MIL-STD-1877A(AT)
7 June 1985

MILITARY STANDARD

BRAZING, NICKEL, HIGH TEMPERATURE VACUUM

NO DELIVERABLE DATA DOCUMENT

AREA THJM

DEPARTMENT OF DEFENSE
Washington, DC 20301

Brazing, Nickel, High Temperature Vacuum

MIL-STD-1877A(AT)

1. This Military Standard is approved for use by US Army Tank-Automotive Command, Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: US Army Tank-Automotive Command, ATTN: AMSTA-GSS, Warren, MI 48397-5000, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document, or by letter.

FOREWORD

This Military standard establishes brazing requirements using nickel base brazing alloys. The requirements are presented in a self-contained form. This is not an acquisition document.

CONTENTS

CONTENTS

TABLES

1. SCOPE

1.1 Purpose. The procedures covered by this standard are intended to be used to insure nickel brazing operations meet prescribed requirements.

1.2 Scope. This standard covers the requirements for brazing in a vacuum atmosphere furnace using nickel base brazing alloys.

1.2.1 Classification. Braze joints shall be classified as follows:

Class 1 - Joints subjected to high stresses or fatigue loading.
Class 2 - Joints subjected to intermediate stresses.
Class 3 - Joints subjected to low stresses.

2. REFERENCED DOCUMENTS

2.1 Issues of documents. The following documents of the issue in effect on date of invitation for bids or request for proposal form a part of this standard to the extent specified herein.

SPECIFICATIONS
MILITARY

MIL-H-6875	- Heat Treatment of Steel Process for.
MIL-T-81533	- 1.1.1 Trichlorethane (Methyl Chloroform) Inhibited, Vapor Degreasing.

STANDARDS
MILITARY

MIL-STD-865	- Selective (Brush Plating), Electrodeposited.

PURCHASE DESCRIPTIONS
MILITARY

M1PD-M-62414	- Metal Texturing, Process for (Liquid Honing).
M1PD-N-62425	- Nickel Plating, Process for.
M1PD-B-62449	- Brazing Alloy, Nickel.

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific acquisition functions should be obtained from the acquisition activity or as directed by the contracting officer.)

(M1PD Specifications and Standards may be obtained from the US Army Tank-Automotive Command, Attn: AMSTA-GSS, Warren, MI 48397-5000.)

2.2 Other publications. The following documents form a part of this standard to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

AMS 4776	- Brazing Alloy, Nickel Base.
AMS 4777	- Brazing Alloy, Nickel Base.
AMS 4779	- Brazing Alloy, Nickel Base.
AMS 5510	- Steel Sheet, Strip, and Plate, Corrosion and Heat Resistant.

(Copies may be obtained from the Society of Automotive Engineers, Inc., 400 Commonwealth Avenue, Warrendale, PA 15096.)

AMERICAN WELDING SOCIETY

AWS A2.4	- Welding Symbols.
AWS A3.0	- Welding Terms and Definitions.

(Copies of the above publications may be obtained from the American Welding Society, 550 N.W. LeJeune Road, P.O. Box 351040, Miami, Florida 33135.)

(Technical society and technical association specifications and standards are generally available for reference from libraries.)

3. DEFINITIONS

3.1 Terms. Definitions of terms relative to the equipment, processes and procedures described in this standard can be found in the AWS A3.0 reference document.

4. GENERAL REQUIREMENTS

4.1 Equipment.

4.1.1 Brazing furnace. The brazing furnace shall be suitable for the intended purpose and shall be capable of maintaining the following conditions:

a. A vacuum of less than 5 microns at 2200 degrees Fahrenheit (°F) [1205 degrees Celsius (°C)].
b. Introducing and circulating cooling gas (argon or nitrogen) at 1700°F (927°C).
c. Uniform heating and cooling of the work load.
d. Uniform temperature in all areas of the work zone in accordance with MIL-H-6875.
e. The leak-up rate of the furnace at ambient temperature and starting at a pressure of 1 micron or less, shall not exceed 200 microns per hour.

4.1.1.1 Alternate hydrogen atmosphere furnace. As an alternate to the vacuum furnace, a hydrogen atmosphere furnace may be used when approved in writing by the acquisition activity.

4.1.2 Instrumentation and controls.

4.1.2.1 Temperature. All brazing furnaces shall be equipped with temperature controllers and recorders in accordance with MIL-H-6875.

4.1.2.2 Vacuum gages and controls. Vacuum furnaces shall be equipped with measuring gages, emission or alphatron type or equivalent, and recording instrumentation. Their suggested location is to place them at the forward side of the main diffusion pump gate.

4.1.3 Fixtures. Brazing fixtures shall be made of non-gassing heat resistant materials, be capable of maintaining proper braze clearance, have dimensional stability, and have compatible coefficients of expansion with parts being joined.

4.1.4 Braze alloy paste applicators. Braze alloy applicator shall be capable of dispensing the required size and amount of braze alloy paste. The materials of the applicators shall not be detrimental to the alloy paste used and may be of tube, bulb, cartridge, or air gun type.

4.1.5 Air pressure source. An air pressure source providing 40 pound force per square inch (psi) minimum shall be required for both wet and dry abrasive blast operations.

4.2 Material.

4.2.1 Braze alloy. Braze alloy may be in any of the following forms: foil, wire, transfer tape, powder, or paste. The braze alloy paste shall be either organic vehicle or water vehicle type.

4.2.1.1 Organic vehicle type. Organic vehicle type alloy paste shall consist of equal parts by volume of braze alloy powder (see table I) and binder. The binder viscosity may be reduced by mixing with thinner up to equal parts by volume. Additional binder and thinner may be added as required to maintain consistency during use.

Note: Preparation for use shall be accomplished by thoroughly mixing the ingredients together in a beaker cleaned with acetone.

4.2.1.2 Water vehicle type. Water vehicle type braze alloy paste shall consist of braze alloy powder and a water vehicle type binder. Premixed cartridge application paste is available from the binder manufacturer.

4.2.2 Thinner. Acetone, technical grade (99.0 percent pure).

4.2.3 Braze stopoff. Braze stopoff may be either stick or liquid form and shall be capable of satisfactorily inhibiting the braze alloy wetting the surface to which the braze stopoff has been applied.

4.2.4 Cooling gas.

4.2.4.1 Argon. The purity shall be 99.995 percent pure with a dew point lower than -60°F (-51°C).

4.2.4.2 Nitrogen gas. Nitrogen may be substituted for argon. The purity shall be 99.995 percent nitrogen with a dew point of -72°F (-58°C).

4.2.5 Vapor degreaser solvent. Stabilized 1-1-1 trichloroethane MIL-T-81533 or equivalent type solvent.

4.2.6 Abrasive wheels. Silicon carbide impregnated cloth wheels.

4.2.7 Wire brush. The wire brush shall have austenitic stainless steel bristles.

4.2.8 Cleaning solvent. Acetone, methyl ethyl ketone (MEK) or isopropyl or methyl alcohol of commercial grade.

4.2.9 Abrasive for abrasive blast.

4.2.9.1 Dry. Nicrobraz blasting grit - 60 or equivalent.

4.2.9.2 Wet abrasive slurry. The wet abrasive slurry shall be in accordance with MIPD-M-62414.

Note: Aluminum oxide grit shall not be considered an equivalent material.

4.2.10 Heat shields. Heat shields shall be made from AMS 5510 metal or equivalent material or fiber-frax cloth.

4.3 Required procedures and operations.

4.3.1 Preparation of parts. All surfaces to be brazed shall be prepared in the following manner except for surfaces that are to be nickel plated (see 4.3.1.6).

4.3.1.1 Cleaning. Part surfaces shall be thoroughly cleaned using appropriate chemical solutions (see 4.2.8).

4.3.1.2 Polishing. Mating surfaces shall be prepared for brazing by polishing with a silicon carbide impregnated cloth wheel or wire brush (see 4.2.6 and 4.2.7).

Note: Polishing is not applicable to plated or otherwise specially prepared surfaces.

4.3.1.3 Vapor degrease. When required to maintain cleanliness, parts and fixtures to be placed in brazing furnace shall be vapor degreased (see 4.2.5).

4.3.1.4 Abrasive blast. All surfaces to be brazed shall be either dry or wet abrasive blasted as follows:

a. Dry abrasive blast. Dry abrasive blasting shall be accomplished using the specified material and air pressure (see 4.1.5 and 4.2.9.1).

Note: After dry abrasive blasting, parts shall be handled in a manner which will prevent contamination of the surfaces.

b. Wet abrasive blast. Except for slushing in oil, wet abrasive blasting shall be performed in accordance with all the requirements of MIPD-M-62414 (see 4.2.9.2).

4.3.1.5 Final wipe. Wet abrasive blasted parts shall have the areas to be brazed, wiped with a clean, lint free wiper wet with a suitable solvent (see 4.2.8).

4.3.1.6 Nickel plate. Nickel plate shall be required on the braze joint area of stainless or corrosion resistant steels and superalloy parts having the equal or larger percentage by weight of the following alloying elements:

a. Titanium - 0.70 percent.
b. Aluminum - 0.40 percent.
c. Titanium plus aluminum - 0.70 percent.

4.3.1.6.1 Application. Nickel plate 0.4 to 0.8 mil (0.010 to 0.020 mm) thick shall be applied in accordance with the requirements of MIL-STD-865 or MIPD-N-62425 and the following:

a. The nickel plate shall extend 0.1 inch (2.54 mm) minimum beyond the braze joint areas indicated by the braze symbol on the engineering drawing unless part geometry does not permit this allowance.

b. The nickel plate shall be applied to each joint surface or surfaces immediately before the braze cycle and to the required braze joint surface or surfaces for each subsequent braze cycle.

Note: The nickel plating does not apply to rebraze cycles.

4.3.1.6.2 Cleaning. The nickel plated braze joint surface shall be thoroughly wiped with a suitable solvent (see 4.2.8).

4.3.2 Assembly. The detail parts shall be fixtured in the position specified on the assembly drawing.

4.3.2.1 Braze joint clearance. The optimum joint clearance between mating surfaces shall be 0.002 to 0.005 inch [0.050 to 0.127 millimeter (mm)] with the following exceptions:

a. When one of the mating surfaces is knurled (0.003 to 0.005 inch/0.076 to 0.127 mm deep), a minimum gap clearance is not required.
b. Isolated areas of the braze gap may have clearances up to 0.010 inch (0.254 mm).
c. Braze gaps at areas with sharp radii (eg, leading and trailing edges of vane to shroud joints) may have clearances up to 0.025 inch (0.635 mm).

4.3.3 Heat treatment. When heat treatment is specified on the engineering drawing, heat treatment may be combined with the braze cycle.

4.3.4 Brazing. The required class of braze joint (see 1.2.1) shall be as specified in the tail of the brazing symbol on the engineering drawing. Braze symbols shall be interpreted in accordance with AWS A2.4.

4.3.4.1 Braze alloy paste application. Braze alloy paste (see 4.2.1.1 and 4.2.1.2) application shall be as follows:

a. Braze alloy paste shall be applied to the braze joint areas designated on the engineering drawing. The fillet shall be kept to a minimum to prevent excessive braze flow and erosion of base metal.
b. When necessary, braze stopoff (see 4.2.3) shall be applied to restrict flow of braze alloy.
c. Excess braze alloy paste shall be removed from the joints.
d. The braze alloy paste shall be dried at room temperature for 2 hours minimum or 160 to 250°F (71 to 121°C) for 50 to 70 minutes.

4.3.4.2 Braze cycle. The braze cycle shall be as follows:

a. The assembly shall be placed in the furnace (see 4.1.1). Suitable high temperature shields (see 4.2.10) shall be used as required on coated parts to protect coating from damage by direct radiation.

b. The cooling gas line shall be purged and the furnace vacuum pumped down to 10 microns or less prior to application of heat.
c. The heating rate shall not exceed 50°F (10°C) per minute from room temperature to 800°F (427°C) and 20°F (-6.7°C) per minute from 800°F (427°C) to the approved equalizing temperature (see table I).
d. If the pressure exceeds 50 microns during the heat-up below 1000°F (538°C), the heat shall be turned off to allow the furnace vacuum to recover to 10 microns or less.
e. The equalizing temperature shall be maintained until the pressure recovers to 2 microns or less and then continued for a period of 60 minutes minimum.
f. The heat-up rate from the equalizing temperature to the brazing temperature shall be at a specified control rate not to exceed 5°F per minute (2.2°C per minute).
g. Unless otherwise specified, the assembly shall be maintained at the specified brazing temperature (see table I) for 10 to 30 minutes.
h. The heat-up rate, equalizing holding time, and brazing temperature and time shall be as approved by the acquisition activity.
i. Unless otherwise specified on the engineering drawing, assembly shall be cooled in a vacuum, argon gas, or nitrogen gas atmosphere. If an argon or nitrogen gas is used, not more than -2 inches gage pressure of cooling gas shall be introduced until reaching a part temperature of 400°F (204°C).
j. Furnace door may be opened below 400°F (204°C).

4.3.4.2.1 Hydrogen atmosphere braze cycle. Request by a contractor to use the alternate hydrogen atmosphere brazing cycle must be submitted in writing for approval. Data to be included shall contain full processing procedure to the acquisition activity.

4.3.4.3 Multiple cycles. Application of braze alloy paste and the braze cycle (see 4.3.4.1 and 4.3.4.2) shall be repeated as required for assemblies requiring more than one braze cycle to complete the assembly operation.

5. DETAIL REQUIREMENTS

5.1 Work instruction submittal. Specific work instructions (process procedures) for each part number and the revision or change of such work instructions shall be submitted to the acquisition acitivity for review prior to use. The acquisition activity material laboratory reserves the right to disapprove any work instruction and change or revision submitted for review.

5.2 Reports. Unless otherwise specified on the purchase order, the supplier shall furnish three copies of a certificate with each shipment. The certificate shall state the following:

a. Purchase order number.
b. Part number and revision letter.
c. Quantity.
d. Brazing heat (lot) number.
e. Conformance to this standard, latest revision.

5.3 Monitoring equipment.

5.3.1 Accuracy of furnace control instruments. The accuracy of temperature measuring and controlling instruments shall be checked at regular intervals of at least once in every 90 working days in accordance with the requirements of MIL-H-6875. The calibrated thermocouple shall be of the platinum type or chromel/alumel type.

5.4 Certification.

5.4.1. Process technique. Initial substantiation tests shall be conducted using this process procedure (equipment, heat treatment, brazing process, etc.) to determine conformance to the engineering drawing requirements for each part configuration. Certification renewal shall be required every 12 months.

Note: If a supplier has more than one facility, each facility shall require separate approval for any given part configuration.

5.5 Test methods.

5.5.1 Inspection. The method of braze inspection and acceptance levels shall be in accordance with the applicable inspection specifications cited on the engineering drawing.

TABLE I. Brazing alloy, and reference brazing temperature.

Braze alloy	Equalizing temperature (2)	Brazing temperature (2)
AMS 4776 (1)	1740°F (949°C)	2050-2075°F (1121-1135°C)
AMS 4777	1740°F (949°C)	1900-1950°F (1038-1066°C)
MIPD-B-62249 (1)	1740°F (949°C)	2110-2135°F (1154-1170°C)
AMS 4779	1740°F (949°C)	2020-2050°F (1104-1121°C)

Note:

(1) Brazing cycle for components containing coated parts must be maintained within this temperature range.

(2) The temperatures noted are actual part temperatures as established in furnace calibrations.

Custodian:
Army - AT

Preparing activity:
Army - AT

(Project No. THJM-A219)

INSTRUCTIONS: In a continuing effort to make our standardization documents better, the DoD provides this form for use in submitting comments and suggestions for improvements. All users of military standardization documents are invited to provide suggestions. This form may be detached, folded along the lines indicated, taped along the loose edge *(DO NOT STAPLE)*, and mailed. In block 5, be as specific as possible about particular problem areas such as wording which required interpretation, was too rigid, restrictive, loose, ambiguous, or was incompatible, and give proposed wording changes which would alleviate the problems. Enter in block 6 any remarks not related to a specific paragraph of the document. If block 7 is filled out, an acknowledgement will be mailed to you within 30 days to let you know that your comments were received and are being considered.

NOTE: This form may not be used to request copies of documents, nor to request waivers, deviations, or clarification of specification requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document*(s)* or to amend contractual requirements.

(Fold along this line)

(Fold along this line)

DEPARTMENT OF THE ARMY

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

BUSINESS REPLY MAIL
FIRST CLASS PERMIT NO. 12062 WASHINGTON D. C.
POSTAGE WILL BE PAID BY THE DEPARTMENT OF THE ARMY

Commander
US Army Tank-Automotive Command
ATTN: DRSTA-GSS
Warren, MI 48080

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ USER
	☐ MANUFACTURER
	☐ OTHER *(Specify)*: _____

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

DD FORM 82 MAR 1426

PREVIOUS EDITION IS OBSOLETE.