING  
WELDABILITY TESTING

Ref: (a) DoDM 4120.24, Defense Standardization Program (DSP) Procedures of 24 Sep 14  
(b) NAVSEAINST 4120.24A  
(c) NAVSEA Technical Publication S9074-AQ-GIB-010/248, Requirements for Welding  
and Brazing Procedure and Performance Qualification

Encl: (1) NAVSEA PPD 802-8999910, Requirements for Using Existing NAVSEA S9074-  
AQ-GIB-010/248 Welding Procedures for Installation Welding of Parts Produced via  
Metal Additive Manufacturing

1. Purpose. This letter provides a project peculiar document (PPD), in accordance with references (a) and (b), for Weldability Testing recommended for immediate use as a part of qualifying Additive Manufacturing (AM) Processes. The specification also includes additional testing for components used by SEA 08 and as invoked by the procuring activity, for high risk welded installations.
2. Scope and Applicability. This document does not apply to Strategic Weapons Systems and Attack Weapon Systems and associated spares and repair parts under the cognizance of Strategic Systems Programs.
3. Background. As metal additively manufactured (AM) materials are increasingly adopted by NAVSEA, there is a need for installation welding requirements for printed parts. Base material S-Groups are already used in Navy documents to allow efficient use of qualified welding procedures across alloy families. Grouping high demand AM materials with S-Groups enables Navy activities to use legacy weld procedures on them. Susceptibility to weldability failure modes varies by material, so AM materials with no known or anticipated weldability concerns are exempted from testing when printed in accordance with NAVSEA documents, while AM materials with compositional similarities to conventional materials associated with weldability challenges are subject to testing to confirm suitability.
4. NAVSEA Discussion
  - a. Enclosure (1) provides the minimum requirements for classifying AM base materials in existing S-Groups in reference (c). The requirements provided herein have been determined to be the most practicable at the time of writing and are based on the idea that base material grouping is historically performed by comparing the chemical composition and mechanical properties of a new alloy with previously grouped base materials. Most alloy types are easily

Subj: PROJECT PECULIAR DOCUMENT FOR METAL ADDITIVE MANUFACTURING  
WELDABILITY TESTING

grouped in this manner and, provided that they do not historically have metallurgical or welding-related concerns, are straightforward to classify as part of an existing S-Group in most cases.

b. For AM base materials where the alloy type is known to have weldability issues, or there are concerns for the effect of heat treatment, a relatively simple test of welding a standard test assembly under limited restraint is performed during the AM procedure qualification. If the weldability test is successful, the AM base material produced by the AM procedure qualification is then grouped in a go-forward manner with respect to future production. This approach was adopted using engineering judgement and the need to take on an acceptable amount of risk to support rapid adoption of AM.

c. Procurement and installation activities should provide feedback to SEA 05 on enclosure (1) based on use of this specification, with the intent that it will be updated and will eventually be incorporated into a stable military specification.

5. NAVSEA Action. NAVSEA provides the requirements of enclosure (1) for immediate use to support the weld fabrication and repair of AM components.

6. NAVSEA Point of Contact. Any questions related to this letter should be directed to Mr. Andrew Lo, [andrew.lo1.civ@us.navy.mil](mailto:andrew.lo1.civ@us.navy.mil), (240) 271-9163.

7. This letter does not authorize any change in the terms, conditions, delivery schedule, price, or amount of any other Government contract. In the event that you consider these requirements represent a change for which you are entitled to an equitable adjustment, you are to comply with the requirements of the "Notification of Changes" clause of the contract.

LATTNER.MARK.K.1  
228764830  
MARK K. LATTNER  
By direction

Digitally signed by  
LATTNER.MARK.K.1228764830  
Date: 2024.10.03 15:23:17 -04'00'

Copy to:  
SUPSHIP BATH ME  
SUPSHIP GULF COAST MS  
SUPSHIP NEWPORT NEWS VA  
SUPSHIP GROTON CT  
NAVSHIPYD NORFOLK VA  
NAVSHIPYD AND IMF PUGET SOUND WA  
NAVSHIPYD PORTSMOUTH NH  
NAVSHIPYD & IMF PEARL HARBOR HI  
COMNAVRMC NORFOLK VA  
MARMC NORFOLK VA  
SOUTHWEST RMC SAN DIEGO CA  
SOUTHEAST RMC MAYPORT FL  
FDRMC DET BAHRAIN

Subj: PROJECT PECULIAR DOCUMENT FOR METAL ADDITIVE MANUFACTURING  
WELDABILITY TESTING

Copy to: (cont'd)

FDRMC DET NAPLES

FDRMC DET ROTA SP

NAVSHIPREPFAC YOKOSUKA JA

HUNTINGTON INGALLS INDUSTRIES

ELECTRIC BOAT

AUSTAL

BLUEFORGE ALLIANCE

THE BARNES GLOBAL ADVISORS

**802-8999910**

---

**REVISION 0**

**PROJECT PECULIAR DOCUMENT**

**REQUIREMENTS FOR USING EXISTING  
NAVSEA S9074-AQ-GIB-010/248 WELDING  
PROCEDURES FOR INSTALLATION WELDING OF  
PARTS PRODUCED VIA METAL ADDITIVE  
MANUFACTURING**



**DISTRIBUTION STATEMENT A: APPROVED FOR PUBLIC RELEASE.**

**PUBLISHED BY DIRECTION OF COMMANDER, NAVAL SEA SYSTEMS COMMAND**

---

**03 OCTOBER 2024**



**RECORD OF REVISIONS**

<b>REVISION NO.</b>	<b>DATE</b>	<b>TITLE OR BRIEF DESCRIPTION/PREPARING ACTIVITY</b>
0	03 OCT 2024	Initial issue.



## FOREWORD

This document contains requirements for assessing the presumed S-Groups of additive manufacturing (AM) base materials. The S-Group verification testing required by this document has been selected to demonstrate that the heat-affected zone of the AM material does not exhibit deleterious behavior when test assemblies or prototypical mock-ups are welded under limited restraint. This behavior is extended to assert that existing welding procedures and personnel are acceptable for welding of AM parts.



## TABLE OF CONTENTS

Chapter/Paragraph	Page
Chapter 1 Scope .....	1-1
1-1 Introduction.....	1-1
1-2 Engineering Intent.....	1-1
1-3 Requirements and Guidance.....	1-1
1-4 Other NAVSEA Additive Manufacturing Qualification Standards.....	1-2
Chapter 2 References .....	2-1
2-1 Required References.....	2-1
2-1.1 Government Documents.....	2-1
2-1.1.1 Defense Standardization Program Documents.....	2-1
2-1.1.2 Other Government Publications.....	2-1
2-1.2 Non-Government Documents.....	2-1
2-2 Background References.....	2-2
2-3 Order of Precedence.....	2-2
Chapter 3 Definitions.....	3-1
3-1 Introduction.....	3-1
3-2 Definitions.....	3-1
Chapter 4 General Requirements .....	4-1
4-1 Scope.....	4-1
4-2 General Requirements.....	4-1
4-2.1 Responsibility.....	4-1
4-2.2 Welding Qualification Requirements.....	4-1
4-2.2.1 Workmanship Qualification.....	4-1
4-2.2.2 Welding Process.....	4-1
4-2.2.3 Welding Filler Materials.....	4-1
4-2.3 Nondestructive Testing Qualification Requirements.....	4-1
4-2.3.1 Visual Inspection.....	4-1
4-2.3.2 Radiographic Testing.....	4-1
4-2.4 Destructive Testing Requirements.....	4-1
4-3 Records.....	4-1
4-3.1 Certification Data Package.....	4-1
4-3.2 Nondestructive Test Reports.....	4-2
4-3.3 Destructive Test Reports.....	4-2
4-3.4 Records Retention.....	4-2
Chapter 5 Testing Requirements.....	5-1
5-1 Scope.....	5-1
5-2 General Requirements.....	5-1
5-2.1 Testing Frequency and Requirements.....	5-1

Chapter/Paragraph	Page
5-2.1.1 S-Groups Not Listed. ....	5-1
5-2.1.2 Reasons for Re-Performing S-Group Verification Testing. ....	5-1
5-2.2 Exceptions. ....	5-1
5-2.2.1 Welding of AM Parts Where Welding Procedure Qualification is Not Required. ...	5-1
5-2.2.2 Welding of AM Parts for Low-Risk Applications. ....	5-1
5-2.3 S-Group Verification Testing Requirements for AM Parts Requiring Post-Weld Heat Treatment. ....	5-1
5-2.4 Test Assembly Retest and Rejection Requirements. ....	5-1
5-2.4.1 S-Group Verification Test Assembly Retests. ....	5-1
5-2.4.2 Maximum Number of Retests Permitted. ....	5-2
5-2.4.3 Additional Retests with NAVSEA Approval. ....	5-2
5-2.4.4 Rejection of AM Materials Following S-Group Verification Testing. ....	5-2
5-2.5 S-Group Verification Test Assembly Repair Welding. ....	5-2
5-3 S-Group Verification Testing Requirements. ....	5-2
5-3.1 S-Group Verification Test Assembly Welding Requirements. ....	5-2
5-3.1.1 Preheat and Interpass Temperature Requirements. ....	5-2
5-3.1.2 Heat Input Requirements. ....	5-2
5-3.1.3 Welding Procedure Selection. ....	5-3
5-3.2 Test Assembly Design Requirements. ....	5-3
5-3.2.1 AM Base Material Heat Treatment Condition. ....	5-3
5-3.2.2 Test Assembly Thickness. ....	5-3
5-3.2.3 Test Assembly Arrangement (PBF). ....	5-3
5-3.2.4 Test Assembly Arrangement (Wire DED). ....	5-3
5-3.2.5 Test Assembly Weld Joint Design. ....	5-3
5-3.2.6 Test Assembly Weld Joint Preparation. ....	5-3
5-3.3 Special S-Group Verification Testing Requirements. ....	5-3
5-3.3.1 Tack Welds and Lock Welds. ....	5-3
5-3.3.2 Fillet Welds. ....	5-4
5-3.3.3 Piping Socket Welds. ....	5-4
5-3.3.4 Other Welds. ....	5-4
5-4 Nondestructive and Destructive Testing Requirements. ....	5-4
5-4.1 Nondestructive Test Requirements. ....	5-4
5-4.1.1 Nondestructive Test Acceptance Criteria. ....	5-4
5-4.2 Destructive Test Requirements. ....	5-4
5-4.2.1 Macro-Etch Examination. ....	5-4
5-4.2.2 Guided Bend Tests. ....	5-4
5-4.2.3 Tension Tests. ....	5-4
5-4.2.4 Welded Extensions for Destructive Testing. ....	5-4
5-4.2.5 Preparation of Specimens for Destructive Testing. ....	5-5
5-4.3 Destructive Test Acceptance Criteria. ....	5-5

<b>Chapter/Paragraph</b>	<b>Page</b>
5-4.3.1 Macro-Etch Examination. ....	5-5
5-4.3.2 Guided Bend Tests. ....	5-5
5-4.3.3 Tension Tests. ....	5-5
5-5 Evaluation of S-Group Verification TestING RESULTS.....	5-5
5-5.1 Certification Data Package. ....	5-5
5-5.2 Certification Data Package Submittal.....	5-5
5-5.3 Certification Data Package Approval. ....	5-5
5-5.4 Certification Data Package Transfer.....	5-6
Chapter 6 Tables and Figures .....	6-1
Appendix A Supplemental Requirements for High-Risk Installations .....	A-1
A-1 General. ....	A-1
A-1.1 General Requirements. ....	A-1
A-1.2 Test Assembly Requirements. ....	A-1
A-1.2.1 Test Assembly Design Recommendation.....	A-1
A-1.2.2 Substitution of AM Shapes. ....	A-1
A-1.2.3 Additional Requirements for NAVSEA 08 Cognizant AM Parts. ....	A-1
A-1.3 Test Assembly Welding and Testing .....	A-1
A-1.3.1 Substitution of Face and Root Bend Tests. ....	A-2
A-1.4 Piping Socket Welds.....	A-2

**LIST OF TABLES**

<b>Table</b>	<b>Title</b>	<b>Page</b>
Table 6-1.	Allowable Filler Materials.....	6-1
Table 6-2.	S-Group Verification Testing Requirements.....	6-2
Table 6-3.	Destructive Testing Requirements.....	6-3

**LIST OF ILLUSTRATIONS**

<b>Figure</b>	<b>Title</b>	<b>Page</b>
Figure 6-1.	S-Group Verification Test Assembly.....	6-4
Figure 6-2.	S-Group Verification Test Assembly Build Orientation.....	6-6

## CHAPTER 1 SCOPE

### 1-1 INTRODUCTION.

This document provides requirements for applying existing Naval Sea Systems Command (NAVSEA) welding requirements to AM parts manufactured using the powder bed fusion (PBF) and wire directed energy deposition (DED) processes. While this document is intended to be used with NAVSEA AM technical publications and AM material project peculiar documents (PPD), the requirements contained herein may also be used independently.

While analogous to conventional cast and wrought forms, AM produces base materials that have distinct microstructural characteristics. In some cases, these microstructures warrant supplemental testing to ensure that existing welding procedures produce acceptable weldments, with particular regard to evaluating the effect of welding on the soundness of the AM material's heat-affected zone.

### 1-2 ENGINEERING INTENT.

This document provides the minimum requirements for classifying AM base materials in existing S-Groups from NAVSEA S9074-AQ-GIB-010/248, Requirements for Welding and Brazing Procedure and Performance Qualification. The requirements provided herein have been determined to be the most practicable at the time of writing and are based on the idea that base material grouping is historically performed by comparing the chemical composition and mechanical properties of a new alloy with previously grouped base materials. Most alloy types are easily grouped in this manner and, provided that they do not historically have metallurgical or welding-related concerns, are straightforward to classify as part of an existing S-Group in most cases.

For AM base materials where the alloy type is known to have weldability issues, or there are concerns for the effect of heat treatment, a relatively simple test of welding a standard test assembly under limited restraint is performed during the AM procedure qualification. If the weldability test is successful, the AM base material produced by the AM procedure qualification is then grouped in a go-forward manner with respect to future production. This approach was adopted using engineering judgement and the need to take on an acceptable amount of risk to support the planned rapid adoption of AM.

This approach does not encompass all available configurations and combinations of base materials, filler materials, weld processes, joint design, and other technical considerations across existing Navy welding requirements. As such, Appendix A specifies supplemental testing for components which may have significant adverse consequences if fabrication or repair welding were to encounter difficulties. This additional testing is required for all components under the cognizance of NAVSEA 08, and may be invoked by the purchasing activity where risk related to a specific AM part must be absolutely minimized.

The requirements contained in this document are intended to be executed by the AM supplier. With the understanding that not all AM suppliers have welding and nondestructive testing programs in conformance with NAVSEA requirements at this time, options have been provided to utilize commercial equivalent materials and standards. Additionally, while the tests herein are intended to be performed by the AM supplier, they may be performed by other capable activities, including the purchasing activity, to support fleet needs.

### 1-3 REQUIREMENTS AND GUIDANCE.

This document contains both mandatory requirements (indicated by the word "shall"), designed to serve as standards applicable to methods, materials, and inspection, and guidance information (indicated by either the word "should" or "may"). Guidance information is recommended but is not mandatory.

**1-4 OTHER NAVSEA ADDITIVE MANUFACTURING QUALIFICATION STANDARDS.**

AM base material that has been qualified for welding in accordance with NAVSEA 250-1500-1, Welding Standard, may be utilized in lieu of performing the S-Group verification testing required by this document, provided the AM feedstock is allowed by NAVSEA 250-1500-1. Qualification evidence in accordance with NAVSEA 250-1500-1 may be submitted as part of the AM procedure qualification package by the AM supplier in lieu of the certification data package required by this document.

## CHAPTER 2 REFERENCES

### 2-1 REQUIRED REFERENCES.

#### 2-1.1 GOVERNMENT DOCUMENTS.

##### 2-1.1.1 Defense Standardization Program Documents.

###### DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-C-24615 - Castings, Nickel-Chromium-Molybdenum-Columbium Alloy

###### DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-22 - Welded Joint Design

MIL-STD-2035 - Nondestructive Testing Acceptance Criteria

(Copies of these documents are available online at <https://quicksearch.dla.mil>.)

##### 2-1.1.2 Other Government Publications.

###### NAVAL SEA SYSTEMS COMMAND (NAVSEA) PUBLICATIONS

S9074-AQ-GIB-010/248 - Requirements for Welding and Brazing Procedure and Performance Qualification

S9074-AR-GIB-010/278 - Requirements for Fabrication Welding and Inspection, and Casting Inspection and Repair for Machinery, Piping, and Pressure Vessels

S9074-A2-GIB-010/AM-PBF - Requirements for Metal Powder Bed Fusion Additive Manufacturing

S9074-A4-GIB-010/AM-WIRE DED - Requirements for Metal Directed Energy Deposition Additive Manufacturing

T9074-AS-GIB-010/271 - Requirements for Nondestructive Testing Methods

250-1500-1 - Welding Standard

(Copies of these documents are available online via Model Based Product Support (MBPS) at <https://mbps.navseapl.navy.mil/Windchill/app/>. To gain access to MBPS, obtain an account with National Help Desk Service Management (NHDSM) at <https://nhdsm.navair.navy.mil> (a valid CAC is required to access this website) and submit a SAAR-N Request. Refer questions, inquiries, or problems to (888) 292-5919. These documents are available for ordering (hard copy) via the Naval Logistics Library (NLL) at <https://nll.navsup.navy.mil>. For questions regarding the NLL, contact the NLL Customer Service at [nllhelpdesk@navy.mil](mailto:nllhelpdesk@navy.mil), (866) 817-3130, or (215) 697-2626/DSN 442-2626.)

#### 2-1.2 NON-GOVERNMENT DOCUMENTS.

###### AMERICAN WELDING SOCIETY (AWS) PUBLICATIONS

AWS A3.0M/A3.0 - Standard Welding Terms and Definitions

AWS B4.0 - Standard Methods for Mechanical Testing of Welds

(Copies of these documents are available online at [www.aws.org](http://www.aws.org).)

###### ASTM INTERNATIONAL

ASTM E8/E8M - Standard Test Methods for Tension Testing of Metallic Materials

- ASTM E23 - Standard Test Methods for Notched Bar Impact Testing of Metallic Materials
- ISO/ASTM 52900 - Additive Manufacturing – General Principles – Fundamentals and Vocabulary

(Copies of these documents are available online at [www.astm.org](http://www.astm.org).)

## 2-2 BACKGROUND REFERENCES.

The following references are included for background information and may not be referenced in this document.

- a. ASME Boiler and Pressure Vessel Code (BPVC)
- b. MIL-STD-1689, Fabrication, Welding, and Inspection of Ships Structure
- c. NAVSEA Letter 9070 Ser 05Z/191, of 22 May 2024, Guidance on Identification and Installation of Low Risk Additively Manufactured Metal Components
- d. NAVSEA Letter 9074 Ser 05P/050, of 01 Mar 2024, Project Peculiar Documents for Metal Additive Manufacturing Material Specifications
- e. NAVSEA Letter 9074 Ser 05P/218, of 18 Jul 2024, Project Peculiar Document for Directed Energy Deposition Additively Manufactured Base Metals for Critical Applications: Requirements for Gas Metal Arc Welding Additively Manufactured Pre-Forms for Low-Alloy Steel Applications
- f. NAVSEA Letter 9074 Ser 05Z/223, of 08 May 2024, Guidance for Performing Non-Destructive Testing and Non-Destructive Testing Procedure Qualification in Support of Additive Manufacturing Efforts
- g. T9074-AD-GIB-010/1688, Requirements for Fabrication, Welding, and Inspection of Submarine Structure
- h. 802-8979757, Directed Energy Deposition Additively Manufactured Base Metals for Critical Applications: Requirements for Gas Metal Arc Welding Additively Manufactured Pre-Forms for Low-Alloy Steel Applications
- i. 802-8979758, Austenitic Chromium-Nickel Stainless Steel, Corrosion-Resistant, Laser Powder Bed Fusion, Additively Manufactured
- j. 802-8979759, Commercially Pure Titanium, Wire Arc, Directed Energy Deposition, Additively Manufactured
- k. 802-8979760, Copper-Nickel (70-30), Wire Arc, Directed Energy Deposition, Additively Manufactured
- l. 802-8979761, Copper-Nickel (70-30), Laser Powder Bed Fusion, Additively Manufactured
- m. 802-8979762, Nickel Aluminum Bronze, Wire Arc, Directed Energy Deposition, Additively Manufactured
- n. 802-8985009, Austenitic Chromium-Nickel-Molybdenum Stainless Steel, Corrosion-Resistant, Directed Energy Deposition, Additively Manufactured

## 2-3 ORDER OF PRECEDENCE.

In the event of a conflict between the text of this document and the references cited herein, the conflict shall be reported to NAVSEA for adjudication.

## CHAPTER 3 DEFINITIONS

### 3-1 INTRODUCTION.

Except as noted herein, welding nomenclature shall be as specified in NAVSEA S9074-AQ-GIB-010/248 or AWS A3.0M/A3.0, as applicable.

Except as noted herein, AM nomenclature shall be as specified in ISO/ASTM A52900.

### 3-2 DEFINITIONS.

- a. AM Base Material. Base material produced via AM using the PBF or wire DED processes. This base material may take the form of AM parts, may be a shape or feature of an AM part designed specifically for subsequent testing (e.g., a prolongation on an existing AM build), or may be a dedicated test assembly.
- b. AM Procedure Qualification. For the purposes of this document, the AM procedure qualification is either the PBF procedure specified in NAVSEA S9074-A2-GIB-010/AM-PBF, Requirements for Metal Powder Bed Fusion Additive Manufacturing, or the DED procedure specified in NAVSEA S9074-A4-GIB-010/AM-WIRE DED, Requirements for Metal Directed Energy Deposition Additive Manufacturing.
- c. AM Supplier. The activity contracted to provide an AM part or a final assembly containing AM parts to the purchasing activity.
- d. Approval (Approved). When the item under consideration requires acceptance by NAVSEA or its authorized representative. “Approval” or “approved,” as used herein, is granted by the NAVSEA authorized representative unless NAVSEA approval is specified.
- e. Authorized Representative. For the purposes of this document, the authorized representative is the government representative designated in accordance with NAVSEA S9074-AQ-GIB-010/248.
- f. Certification Statement. Where testing is required, the certification package shall include a written statement made by the responsible official of the AM supplier certifying that the tests and test results meet all requirements of this document and that the AM base material’s presumed S-Group has been validated as its actual S-Group for welding with procedures and personnel qualified in accordance with NAVSEA S9074-AQ-GIB-010/248.
- g. Conventional Base Material. Material in a conventional product form (cast, wrought, forged, etc.) procured to an applicable military or commercial specification for installation via welding using procedures and personnel qualified in accordance with NAVSEA S9074-AQ-GIB-010/248.
- h. High-Risk Installation. Installation or fabrication of an AM part which poses a significant risk to critical path for ship’s schedule or maintenance availability if welding issues arise. All AM parts under the cognizance of NAVSEA 08 are considered high-risk installations for the purposes of this document (see Appendix A).
- i. Purchasing Activity. The activity purchasing an AM part intended to be welded using welding procedures and personnel qualified in accordance with NAVSEA S9074-AQ-GIB-010/248. It may be a commercial shipyard or their subcontractor(s), a government shipyard or repair activity, or other government agency. The purchasing activity is responsible for involving the appropriate NAVSEA technical stakeholders in decisions related to AM parts.
- j. Material Condition. One of three general categories of post-processing following the build.
  - (1) As-Built. The absence of a heat treatment. For the purposes of this document, application of post-processing techniques near room temperature (e.g., machining) are still considered to be in the as-built condition.

- (2) Heat Treated Within PPD Requirements. Post-build heat treatment in accordance with NAVSEA Letter 9074 Ser 05P/050 of 01 Mar 2024.
- (3) Heat Treated Outside PPD Requirements. Post-build heat treatment not in accordance with NAVSEA Letter 9074 Ser 05P/050 of 01 Mar 2024. This specifically includes heat treatment in accordance with NAVSEA S9074-AR-GIB-010/278, Requirements for Fabrication Welding and Inspection, and Casting Inspection and Repair for Machinery, Piping, and Pressure Vessels, excluding presumed group S-1 materials.
- k. Presumed S-Group. The S-Group to which an AM base material is presumed to be interchangeable based on similar chemical composition and mechanical properties. This assumption is made based on chemical composition and mechanical properties testing during AM procedure qualification, or as prescribed by the applicable AM material specification.
- l. S-Group (S-Number). A designation used to group base materials for procedure and performance qualification in accordance with NAVSEA S9074-AQ-GIB-010/248. The designation of a specific base metal's S-Group is typically based on its chemical composition and mechanical properties. The S-Group is analogous to AWS M-Numbers and American Society of Mechanical Engineers (ASME) P-Numbers.
- m. S-Group Verification Testing. Testing performed in accordance with the requirements of this document to evaluate AM base materials for classification as part of an existing S-Group. The purpose of this testing is to validate that the AM base material performs like conventional product forms when welded using procedures and personnel qualified in accordance with NAVSEA S9074-AQ-GIB-010/248.

## CHAPTER 4 GENERAL REQUIREMENTS

### 4-1 SCOPE.

This chapter addresses the general requirements for S-Group verification testing of PBF and wire DED AM base materials.

### 4-2 GENERAL REQUIREMENTS.

4-2.1 RESPONSIBILITY. When this document is specified, the AM supplier (or its subcontractors) shall perform the required tests identified herein to determine if the presumed S-Group of an AM base material is its actual S-Group for the purposes of NAVSEA S9074-AQ-GIB-010/248.

4-2.2 WELDING QUALIFICATION REQUIREMENTS. Welding procedures and welders (or welding operators) shall be qualified in accordance with NAVSEA S9074-AQ-GIB-010/248 for the presumed S-Group of the AM base material. Where qualification in accordance with NAVSEA S9074-AQ-GIB-010/248 is not practicable, welding procedures and welders (or welding operators) qualified in accordance with AWS, ASME Boiler and Pressure Vessel Code (BPVC), or other commercial standards may be used.

4-2.2.1 Workmanship Qualification. Welders (or welding operators) need not be trained on welder workmanship in accordance with NAVSEA S9074-AQ-GIB-010/248 when commercial standards are used for welding of S-Group verification test assemblies.

4-2.2.2 Welding Process. Shielded Metal Arc Welding (SMAW) or Gas Tungsten Arc Welding (GTAW) processes shall be used to the maximum extent practicable for performing S-Group verification testing when no welding process is specified.

4-2.2.3 Welding Filler Materials. Welding filler material shall be as specified in [table 6-1](#), unless otherwise approved by NAVSEA.

4-2.3 NONDESTRUCTIVE TESTING QUALIFICATION REQUIREMENTS. Nondestructive testing procedures, equipment, and personnel shall be qualified in accordance with NAVSEA T9074-AS-GIB-010/271, Requirements for Nondestructive Testing Methods, as modified by current NAVSEA AM nondestructive testing guidance (e.g., NAVSEA Letter 9074 Ser 05Z/223 of 08 May 2024). Where qualification in accordance with NAVSEA T9074-AS-GIB-010/271 is not practicable, nondestructive testing procedures, equipment, and personnel qualified in accordance with AWS, ASME, American Society for Nondestructive Testing (ASNT), or other commercial standards may be used.

4-2.3.1 Visual Inspection. Visual inspection (VT) shall be accomplished prior to any magnetic particle testing (MT) or liquid penetrant testing (PT) when MT or PT is a required inspection.

4-2.3.2 Radiographic Testing. Radiographic testing (RT) may be performed before or after VT and MT or PT, at the discretion of the AM supplier.

4-2.4 DESTRUCTIVE TESTING REQUIREMENTS. Destructive testing shall be in accordance with applicable AWS or ASTM standards, as modified by this document.

### 4-3 RECORDS.

4-3.1 CERTIFICATION DATA PACKAGE. At a minimum, the certification data package shall contain the following items:

- a. Certification data package number, revision, and date.
- b. The AM supplier's name.

- c. Identification of the AM procedure used to manufacture the S-Group verification test assemblies and/or prototypical mock-up, including machine make, model and serial number, and feedstock.
- d. Actual chemical composition and mechanical properties of the AM base material (e.g., applicable test reports from the AM procedure).
- e. Material specification of the AM base material (e.g., NAVSEA PPD or applicable commercial specification).
- f. Presumed S-Group for the AM base material.
- g. The specific heat or lot number, or equivalent identification, of the AM base material used for all testing.
- h. The heat treatment condition of the AM base material (see 3-2.j).
- i. The welding procedure used.
- j. Welder/welding operator (name and employee number).
- k. Filler material used for welding test assemblies, including filler material conformance test certificates.
- l. Nondestructive test results and acceptance criteria.
- m. Destructive test results and acceptance criteria.
- n. Certified nondestructive and destructive test reports for all tests/inspections performed, including photomicrographs of the macro-etch cross-sections (see 5-4.3.1).
- o. Guided bend test mandrel radius, if not reported in the destructive test report (see 5-4.2.2).
- p. Heat treatment records, if applicable.
- q. Repair welding data, if applicable (see 5-2.5.e).
- r. The failed retest technical data package in accordance with 5-2.4.2, if applicable.
- s. The failed second retest technical data package in accordance with 5-2.4.3, if applicable.
- t. If elevated S-Group verification testing was performed in lieu of the S-Group verification testing requirements of Chapter 5 (see Appendix A).
- u. Results of the required evaluation (see 5-5), as applicable.
- v. A certification statement in accordance with 3-2f.

**4-3.2 NONDESTRUCTIVE TEST REPORTS.** Nondestructive test reports shall, at a minimum, contain the information required by NAVSEA T9074-AS-GIB-010/271, regardless of whether the nondestructive testing procedure used is qualified in accordance with NAVSEA T9074-AS-GIB-010/271 or not.

**4-3.3 DESTRUCTIVE TEST REPORTS.** Destructive test reports shall, at a minimum, contain the information required by the applicable AWS or ASTM standard invoked for the testing.

**4-3.4 RECORDS RETENTION.** Records shall be retained in accordance with NAVSEA S9074-A2-GIB-010/AM-PBF or NAVSEA S9074-A4-GIB-010/AM-WIRE DED, as applicable.

## CHAPTER 5 TESTING REQUIREMENTS

### 5-1 SCOPE.

This chapter addresses the specific requirements for validating that existing NAVSEA welding procedures in accordance with NAVSEA T9074-AQ-GIB-010/248 are acceptable for use on AM base material.

### 5-2 GENERAL REQUIREMENTS.

**5-2.1 TESTING FREQUENCY AND REQUIREMENTS.** S-Group verification testing shall be performed when specified in [table 6-2](#). S-Group verification testing shall be completed during AM procedure qualification and approved prior to production welding of part(s) manufactured using the same AM procedure. For cases where AM procedure qualification has already been completed, S-Group verification shall be completed separately.

**5-2.1.1 S-Groups Not Listed.** The requirements of this document may be used for S-Group verification testing of S-Groups not listed in [table 6-2](#). A description of the proposed tests shall be submitted to NAVSEA for approval prior to conducting S-Group verification testing.

**5-2.1.2 Reasons for Re-Performing S-Group Verification Testing.** When the associated AM procedure requires Level I or Level II requalification in accordance with NAVSEA S9074-A2-GIB-010/AM-PBF or NAVSEA S9074-A4-GIB-010/AM-WIRE DED, as applicable, S-Group verification testing shall be re-performed in accordance with this document.

**5-2.2 EXCEPTIONS.** S-Group verification testing is not required for the following applications, or when otherwise approved by NAVSEA. Where S-Group verification testing is not required, the AM base material may be treated as if its presumed S-Group were its actual S-Group, and a certification data package (see 4-3.1) is not required.

**5-2.2.1 Welding of AM Parts Where Welding Procedure Qualification is Not Required.** S-Group verification testing is not required for welding of AM parts where welding procedure qualification is not required by the applicable fabrication standard (e.g., “minor structure” welding).

**5-2.2.2 Welding of AM Parts for Low-Risk Applications.** S-Group verification testing is not required for low-risk AM parts when AM procedure qualification is not required.

**5-2.3 S-GROUP VERIFICATION TESTING REQUIREMENTS FOR AM PARTS REQUIRING POST-WELD HEAT TREATMENT.** Where post-weld heat treatment is required for the AM part, NAVSEA shall be contacted for guidance.

### 5-2.4 TEST ASSEMBLY RETEST AND REJECTION REQUIREMENTS.

**5-2.4.1 S-Group Verification Test Assembly Retests.** If an S-Group verification test assembly fails to meet the applicable acceptance criteria of this document, it may still be considered part of its presumed S-Group if retested under the following conditions:

- a. An S-Group verification test assembly that fails to meet nondestructive testing acceptance criteria may be repair welded as specified in 5-2.5 and retested in accordance with this chapter.
- b. An S-Group verification test assembly that fails to meet nondestructive testing or macro-etch acceptance criteria may be retested. The retest shall consist of one new S-Group verification test assembly for each S-Group verification test assembly that failed to meet nondestructive testing or macro-etch acceptance criteria. The new S-Group verification test assembly shall pass all required nondestructive and destructive testing.
- c. An S-Group verification test assembly that fails to meet destructive testing acceptance criteria may be retested. The retest shall consist of two new S-Group verification test assemblies for each

S-Group verification test assembly that failed to meet destructive testing acceptance criteria. Both new S-Group verification test assemblies shall pass all required nondestructive and destructive testing.

**5-2.4.2 Maximum Number of Retests Permitted.** Only one retest cycle shall be permitted for AM base material undergoing S-Group verification testing without NAVSEA approval. Prior to performing the retest, the cause for failure shall be evaluated and the cause and action(s) taken on the subsequent S-Group verification test assembly to avoid this failure shall be documented.

**5-2.4.3 Additional Retests with NAVSEA Approval.** A second retest cycle shall require NAVSEA approval. A detailed technical data package detailing the tests performed, the assessed cause(s) of failure, proposed corrective actions, and any other technical rationale required to support adjudication of the failed S-Group verification testing shall be submitted to NAVSEA for approval.

**5-2.4.4 Rejection of AM Materials Following S-Group Verification Testing.** Any AM base material produced using an AM procedure that fails S-Group verification testing shall be rejected and shall not be used for production applications. AM base material produced using an AM procedure that has failed S-Group verification testing shall be quarantined, and NAVSEA shall be contacted for guidance.

**5-2.5 S-GROUP VERIFICATION TEST ASSEMBLY REPAIR WELDING.** Welded S-Group verification test assemblies that fail nondestructive testing may be repair welded in accordance with the following requirements.

- a. The defects repaired are identified by the nondestructive testing required for S-Group verification test assembly and are not indicative of inadequate AM base material performance or unexpected metallurgical failure.
- b. Repair welding is representative of repair welds that could be performed on production weldments.
- c. Incomplete penetration and lack of fusion assessed to be the result of welder performance may be repaired. Cracks, except for crater cracks, shall not be repaired.
- d. Only one repair welding cycle is permitted per S-Group verification test assembly.
- e. Repair welding details are provided in the certification data package (see 4-3.1.q), to include the results of the nondestructive test(s) that failed to meet the requirements of this document, and the repair work performed to correct the condition (e.g., a description of the deficient condition, depth of repair, and any special repair techniques used).

### **5-3 S-GROUP VERIFICATION TESTING REQUIREMENTS.**

#### **5-3.1 S-GROUP VERIFICATION TEST ASSEMBLY WELDING REQUIREMENTS.**

**5-3.1.1 Preheat and Interpass Temperature Requirements.** Minimum preheat and maximum interpass temperature requirements shall be in accordance with the applicable fabrication standard for the presumed S-Group. For AM base materials with presumed S-Groups that do not have minimum preheat or maximum interpass temperatures specified in the applicable fabrication standard, minimum preheat and maximum interpass temperature requirements shall be as qualified in the welding procedure, unless otherwise approved by NAVSEA. For AM base materials with presumed S-Groups where the applicable fabrication standards invoke different minimum preheat and maximum interpass temperatures, any applicable minimum preheat and maximum interpass temperature may be used to complete S-Group verification testing. A change between minimum preheat and maximum interpass temperatures invoked by different fabrication standards is not a reason to re-perform S-Group verification testing.

**5-3.1.2 Heat Input Requirements.** Welding of S-Group verification test assemblies shall involve the maximum practicable heat input and maximum preheat/interpass temperatures permitted by good welding practice and the applicable welding procedure, in order to produce the lowest possible cooling rate.

5-3.1.3 Welding Procedure Selection. The welding procedure for S-Group verification testing shall be selected based on the presumed S-Group of the AM base material.

5-3.2 TEST ASSEMBLY DESIGN REQUIREMENTS. S-Group verification testing shall be performed using the [figure 6-1](#) S-Group verification test assembly.

5-3.2.1 AM Base Material Heat Treatment Condition. S-Group verification testing shall be performed on the AM base material in the same heat treatment condition in which it will be welded in production (see 3-2.j). When multiple heat treatment conditions for the same AM part(s) are used in production, S-Group verification testing shall be performed on AM base material in each heat treatment condition to be used in production.

5-3.2.2 Test Assembly Thickness. The S-Group verification test assembly thickness shall be a minimum of ½ inch for PBF AM base material and shall be a minimum of ¾ inch for wire DED AM base material, unless otherwise approved by NAVSEA.

5-3.2.3 Test Assembly Arrangement (PBF). The S-Group verification test assembly shall consist of two PBF AM base material specimens. One side (Side A) shall be manufactured such that the PBF build orientation is perpendicular to the long axis (e.g., the weld axis) of the S-Group verification test assembly. The other side (Side B) shall be manufactured such that the PBF build orientation is inclined not less than 45 degrees from the long axis of the S-Group verification test assembly, and preferentially parallel to the long axis of the S-Group verification test assembly.

5-3.2.4 Test Assembly Arrangement (Wire DED). The S-Group verification test assembly shall consist of two wire DED AM base material specimens. One side (Side A) shall be manufactured such that the wire DED build orientation is perpendicular to the long axis (e.g., the weld axis) of the S-Group verification test assembly. The other side (Side B) shall be manufactured such that the wire DED build orientation is parallel to the long axis of the S-Group verification test assembly.

5-3.2.5 Test Assembly Weld Joint Design. The S-Group verification test assembly weld joint design shall be a B1V.1, as specified in MIL-STD-22. The backing bar may be conventional or AM base material of the same presumed S-Group as the S-Group verification test assembly to be welded. The S-Group verification test assembly shall be clamped or fixed to prevent movement during welding.

5-3.2.6 Test Assembly Weld Joint Preparation. S-Group verification test assemblies shall be machined or ground to sound metal prior to fit-up for welding for a minimum of 1 inch from the expected weld area. Such machining or grinding shall not reduce the test assembly thickness below that specified in 5-3.2.2. All features such as support structures, surface irregularities resulting from the AM process, or other conditions that may interfere with welding or nondestructive and destructive testing shall be removed. Contaminants and deleterious materials (e.g., paint, oil, grease, moisture, cutting or machining fluids, mill scale, slag, oxides) that may interfere with a sound weld shall be removed for a minimum of ½ inch from the expected weld area.

5-3.3 SPECIAL S-GROUP VERIFICATION TESTING REQUIREMENTS. This section addresses S-Group verification testing requirements for special applications such as lock welds and tack welds, fillet welds, piping socket welds, and other weld joint configurations. Welding shall be as specified in 5-2 and 5-3. S-Group verification test assembly design, inspection requirements, and acceptance criteria shall be as described in this section.

5-3.3.1 Tack Welds and Lock Welds. S-Group verification testing for tack welds and lock welds shall be a prototypical mock-up of the production application. A partial mock-up representative of the thickness and orientation of the AM base material to be welded plus an additional 1 inch (approximately) of AM base material in each direction around the weldment is considered an acceptable test assembly. The S-Group verification test assembly shall be subjected to VT and PT, as specified in 5-4.1. A macro-etch cross-section transverse to the weld shall be prepared in accordance with 5-4.2.1 and examined in accordance with 5-

4.3.1. In lieu of performing a prototypical mock-up, an S-Group verification test in accordance with the requirements of this chapter may be used to qualify tack welds and lock welds.

5-3.3.2 Fillet Welds. Fillet welds shall be tested in accordance with the S-Group verification testing requirements specified in this chapter, unless otherwise approved by NAVSEA.

5-3.3.3 Piping Socket Welds. Piping socket welds shall be tested in accordance with the S-Group verification testing requirements specified in this chapter, unless otherwise approved by NAVSEA.

5-3.3.4 Other Welds. Other configurations shall be as approved by NAVSEA.

## 5-4 NONDESTRUCTIVE AND DESTRUCTIVE TESTING REQUIREMENTS.

5-4.1 NONDESTRUCTIVE TEST REQUIREMENTS. S-Group verification test assemblies shall be nondestructively tested as follows.

- a. Prior to welding, the weld joint preparation and adjacent ½ inch of AM base material shall be subjected to VT and either MT or PT (as applicable).
- b. Following completion of welding, the entire weld joint and adjacent ½ inch of AM base material shall be subjected to VT, MT, or PT (as applicable).
- c. RT is not required unless specified by the NAVSEA authorized representative or otherwise required by this document for high-risk installations (see Appendix A). When RT is required, it shall be 360-degree (or 100 percent) RT inspection of the weld.
- d. For butt welded test assemblies, indications within 1 inch from each end of the test assembly may be disregarded unless the area will be included within a destructive test specimen. This allowance does not apply to pipe-type test assemblies.

5-4.1.1 Nondestructive Test Acceptance Criteria. Unless otherwise approved by NAVSEA, acceptance standards for all nondestructive testing required by this document shall be based on the class I nondestructive test acceptance criteria of MIL-STD-2035, as modified by the applicable AM nondestructive test acceptance criteria provided by NAVSEA (e.g., NAVSEA Letter 9074 Ser 05Z/223 of 08 May 2024).

5-4.2 DESTRUCTIVE TEST REQUIREMENTS. Destructive testing shall be in accordance with [table 6-3](#) and this section.

5-4.2.1 Macro-Etch Examination. Macro-etch cross-sections shall be prepared and etched in accordance with good metallographic practice. Macro-etch cross-sections shall be examined at a minimum magnification of 10x.

5-4.2.2 Guided Bend Tests. Guided bend tests shall be in accordance with AWS B4.0. For AM base materials with 20 percent or lower minimum elongation requirements, elongation for determining bend radius shall be selected based on the applicable AM material specification. For AM base materials with a minimum elongation greater than 20 percent, bend testing radius determination shall be performed using 20 percent elongation. Guided bend test mandrel radius shall be reported (see 4-3.1.o).

5-4.2.3 Tension Tests. Transverse tension testing shall be in accordance with ASTM E8/E8M. Tension test specimen geometry shall accommodate the weld metal and the AM base material heat-affected zone within the gauge length. Ultimate tensile strength, elongation, reduction in area, and yield strength (0.2 or 0.5 percent, as applicable to the material specification) shall be reported.

5-4.2.4 Welded Extensions for Destructive Testing. Prolongations or extensions may be welded to destructive test specimens using any metallurgically compatible base material and any suitable filler materials, welding procedures, welded joint designs, and welders (or welding operators) to facilitate destructive testing if the destructive test specimens identified in this document do not satisfy length requirements for available destructive testing equipment. Welding of prolongations or extensions should take place before any required machining or surface preparation of the destructive test specimens. These

welds shall not adversely affect the results of destructive testing, but otherwise do not have any acceptance criteria or requirements. Destructive test specimens with welded prolongations or extensions shall be specifically identified as such in destructive test reports.

**5-4.2.5 Preparation of Specimens for Destructive Testing.** Care shall be taken during machining of specimens for destructive testing to prevent reduction of specimen thickness below that specified in 5-3.2.2. Thermal cutting of destructive test specimens shall not be performed unless the heat-affected zone from the thermal cutting process is removed via machining prior to destructive testing. Electrical discharge machining (EDM) may be used, provided that the recast layer from the EDM process is removed via machining prior to destructive testing.

### **5-4.3 DESTRUCTIVE TEST ACCEPTANCE CRITERIA.**

**5-4.3.1 Macro-Etch Examination.** The macro-etch cross-section shall be free of cracks. Linear indications or other discontinuities greater than  $\frac{1}{32}$  inch in the weld fusion zone or heat-affected zone of the cross-section shall be cause for rejection. Defects such as lack of fusion, slag, or oxides shall be cause for rejection. Macro-etch cross-sections containing lack of fusion, slag, or oxides may be accepted at the discretion of the NAVSEA authorized representative if the defects are not located in weld beads adjacent to the AM base material. Photomicrographs of such indications shall be included in the certification data package (see 4-3.1.n). Questionable indications shall be examined at higher magnification. If a questionable indication is determined to be a crack, the cause shall be evaluated and reported to NAVSEA for further guidance.

**5-4.3.2 Guided Bend Tests.** After bending, guided bend test specimens shall have no cracks or other open defects greater than  $\frac{1}{8}$  inch. Cracks occurring on the corners of the specimen shall be disregarded unless there is definite evidence that they result from failure of the AM base material. Openings in the weld metal or base metal outside of the heat-affected zone of the S-Group verification test assembly shall not be cause for rejection; however, they shall be reported for information.

**5-4.3.3 Tension Tests.** Tension test results shall have an ultimate tensile strength and elongation not less than the minimum specified in the applicable AM material specification. If the filler material used for welding and the AM base material have different minimum ultimate tensile strength and elongation requirements identified in their respective material specifications, the strength of the weaker material shall take precedence. For AM base materials with no AM material specification, the ultimate tensile strength and elongation shall be reported for information. For AM material specifications that do not specify a minimum ultimate tensile strength or minimum elongation requirement, test results shall be reported for information.

## **5-5 EVALUATION OF S-GROUP VERIFICATION TESTING RESULTS.**

**5-5.1 CERTIFICATION DATA PACKAGE.** The results of S-Group verification testing shall be evaluated and a determination shall be made whether existing NAVSEA S9074-AQ-GIB-010/248 welding procedures are acceptable for use on the AM base material being tested. This determination shall be based on successfully completing the testing described in this chapter and shall be documented in the certification data package.

**5-5.2 CERTIFICATION DATA PACKAGE SUBMITTAL.** The certification data package (see 4-3.1), if prepared as part of an initial AM procedure qualification, shall be submitted to NAVSEA for approval as part of the AM procedure qualification package. Where S-Group verification testing is completed separately from AM procedure qualification (see 5-2.1), or where elevated S-Group verification testing is required for a specific component (see [table 6-2](#)), the certification data package shall be submitted for approval to the NAVSEA authorized representative of the purchasing activity.

**5-5.3 CERTIFICATION DATA PACKAGE APPROVAL.** Approval of the certification data package constitutes acceptance that existing NAVSEA S9074-AQ-GIB-010/248 welding procedures are acceptable

for use on the AM base material. This permits AM base material produced by the approved AM procedure to be treated as if its presumed S-Group were its actual S-Group for the purposes of NAVSEA S9074-AQ-GIB-010/248, including welding procedure qualification, welding procedure cross-qualification, and performance qualification of welders (or welding operators).

**5-5.4 CERTIFICATION DATA PACKAGE TRANSFER.** The approved certification data package is transferable between all activities and does not require re-performance of S-Group verification testing unless specifically required by the NAVSEA authorized representative of the receiving NAVSEA activity or the materials/welding engineering group of the receiving commercial activity.

**CHAPTER 6  
TABLES AND FIGURES**

**Table 6-1. Allowable Filler Materials**

Presumed S-Group Number <sup>1/</sup>	Allowable Filler Material A-Group <sup>2/, 3/</sup>	
	Covered Electrode	Bare Wire
S-1	A-2A	A-2B
S-8	A-8A	A-8B
S-34	A-34A	A-34B
S-36A	-	A-36B A-37B
S-42	A-42A	A-42B
S-43 <sup>4/</sup>	A-43A	A-43B
S-52	-	A-51B

NOTES:

<sup>1/</sup> Filler materials for S-Groups not listed in this table shall be as specified by NAVSEA.

<sup>2/</sup> Commercial equivalents to military specification filler material are permitted for welding S-Group verification test assemblies.

<sup>3/</sup> The A-Groups specified in this table are those specified in NAVSEA S9074-AQ-GIB-010/248.

<sup>4/</sup> For Alloy 625 type (UNS N06625) AM base materials, Alloy 625 type (UNS N06625) filler materials shall be used.

Table 6-2. S-Group Verification Testing Requirements

Presumed S-Group Number <sup>1/</sup>	AM Process	S-Group Verification Testing <sup>2/</sup>		
		Heat Treatment Condition <sup>3/</sup>		
		As-Built	PPD Heat Treatment	Non-PPD Heat Treatment
S-1	Wire DED <sup>4/</sup>	-	-	X
S-8	PBF <sup>5/</sup>	-	-	X
	Wire DED <sup>4/</sup>	-	-	X
S-34	PBF <sup>6/</sup>	X	X	X
	Wire DED <sup>7/</sup>	X	X	X
S-36A	Wire DED <sup>8/</sup>	X	X	X
S-42	PBF <sup>4/</sup>	X	X	X
	Wire DED <sup>4/</sup>	X	X	X
S-43	PBF <sup>4/</sup>	X	X	X
	Wire DED <sup>4/</sup>	X	X	X
S-52	Wire DED <sup>9/</sup>	-	-	X

NOTES:

<sup>1/</sup> S-Groups not listed in this table may be evaluated using the requirements of this document when approved by NAVSEA.

<sup>2/</sup> S-Group verification testing shall be as specified in Chapter 5. For high-risk installations, the additional testing identified in Appendix A may be required at the discretion of NAVSEA or the NAVSEA authorized representative.

<sup>3/</sup> See 3-2.j.

<sup>4/</sup> The PPD for this S-Group/AM process combination has not yet been issued.

<sup>5/</sup> See 802-8979758.

<sup>6/</sup> See 802-8979761.

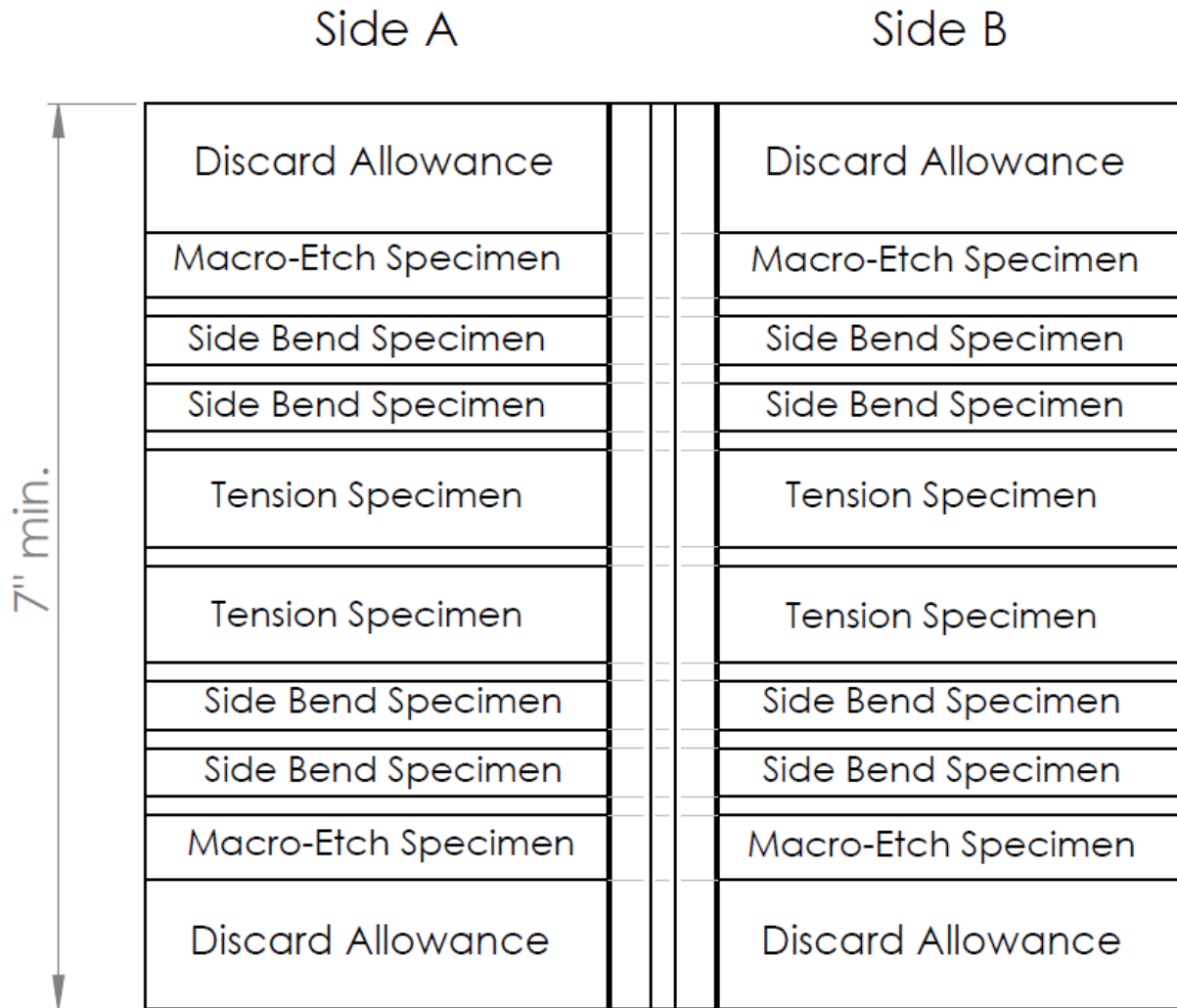
<sup>7/</sup> See 802-8979760.

<sup>8/</sup> See 802-8979762.

<sup>9/</sup> See 802-8979759.

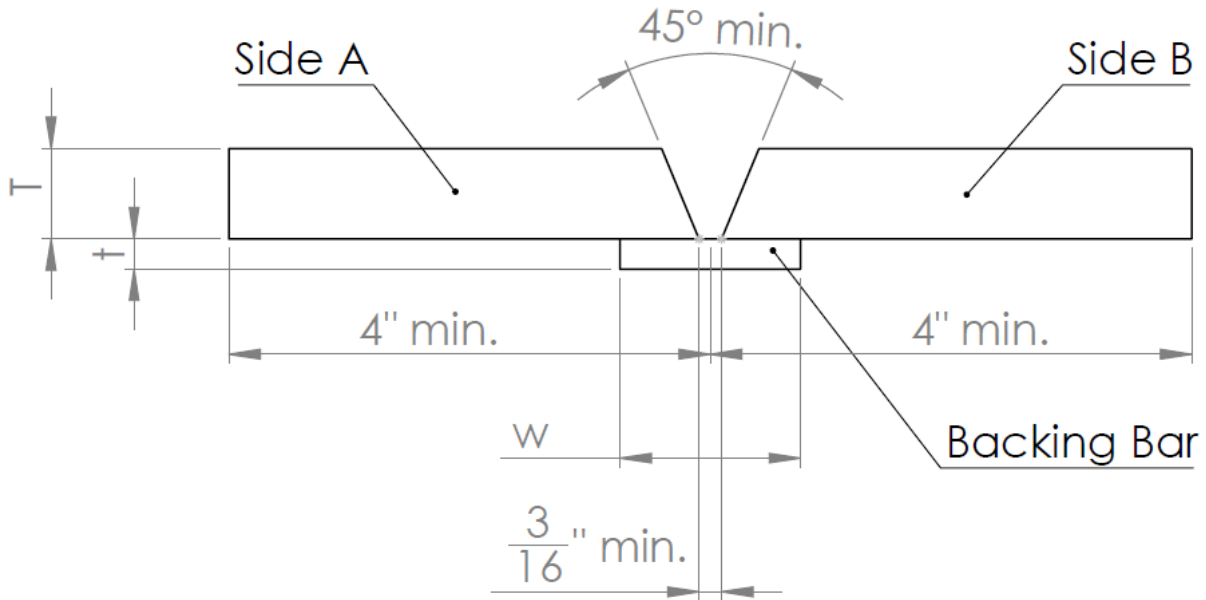
Table 6-3. Destructive Testing Requirements

Test Assembly Type	Transverse Tension Test Specimens	Guided Bend Test Specimens (Side Bends) <sup>1/</sup>	Transverse Macro-Etch Cross-Sections <sup>2/</sup>
S-Group Verification	2	4 <sup>3/</sup>	2 <sup>4/</sup>
<p>NOTES:</p> <p><sup>1/</sup> When the S-Group verification test assembly is less than ½ inch thick, root and face bends may be substituted for the side bend specimens (see A-1.3.1).</p> <p><sup>2/</sup> Transverse macro-etch cross-sections shall include at least ½ inch of AM base material from each side of the weld and shall be taken through the largest MT or PT (as applicable) indication in the fusion zone or heat-affected zone. If no MT or PT (as applicable) indications are available, the macro-etch cross-sections may be taken from any suitable location along the weld length.</p> <p><sup>3/</sup> Side bend test specimens shall be taken transverse to the weld, and the bend axis shall be aligned with the nominal centerline of the weldment.</p> <p><sup>4/</sup> In lieu of two macro-etch cross-sections including ½ inch of AM base material from each side of the weld, four macro-etch cross-sections may be taken, with two macro-etch cross-sections capturing the heat-affected zone from each side of the weld (i.e., two macro-etch cross-sections of the heat-affected zone from each AM base material plate used for the S-Group verification test assembly).</p>			



a. Top View

**Figure 6-1. S-Group Verification Test Assembly**

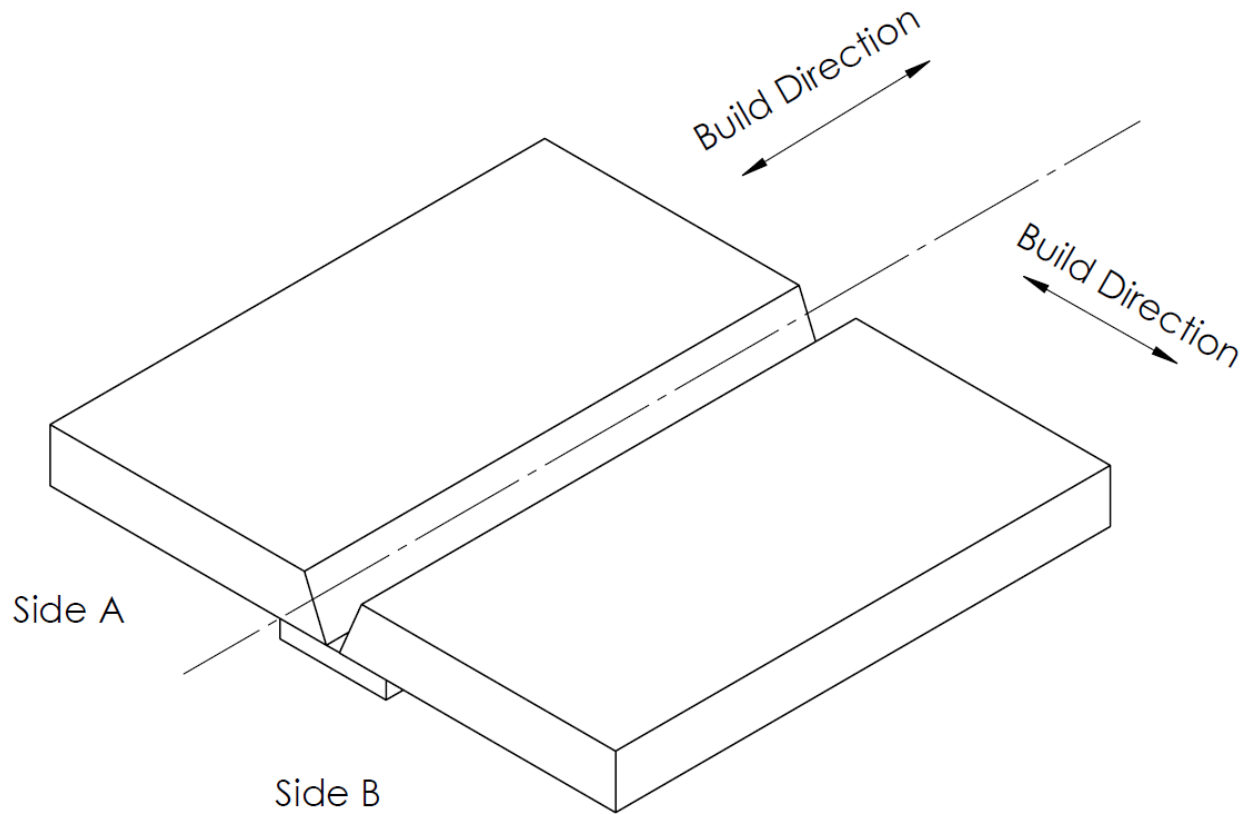


b. Side View

## NOTES:

1. This figure is provided as an example and is not intended to be prescriptive regarding specific dimensions. The AM supplier is permitted to adjust the dimensions of the S-Group verification test assembly to suit build volume requirements, AM process requirements, and related aspects of the AM process, provided that the build orientations specified in 5-3.2 are satisfied and the destructive test specimens required by this document can be extracted from the modified test assembly and tested.
  - a. In lieu of a single test assembly, multiple test assemblies may be used and welded to provide the total number of destructive test specimens required.
  - b. If the use of two smaller test assemblies in lieu of the single S-Group verification test assembly is desired, two 4- by 4-inch AM base material plates should be used for Side A, and two 4- by 4-inch AM base material plates should be used for Side B.
  - c. The minimum width of any modified S-group verification test assembly shall be sufficient to ensure that the AM base material heat-affected zones are captured in the gauge length of the tension test specimens and in the bend area of the bend test specimens. The AM supplier may increase the width of the S-Group verification test assembly if required to suit available destructive test equipment.
2. Test specimen locations are representative and are not to be construed as prescriptive.
3. Thickness of the test assembly (T) shall be as specified in 5-3.2.2.
4. Thickness of the backing bar (t) shall be ¼ inch minimum. Width of the backing bar (w) shall be 1½ inch minimum. See 5-3.2.5 for backing bar material requirements.
5. Build orientation shall be as specified in 5-3.2.3 and 5-3.2.4. See [figure 6-2](#) for guidance.

**Figure 6-1. S-Group Verification Test Assembly - Continued**



NOTE:

1. This figure is provided as a visual example to assist in design of the [figure 6-1](#) S-Group verification test assembly regarding build orientation (see 5-3.2.3 and 5-3.2.4). The figure is provided for information and is not intended to be prescriptive.

**Figure 6-2. S-Group Verification Test Assembly Build Orientation**

## APPENDIX A SUPPLEMENTAL REQUIREMENTS FOR HIGH-RISK INSTALLATIONS

### A-1 GENERAL.

This appendix provides requirements for elevated S-Group verification testing when such testing is required for high-risk installations or when specified by the purchasing activity, NAVSEA, or the NAVSEA authorized representative. The S-Group verification testing required by this appendix are minimum requirements and may be supplemented with additional testing as required to suit specific applications and requirements.

**A-1.1 GENERAL REQUIREMENTS.** The elevated S-Group verification testing specified herein may be used in lieu of the [figure 6-1](#) S-Group verification testing requirements for the purposes of validating that an AM procedure produces AM base material whose presumed S-Group may be treated as its actual S-Group for the purposes of welding procedure and performance qualification in accordance with NAVSEA S9074-AQ-GIB-010/248. If elevated S-Group verification testing is performed in lieu of the S-Group verification testing specified in Chapter 5, it shall be documented in the certification data package (see 4-3.1).

**A-1.2 TEST ASSEMBLY REQUIREMENTS.** The elevated S-Group verification test assembly shall be prototypical of the welded application, including joint restraint, when practicable. If the use of a prototypical mock-up is not practicable, the design of the S-Group verification test assembly, including joint restraint, shall be as specified by the purchasing activity, NAVSEA, or the NAVSEA authorized representative.

**A-1.2.1 Test Assembly Design Recommendation.** Prolongations or integral extensions (see MIL-C-24615 for an example of a “false end” used for weldability testing) of sufficient size to remove the required destructive test specimens should be incorporated into the part verification build where practicable. The prolongation or integral extension may be removed from the part verification build prior to machining and welding of the prototypical S-Group verification test assembly, if so desired by the AM supplier.

**A-1.2.2 Substitution of AM Shapes.** Where prolongations or integral extensions on the part verification build are not practicable, representative AM base material that duplicates the relevant dimensions of the welded portion of the AM component or part shall be used. The AM shapes shall replicate the build orientation and physical arrangement of the AM part to be welded in production and shall be prepared to prototypical of the portion of the AM part to be welded. These AM shapes shall be of sufficient size to perform the nondestructive testing and extract the destructive test specimens required by this document.

**A-1.2.3 Additional Requirements for NAVSEA 08 Cognizant AM Parts.** For AM parts under the cognizance of NAVSEA 08, the following additional requirements apply.

- a. Prototypical mock-ups of AM parts manufactured using the PBF process shall use the powder lot intended to be used for the production build, unless otherwise approved by NAVSEA.
- b. RT shall be performed on the prototypical mock-up prior to destructive testing in accordance with 5-4.1, unless otherwise approved by NAVSEA.
- c. If S-Group verification testing has been previously performed for an AM procedure, then destructive testing of the prototypical mock-up shall be reduced to two macro-etch specimens for each powder lot. Specimens shall be prepared as specified in 5-4.2.1 and examined in accordance 5-4.3.1, except that a minimum magnification of 50x shall be used.

**A-1.3 TEST ASSEMBLY WELDING AND TESTING.** S-Group verification testing for these test assemblies should otherwise be in accordance with the requirements of this document.

**A-1.3.1 Substitution of Face and Root Bend Tests.** Where the prototypical mock-up is of insufficient thickness to provide adequate side bend test specimens, root and face bend tests may be performed in lieu of side bend tests. In such a case, two root and two face bend specimens in accordance with AWS B4.0 shall be substituted for the side bend test specimens required by [table 6-3](#).

**A-1.4 PIPING SOCKET WELDS.** For elevated S-Group verification testing of piping socket welds, a prototypical mock-up in accordance with the requirements of A-1.2 shall be tested. The prototypical mock-up shall be subjected to VT and PT, as specified in 5-4.1. Each socket procedure test assembly shall be sectioned into quadrants to provide four macro-etch cross-sections approximately 90 degrees apart; socket S-Group verification test assemblies less than 0.840-inch nominal diameter may be sectioned in half to provide one macro-etch cross-section. At least one macro-etch cross-section shall be taken through a start/stop location. Macro-etch cross-sections shall be prepared as specified in 5-4.2.1 and examined in accordance with 5-4.3.1.

**802-8999910**

---

---