

# NS 2.0 Nobles Specification Soldering Procedure and Performance Qualification



## 1. Scope

The scope of this specification is to define the technical and quality requirements of solder joints and qualification of solderers at Nobles Worldwide in the production of military products. The primary focus of this specification is meeting the requirements of AWS B 2.3/B2.3M Specification for Soldering Procedure and Performance Qualification. This specification establishes testing methods, sampling frequency, and acceptance criteria for the production and inspection of soldered joints.

Nobles Worldwide is responsible for the soldering quality done by our employees, including the use of qualified soldering procedures and qualified solderers. It is the responsibility of Nobles Worldwide to assure that soldering procedure specifications meet all requirements of the designs as specified herein or on the drawings. Nobles Worldwide shall maintain the applicable soldering procedure specifications, soldering procedure qualification records, and soldering performance qualification records.

This document is intended primarily for use with torch soldering.

See section 7 for specifications for legacy documents that call for soldered joints but have no other criteria or requirements.

## 2. Referenced Documents

AWS B 2.3/B2.3M	Specification for Soldering Procedure and Performance Qualification
ASTM E 340	Standard Test Method for Macroetching Metals and Alloys
AWS B 2.1/B 2.1M	Base Metal Grouping for Welding Procedure and Performance Qualification
AWS B 4.0	Standard Method for Mechanical Testing of Welds
AWS A 3.0M/A 3.0	Standard Welding Terms and Definitions, Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying
ASTM B 32-04	Specification for Soldering Filler Metal
ASTM B 907-05	Standard Specification for Zinc, Tin, And Cadmium Base Alloys used as Solders
ASTM B 813	Specification for Liquid and Past Fluxes
ANSI Z49.1	Safety in Welding, Cutting, and Allied Processes

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NFPA 51B

Standard for Fire Prevention During Welding, Cutting, and  
Other Hot Work

## 3. Definitions –

(Ref.: AWS A 3.0M/A 3.0 Standard Welding Terms and Definitions, Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying)

### 3.1. Company

Nobles Worldwide, who is responsible for approval, signature, and certification as required in AWS B 2.3/B 2.3M. This responsibility lies with Engineering as the design activity or Quality Assurance as may be applicable.

### 3.2. Qualification Variable

A soldering variable, which if changed beyond the limitations specified, requires requalification of the procedure.

### 3.3. Qualified Solderer

A person who is qualified to the requirements of this document or AWS B 2.3/B 2.3M to perform manual soldering.

### 3.4. Qualifier

The Quality Manager or designated person that is responsible for conducting and supervising qualification testing.

### 3.5. Referencing Document

The drawing, product standard, or contractual requirement that invokes the soldering requirements. **If a Nobles Worldwide drawing specifies soldering with no other criteria this document is the Referencing Document.**

### 3.6. Soldered test assembly

Work pieces joined by soldering for the purpose of qualifying soldering procedures, solderers, or joint designs.

### 3.7. Soldering procedure qualification record

A record of soldering variables used to produce an acceptable soldering test assembly and the results of the tests conducted on the assembly to qualify a soldering procedure specification.

### 3.8. Soldering Procedure Specification (SPS)

A document specifying the required soldering variables for a specific application.

### 3.9. Soldering Variable

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Any controllable detail of a soldering procedure which is required to be addressed on the SPS.

## 3.10. Specimen

The soldered test assembly or portion thereof that is evaluated for qualification purposes.

## 3.11. Specimen Blank

That portion of a soldered test assembly that is removed for the production of a specimen. In some cases, the specimen blank is also the specimen.

## 4. Technical Requirements

### 4.1. General

A soldering procedure qualification provides test data for assessing the properties of a soldered joint. It is the obligation of Nobles Worldwide to produce soldered assemblies that have properties suitable for the application. The proof of production solder soundness is determined by the type and extent of testing and examination applied, which is the responsibility of the Referencing Document.

Safety must be the first concern of all hot processes. When required, safety procedures shall be developed for the safe use of the materials and equipment involved in soldering joints. Refer to the following for safety guidelines:

ANSI Z49.1	Safety in Welding, Cutting, and Allied Processes
NFPA 51B	Standard for Fire Prevention During Welding, Cutting, and Other Hot Work

Always refer to the safety data sheets for all materials and the operational manuals for all equipment used in soldering processes.

4.1.1. Each soldering procedure shall be qualified to establish the properties that are expected to result from its application to production soldered joints. To qualify a soldering procedure, the following steps are required:

- 4.1.1.1. Nobles shall prepare a preliminary soldering procedure specification (SPS) to be used in making a soldered test assembly. The Nobles format will be used.
- 4.1.1.2. When preparing a SPS the guidelines and tables provided within AWS B2.3/B2.3M shall be used for Base Metal Groups, Filler Metals, and Fluxes.
- 4.1.1.3. The actual conditions used in making the soldered test assembly and the results of the required examination and specimen testing shall be recorded on a soldering procedure qualification record (SPQR). The Nobles format will be used.

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- 4.1.1.4. When the results meet the acceptance criteria of AWS B2.3/B2.3M, Nobles will certify by signature and date that the soldering and testing for procedure qualification are in accordance with this document or AWS B2.3/B2.3M.
- 4.1.1.5. If the results do not meet the acceptance criteria, a new soldered test assembly shall be prepared. Soldered test assemblies shall not be repaired.
- 4.1.1.6. Nobles cannot accept soldering procedures for any other company. Only Nobles procedures can be certified and used.
- 4.1.2. During the making of procedure test assemblies for qualification, see Table A1 of AWS B2.3/B2.3M, the solderer shall be under the full supervision and control of the Quality Assurance Manager or their delegate as the Qualifier. The qualifier is responsible for ensuring proper:
  - 4.1.2.1. Preparation of workpieces for soldering
  - 4.1.2.2. Documentation of the soldering test assembly variables
  - 4.1.2.3. Preparation of specimens from the completed soldered test assembly
  - 4.1.2.4. Performance of examination and mechanical tests, and
  - 4.1.2.5. Documentation of results.
- 4.1.3. A change in qualification variable beyond the allowed limits in AWS B2.3/B2.3M shall require requalification of the SPS and preparation of a new SPS. Changes in other variables shall not require requalification, provided such changes are documented in a revised SPS.
- 4.1.4. SPQRs shall not be revised, except to correct errors or add omitted information. However, all such changes shall be identified and dated on the SPQR.
- 4.1.5. SPS and SPQR shall be identified as specified by the Quality Assurance Manager to allow traceability between the SPS and the SPQR. The Quality Assurance Manager shall specify the location and method of retention for these records.
- 4.1.6. A SPS may require the support of more than one SPQR; while one SPQR may support a number of SPSs.
- 4.2. Soldering Test Assemblies and Acceptance Criteria

Each soldering procedure shall be qualified by making one or more test assemblies. These may be standard test assemblies (as defined in AWS B2.3/B2.3M; Figure C.1 to C.4), actual production assemblies, or workmanship soldered test assemblies (as defined in AWS B2.3/B2.3M; Figure C.5) when allowed by the Quality Assurance Manager.

#### 4.2.1. Visual Examination

All soldered test assemblies shall be inspected by visual means prior to cutting for testing.

4.2.2. Acceptance Criteria for Visual Examination. The results of the visual examination shall meet the following requirements:

- 4.2.2.1. Solder metal shall be present at all edges of a joint
- 4.2.2.2. No unmelted filler metal shall be present
- 4.2.2.3. No cracks shall be visible in the joint

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4.2.2.4. No evidence of base metal melting shall be present.

4.2.3. Tension Test

When specified by the Referencing Documents tension tests shall be done in accordance with AWS B2.3/B2.3M section 4.2.3.

4.2.4. Bend Test

When specified by the Referencing Documents bend tests shall be done in accordance with AWS B2.3/B2.3M section 4.2.4.

4.2.5. Macroetch Test

When specified by the Referencing Documents macroetch tests shall be done in accordance with AWS B2.3/B2.3M section 4.2.5.

4.2.6. Peel Test

When specified by the Referencing Documents peel tests shall be done in accordance with AWS B2.3/B2.3M section 4.2.6.

4.2.7. Workmanship Soldered Test Assemblies

For joints other than those identified above as standard test assemblies, one workmanship test assembly representative of the design details of the joint to be qualified is required. Production parts may be used for the workmanship test assembly.

4.2.7.1. Test assemblies of linear joints shall be representative of the production parts or use production parts for the test assembly. The test assembly shall be cut perpendicular to the soldered joint into five equal parts. The two parts adjacent to the center part shall be selected as macroetch specimen blanks.

4.2.7.2. Soldered test assemblies of circular joints shall be cut into quadrants. Two opposing quadrants shall be selected as macroetch specimen blanks.

4.2.7.3. The four cut sides of the macroetch specimen blanks shall be smoothed and etched with a reagent to give a clear definition of the solder and examined with a three to ten power magnifying glass. Macroetching and evaluation may be done at Nobles (see ASTM E 340 Standard Test Method for Macroetching Metals and Alloys) or sent to a third party approved by the Quality Assurance Manager.

4.2.7.4. Acceptance Criteria for Workmanship Tests

None of the cross sections, when considered individually, shall have a total length of discontinuities, such as pores, voids, unsoldered areas, and inclusions, greater than 20% of any single solder length of each joint member. No cracks shall be present in the joint or in the base metal.

4.3. Qualification Variables

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A change in any of the variables listed below beyond the limits listed in AWS B2.3/B2.3M section 4.3 shall require requalification of the SPS and the preparation of a new SPS.

- 4.3.1. Soldering Process
  - 4.3.2. Base Metal
  - 4.3.3. Base Metal Thickness
  - 4.3.4. Base Metal Preparation
  - 4.3.5. Solder Filler Metal
  - 4.3.6. Soldering Flux
  - 4.3.7. Bath Composition
  - 4.3.8. Soldering Atmosphere
  - 4.3.9. Soldering Temperature
  - 4.3.10. Soldering Time
  - 4.3.11. Joint Design
  - 4.3.12. Joint Clearance
  - 4.3.13. Solder Flow Position
  - 4.3.14. Postsolder Heat Treatment
  - 4.3.15. Precoating (Tinning)
5. Soldering Performance Qualification

#### 5.1. General

Soldering performance qualification tests determine the ability of qualified solderers to make sound soldered joints following a soldering procedure specification (SPS) and under conditions that will be encountered in production applications.

- 5.1.1. Qualification under this section requires completion of a test soldered assemblies in accordance with a qualified SPS, acceptance by the Qualifier of the test soldered assemblies, and the results of the specimen tests.
- 5.1.2. Acceptance of performance test soldered assemblies may be allowed by either one of the two methods:
  - 5.1.2.1. Qualification by visual examination, which will be used unless specified by the Referencing Documents
  - 5.1.2.2. Qualification by specimen testing.
- 5.1.3. Performance qualification by specimen testing shall qualify the individual to perform production soldering, where qualification by either specimen testing or visual examination is specified.
- 5.1.4. A solderer who completes an acceptable procedure qualification test assembly shall be qualified for production work within the limits of variables specified as Qualification Variables for Solderers.
- 5.1.5. Qualification is permitted on production soldered assemblies provided that such qualification is not prohibited by the Referencing Document.
- 5.1.6. Test Assemblies shall not be repaired.

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- 5.1.7. The solderer undertaking performance qualification tests shall be under the full supervision and control of the Quality Assurance Manager or their delegate as the Qualifier during the making of test soldered assemblies. Acceptance or rejection and documentation of test results are the responsibility of the Qualifier. Performance qualification documentation shall be dated and signed by the Qualifier. Nobles' format shall be used.
- 5.1.8. The performance qualification shall remain in effect indefinitely unless the solderer does not solder with the qualified process for a period exceeding six months or if there is some specific reason to question the ability of a solderer.
- 5.1.9. A solderer who fails the performance test required by this section may be retested at the option of the Qualifier.
- 5.2. Qualification by Visual Examination
- 5.2.1. Qualification by visual examination shall be used by Nobles unless otherwise specified by the Referenced Documents.
- 5.2.2. Qualification by visual examination requires completion of a workmanship test soldered assembly or production parts, which shall be accepted or rejected by visual examination.
- 5.2.3. Unless otherwise specified in the Reference Document, the test assembly shall be visually examined and shall meet the following requirements:
- 5.2.3.1. Solder metal shall be present at all edges of a joint
  - 5.2.3.2. No unmelted solder filler metal shall be present
  - 5.2.3.3. No cracks shall be present in the solder metal or base materials.
- 5.3. Qualification by Specimen Testing
- When qualification by specimen testing is required workmanship soldered test assemblies shall be used, the specimens and testing shall be done in accordance with AWS B2.3/B2.3M and below.
- 5.3.1. The test assembly shall be a production joint using production parts.
- 5.3.2. Linear joints shall be cut perpendicular to the soldered joint into five (5) equal parts. The two parts adjacent to the center part shall be selected as macroetch specimen blanks. Circular joints shall be cut into quadrants. Two opposing quadrants shall be selected as macroetch specimen blanks.
- 5.3.3. The four cut sides of the two macroetch specimen blanks shall be smoothed and etched with a suitable reagent to give a clear definition of the solder and examined with three (3) to ten (10) power minimum magnifying glass.
- 5.3.4. None of the cross sections, when considered individually, shall have a total length of discontinuities, such as pores, voids, unsoldered areas, and inclusions, greater than 20% of any single joint length. No cracks shall be present in the joint or in the base metal.
- 5.4. Qualification Variables for Solderers

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Solderers must be requalified when there is any change in qualification variables as described below:

#### 5.4.1. Soldering Process

- 5.4.1.1. A change from one soldering process to another
- 5.4.1.2. The addition of any other soldering process to that or those already qualified

#### 5.4.2. Base Metal

- 5.4.2.1. A change from a base metal given under one BM number in AWS B2.3/B2.3M Table B.1 to a base metal given under another BM number with the exception as given in Table A.3.
- 5.4.2.2. A change from a base metal not included in Table B.1 to any other base metal.
- 5.4.2.3. The soldering of dissimilar metal joints does not need to be requalified if the base metals involved are included in only one of the eight categories given in 1.1 Base Metals and if the soldering conditions for the dissimilar metal joints are the same as for each of the base metals involved and are within the limitations of the procedure qualification variables.

#### 5.4.3. Base Metal Thickness

A change in base metal thickness to a value outside the range qualified in accordance with AWS B2.3/B2.3M Table A.2 requires requalification.

#### 5.4.4. Solder Filler Material

- 5.4.4.1. A change from a filler metal given in AWS B2.3/B2.3M Table A.5 under one FM number to a filler metal given under another FM number or to a filler metal not included in the table.
- 5.4.4.2. A change from a filler metal not included in Table A.5 to any other filler metal.
- 5.4.4.3. A change from preplaced filler metal or mechanically fed filler metal.

#### 5.4.5. Soldering Position

- 5.4.5.1. A change in position qualified in AWS B2.3/B2.3M Table A.4.
- 5.4.5.2. Other Positions: When production soldering is performed in a position that does not conform to any of the soldering positions included in AWS B2.3/B2.3M Figure C.7, qualification test soldered assemblies shall be made in the production soldering position. Such qualifications are valid only for the position actually tested except that an angular deviation of 15 degrees is allowed.
- 5.4.5.3. If the filler metal is preplaced in the joint so that there is no major flow, the joint may be soldered in any position without requalification.

#### 5.4.6. Joint Design



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- 5.4.6.1. A change from a butt joint to any joint with overlapping members or vice versa.
- 5.4.6.2. An increase in lap length of 1/16 inch (2 mm) or 25%, whichever is greater, for sheet and plate.
- 5.4.6.3. See AWS B2.3/B2.3M Figure C.6 for typical joint design.
- 5.4.7. Precoating (Tinning)

The SPS shall be requalified when there is a change from a precoated to a non-precoated state prior to soldering the joint or vice versa.

### 6. Quality Assurance Provisions

- 6.1. Inspection of soldered joints shall be done visually unless otherwise specified. The requirements of section 7 below shall be the acceptance criteria.
- 6.2. Inspection Sampling Plans

Sampling plans shall be specified or approved by Nobles Worldwide Engineering or Quality Assurance.

### 7. Drawing Requirements for Soldered Joints

- 7.1. When no soldering details or criteria are called for on a Nobles Worldwide document that includes/requires soldering this document becomes the Referencing Document and the following shall be used:
  - 7.1.1. Soldering shall be performed using a qualified process by a qualified solderer.
  - 7.1.2. The process shall be qualified in accordance with this document.
  - 7.1.3. The solderer shall be qualified in accordance with this document.
  - 7.1.4. Inspection shall be visual unless otherwise specified.
  - 7.1.5. Unless otherwise specified the assembly shall be visually examined and shall meet the following requirements:
    - 7.1.5.1. Solder metal shall be present at all edges of a joint
    - 7.1.5.2. No unmelted solder filler metal shall be present
    - 7.1.5.3. No cracks shall be present in the solder metal or base materials.
- 7.2. The following details will be called out on Referencing Documents for soldered joints as required:
  - 7.2.1. Dimensional requirements, fillet size, area to be joined, or
  - 7.2.2. Soldering shall be performed in accordance with this document
  - 7.2.3. Filler metal requirements
  - 7.2.4. Proof of production solder soundness as determined by the type and extent of testing and examination to be applied
    - 7.2.4.1. Examination acceptance criteria
    - 7.2.4.2. Testing acceptance criteria,
      - 7.2.4.2.1. Qualification requirements or
      - 7.2.4.2.2. Production requirements

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- 7.2.5. Special requirements for surface finish or appearance
- 7.2.6. Sampling plan for inspection if higher than normal or special

**8. Ordering Information**

Purchase Orders from Nobles shall contain the following information when soldering is a requirement. If there is any missing information or questions, the supplier must seek clarification prior to starting work:

- 8.1. Part number and revision of part being procured with a drawing
- 8.2. Quantity to be delivered and schedule of delivery
- 8.3. Title, identification, and revision of this specification
- 8.4. Testing and reporting requirements
- 8.5. Certification requirements including personnel and materials
- 8.6. Soundness standards and sampling
- 8.7. Packaging requirements
- 8.8. Special instructions or requirements

**9. Notes / Revision History**

<b>Revision Level</b>	<b>Date</b>	<b>Description</b>	<b>Approved/By</b>
A	2017-12-12	Initial Release	Steve Thieman