NERVA TEST OPERATIONS

Nuclear Rocket Development Station

MASTER

TO: Distribution
FROM: N. E. Erickson

DATE: July 31, 1967
NTO-M-18024
DHC:NEE:dls

SUBJECT: Transmittal of Final Issue of NTO-S-0001, Revision 2

DISTRIBUTION: See attached.

Attached is a copy of the Final Issue of NTO-S-0001, Revision 2, "NTO Specification for Welding Stainless Steel Using the Tungsten Arc Inert Gas Process with "Y" Rings."

For additional copies, please contact NTO Documentation and Reporting, NRDS.

N. E. Erickson, Manager
NERVA Test Operations

Enclosure

DISTRIBUTION OF THIS DOCUMENT UNLIMITED

X-11057

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

MASTER

NTO SPECIFICATION
FOR
WELDING STAINLESS STEEL USING
THE TUNGSTEN ARC INERT GAS PROCESS WITH "Y" RINGS

NTO-S-0001
Revision 2

Prepared By
M. D. Phillips

Approved by: John W. Sadler
J. W. Sadler, Manager
NTO Site Engineering

DISTRIBUTION OF THIS DOCUMENT UNLIMITED

Issue Date
July 28, 1967

NOTICE
This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Energy Research and Development Administration, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

1.0 PURPOSE

The purpose of this document is to establish the procedures applicable to the use of tungsten arc inert gas welding in conjunction with "Y" type consumable inserts on stainless steel.

2.0 SCOPE

This procedure covers the requirements for Tungsten-Inert Gas (T.I.G.) butt welding of "Y" Ring Inserts in 300 series stainless steel piping.

3.0 APPLICABLE DOCUMENTS

The following specifications and publications of the issues indicated by date form a part of this specification, to the extent specified herein. Where no date is indicated, the applicable issue shall be the latest in effect.

Military

Mil-T-5021C	Tests, Aircraft and Missile Welding Operators Qualification
Mil-STD-410A	Qualification of Inspection Personnel, Magnetic Particle and Penetrant

Other

NTO-QCS-112	Levels of Cleanliness
NTO-QCS-107	Liquid Penetrant Examination of Weldments
NTO-QCS-105	Radiography of Fusion Welds
NTO-QCS-111	Missile Welding Operators Qualification
NTO-QRI-13.1	Certification of Non-destructive Testing Personnel

4.0 WELDER QUALIFICATION

4.1 All welders using these procedures shall be qualified in accordance with Mil-T-5021C or NTO-QCS-111.

5.0 GENERAL REQUIREMENTS

5.1 Welding operations conducted as the final weld on a piping system which has previously been cleaned to a precision cleanliness level shall not contaminate the subject system. The welding operation cleanliness shall conform to NTO-QCS-112.

5.2 The edges or surfaces of the parts to be joined by welding shall be prepared by machining or grinding as shown in Figure 1. The edges shall be cleaned of all slag, burrs, oil, grease, and dirt to present a clean and substantially smooth surface for welding. Thoroughly clean all foreign material from inside of passages.

5.3 All oxides shall be removed from the weld area prior to tack welding of the "Y" Ring Insert. Abrasive papers or a stainless steel wire brush are acceptable means for oxide removal. Where a line which has been certified clean is affected, appropriate plugging methods are to be used to maintain system cleanliness, i.e., plastic bags or expandable plugs. Prior to and after removing the plug, the entire weld area and the affected area shall be wiped clean with a lint-free cloth saturated with reagent-grade Methyl Ethyl Ketone (MEK) for the removal of grease, fingerprints, or other contaminants.

5.3.1 The "Y" Ring Insert shall be cleaned of all oxides in a manner similar to section 5.3, prior to tack welding.

5.4 Tack Welding of "Y" Ring Insert

5.4.1 Tack welding of the "Y" Ring Insert is not required if the insert is a pre-formed solid ring and the joint can be clamped in position.

5.4.2 Where tack welds are used, the fusion of the insert arm to the bevel is sufficient. A tack weld spacing of 2 - 4 inches is adequate.

5.4.3 Locate the "Y" ring on one side of joint as shown in Figure 2. Then tack weld as per 5.4.2. Rings over 1/2" in diameter are rolled with an overlap. Tack to first assembly section to within a few inches of overlap then secure the overlap with a vice-grip pliers and saw completely through the side-by-side insert sections. This will leave a gap the width of the saw blade which is to be bridged with weld rod after the interior purge is complete and prior to starting the weld.

Locate the second half of the assembly in its proper position, and tack weld using a slight offset sequence from the first set of tacks.

5.5 Alignment

- 5.5.1 The outward inclined arms of the "Y" Ring Insert creates a double-cup effect with the assembly becoming self-aligning.
- 5.5.2 In cases where there is local misalignment between the two pipes which are to be welded, the insert arm may be pushed into position with a hammer and flat-end chisel.
- 5.5.3 Where large misalignment gaps exist, it is necessary that filler metal be added simultaneously with reduction of the insert. 1/16" filler rod, as specified in the applicable assembly drawing, is held in contact with the inset vee of the "Y" Ring Insert and allowed to enter the weld puddle without rod movement as the arc advances.

5.6 Inert Gas Interior Purge

- 5.6.1 The interior purge shall be acceptable for welding when a volume of welding-grade Argon or helium equal to ten times the volume of the system has passed through the system at a flow rate not to exceed 60 SCFH.
 - 5.6.2 Internal purge rates shall be reduced to 5 - 20 CFH prior to welding. The exhaust vent from the pipe-end cap shall be 3/16" tubing.
- 5.7 Personnel performing non-destructive testing shall be certified in accordance with NTO-QRI-13.1.

6.0 PROCESS

- 6.1 Prior to starting the root pass, a 1/2" long weld should be started 180° from the point the weld bead is to be started. If the weld is not to be started immediately, a second 1/2" long weld should be made at the starting point (180° from the first 1/2" long weld).
- 6.2 The torch should be held such that the electrode is on a radius line at all times.
- 6.3 Intermediate arc stops are to be made by reversing the movement of the torch. Restart overlap for the root pass shall be 3/4" to 1" in length.
- 6.4 Horizontal welds (pipe in the horizontal plane) shall be started at the bottom of the pipe and proceed towards the top.

- 6.5 Advancement of the torch is determined by breakdown of the Vee formed by inclined arms of the insert. As the arms are melted and drawn into the crater, there is a "wetting action" up the beveled sides. The molten weld surface becomes slightly concave as the root-pass fusion is established.
- 6.6 Torch movement should be in a forward direction of travel. Side movement or weaving shall not exceed the width of the "Y" Ring Insert.
- 6.7 The suggested weld setup is as follows:

Welding current:	65-75 amps DCSP 10-15 volts
Arc length:	1/8 inch
Welding speed:	4-6 IPM (Manual)

- 6.8 The root pass shall be radiographed and accepted per NTO-QCS-105 before proceeding with filler passes.

7.0 WELDING

- 7.1 Establish a purge at 5 to 15 CFH of Argon before welding and maintain this purge until a minimum of 3/16 inch or three layers of weld have been deposited. Deposit all welding passes in the same sequence as the tacks. The number of weld increments will be determined by the pipe size. The length of the weld deposits (increments) should not exceed 3 inches for pipe over 6 inch diameter and 2 inches for pipe up to 6 inch diameter. to eliminate distortion, and changes in the physical properties of the base material.
- 7.2 Stagger the starts and ends of increments to avoid start and stop occurrences in the same area through the depth of the joint.
- 7.3 Whenever the material temperature is below 60°F., preheat it to a minimum of 60°F. prior to welding.
- 7.4 Interpass temperature must not exceed 350°F. Tempilsticks or equivalent measuring crayons may be used after each pass to check the temperature of the base metal. Apply the tempilstick to the base metal adjacent to the weld.

8.0 CLEANUP AND DEFECT REMOVAL

- 8.1 Thoroughly clean oxides of each completed bead or layer with a stainless steel wire brush and/or other tools.

- 8.2 Remove all weld splatter from the weld surface before laying down the next bead or layer.
- 8.3 Visually inspect and remove any cracks or blowholes that appear on the welding surface by grinding before depositing the next bead or layer.

9.0 REPAIR

- 9.1 The weld defect shall be removed by local removal of metal using a small rotary stainless-steel file or by grinding, providing this operation does not include breaking completely through the weld into the inside of the pipe.
- 9.2 The reworked area shall be liquid dye penetrant inspected per NTO-QCS-107 to insure complete removal of the defect. If this inspection reveals the continued presence of the defect, Section 9.1 shall be repeated.
- 9.3 All dye penetrant and developer shall be removed by wiping with a clean, lint-free cloth saturated in reagent-grade MEK.
- 9.4 Where complete removal of defects can be accomplished and still meet the requirements of Section 9.1, the second weld pass may be made directly over the reworked area.
- 9.5 Where complete removal of the defect cannot be accomplished without breaking through the inside surface of the weld, the defect will be recorded on an inspection report; and NTO and Source Engineering will be contacted for resolution of the problem.

10.0 FILLER PASSES

- 10.1 Welders certified by this procedure, only, must use TIG welding for filler passes.

11.0 WELDING SPECIFICATION FOR STAINLESS STEEL .100 INCH AND THICKER USING THE TUNGSTEN INERT GAS PROCESS WITH "Y" RINGS

11.1 Applicable Materials (Not all inclusive):

Base Material

304 to 304
304L to 304L or 304

Filler Material

308L
308ELC

Base Material

Filler Material

316 to 316, 304L or 304
316L to 316L, 316, 304L or 304
347 to 347, 316L, 316, 304L, or 304

316
316ELC
347

11.2 General Parameters:

Thickness	.100" and thicker
Weld prep level angle	37 1/2 degrees, approx.
Weld prep land	1/32 Max.
Consumable Insert	"Y" ring
Root Gap	None
Rod	3/32, 1/8 filler metal
Amperage	Fusion pass 65/75 Filler passes 65/130
Voltage	12/18
Shield Gas	16/22 CFH Argon
Purge Gas	5/20CFH Argon
Tungsten electrode	3/32, round 2% thoriated

12.0 IDENTIFICATION

- 12.1 Each weld shall be identified with a symbol orienting its location and the welding operators symbol.
- 12.2 Such symbols shall be vibratol etched adjacent to the weld on the base metal. Penetration of the etch shall be done in a workmanshiplike manner and limited to producing a readable image. Undue penetration will be cause for rejection.

FIGURE I Edge Preparation

FIGURE 2 Location of "Y" Ring