



B. References: Unless noted otherwise, all references shall be the latest edition.

1. ASME Boiler and Pressure Vessel Code, Section IX, latest edition.
2. AWS A 3.0 Terms and Definitions, latest edition.
3. ANSI/ASME B 31.3 Chemical Plant and Petroleum Refinery Piping Code.
4. ASNT-TC-1A.
5. ASME BPEa-2000 and BPE-1997 – Bioprocessing Equipment Standard.

C. Attachments

1. Section 18003-Attachment A - Weld Verification Check List.
2. Section 18003-Attachment B - Welding Inspection Log.
3. Section 18003-Attachment C - Acceptable Weld Profile.

#### 1.04 SUBMITTAL

A. Not Applicable.

#### 1.05 QUALITY ASSURANCE

A. Not Applicable.

#### 1.06 DELIVERY, STORAGE, HANDLING

A. Not Applicable.

#### 1.07 PREREQUISITES

A. Contractors involved in a project that references welds to a section of A.S.M.E. must understand what is being requested. Typical specifications for certification and/or qualification are as follows:

1. Welders must be certified to A.S.M.E. - Section IX. The Contractor must have:
  - a. A Q.A. Manual and Program in effect. A copy of the Q.A program shall be made available to the Owner for review prior to award of the contract.
  - b. A set of General Weld Standards. Contents may include:
    - (1) Method(s) of verifying material i.e. MTR's.
    - (2) Method(s) of verifying tube ends are cut square.
    - (3) Method(s) of verifying tube cleanliness.
    - (4) Tungsten electrode length verification.
    - (5) Tungsten electrode tip preparation i.e., "grind tungsten lengthwise to 22-1/2 degrees and flatten end to 0.13mm (.005").

- c. Qualified procedures in place.
  - (1) Generate test coupons that are sent to a qualified test lab for destructive testing (bends and tensiles).  
Bend tests are predetermined over a certain sized radius. Two each root and face bends must be performed. Careful examination must be done at the Heat Affected Zone (HAZ) to inspect for possible cracking.
- 2. Tensile test performed must be examined for the following:
  - a. The stress level at which the specimen breaks must equal or exceed the tensile stress of the materials being joined together.
  - b. Should the specimen break on the weld, as opposed to being adjacent, (but still meet the base stress criteria) the sample is good.
- 3. Standard Operating Procedures (S.O.P.'s) for purge gas certification and acceptance criteria including:
  - a. Calibrated O<sub>2</sub> analyzer and moisture meter and a method of recording initial fill and purge of distribution system. Sample at bulk tank.
  - b. An acceptance criteria defining maximum impurities by volume of oxygen and moisture.
- B. By A.S.M.E. Code, the Contractor has now proven that the process and techniques used meet A.S.M.E. criteria for procedure qualifications.
- C. Each time the Contractor certifies a new welder, the welder shall follow an approved welding procedure. Completed sample coupons shall be evaluated by either a bend test or x-ray.

#### 1.08 COMPONENT & WELD IDENTIFICATION

- A. Each weld is to be numbered on a weld map drawing.. This identification shall be marked on the tubing, near the weld, with a permanent chloride free marker or approved mechanical or electrical etching method. The weld number consists of the document drawing number followed by a sequential weld identification number. The weld inspection check list, weld trace, (Example, Welding Inspection Log, Attachment B) and the actual weld shall be identified primarily by this number. Contractor is to submit their version of log with their bid.
- B. The record for each weld shall include:
  - 1. Welders identification symbol or initials.
  - 2. Location where the weld is made.
  - 3. Welding machine used.
  - 4. Size and type of components to be welded.
  - 5. Weld identification number.
  - 6. Weld inspected by Owner's Representative.

C. The inspector shall verify that the tube adjacent to the weld is marked, or labeled by an approved method, with the weld number.

1. Random cutout may be an option.

## PART 2 PRODUCTS

A. Not Applicable.

## PART 3 EXECUTION

### 3.01 WELD PREPARATION

A. Each welder shall produce one acceptable weld coupons prior to the start of any production welding for each welding machine, welding procedure, welding specification, welding position, nominal pipe size and wall thickness change.

1. In addition, the Contractor shall produce one acceptable weld coupon when welder changes heat, size or shuts off machine.
2. The coupons shall be cut about 13mm (1/2") on each side of the weld to allow for visual examination of the root side of the weld.
3. Coupons shall be identified by a permanent marking method. Identification shall include: Welder's initials, machine number, date and time. This information shall be entered in the weld log. The inspector shall initial and date the coupon upon acceptance. If the coupon is rejected the inspector shall so note on the coupon. No production welding will proceed until an acceptable welded coupon is provided. All coupons shall be retained by the client or his inspection agent.

B. Tube sections verification (By Contractor):

1. The length of tube is as required to give spool dimensions as shown on the document drawing.
2. Tube ends are machined using a special tool to assure squareness.
3. Burrs are removed from machined ends.
4. No tool has been contaminated by contact with carbon steel.
5. Verify tube roundness is to specified tolerances.

C. Cleaning Verification:

1. Components are cleaned with isopropyl alcohol (IPA). The cleaned ends should not be touched by the skin (fingers) before welding. Welders, fitters, etc. shall wear cotton gloves when handling sanitary tube ends.

2. No visible foreign material is acceptable at the weld ends of the components. This includes lint from cleaning cloths.
3. Tungsten electrode must be clean and uncontaminated.

D. Joint Fit-up:

1. A joint fit-up should exhibit a square tight joint. However, if this is not possible the gap between ends of welding components shall not exceed 0.08mm (.033") for 0.89mm (.035") wall. 0.10mm (.004") for 1.25mm (.049") wall and 0.13mm (.005") for 1.65mm (.065") wall and 2.11mm (.083") wall.
2. The joint shall be centered on the tungsten electrode.

E. Weld Machine Settings:

1. The Contractor shall set the machine in accordance with appropriate welding schedule as shown in the welding procedure. Settings cannot deviate more than 10 percent without prior approval of the Welding Inspector.
2. The Welding Inspector shall verify machine settings are in accordance with the procedure requirements (located at each machine).
3. The Contractor shall assure that the electrode has been rotated to proper start position.
4. The Contractor shall assure purge gas is of good quality.
  - a. Total overall purity = 99.996 percent.
5. Do not use gas from the cylinder when pressure gage indicator falls below 27.6 BAR (400 psig).
6. The Contractor shall assure that the purge flow is in accordance with the qualified weld procedure.
  - a. Purge flows should be verified at the furthest point at the beginning of each day.
  - b. At the bulk tank after each delivery.
  - c. At the furthest point of any new manifold or distribution subheader.
  - d. Oxygen level is less than 5.0 PPM.
  - e. Moisture is less than 3.0 PPM.
  - f. Total hydrocarbon content is less than 1.0 PPM.
7. The Inspector shall verify items 3.01E.1 thru 3.01E.6.

F. Machine Warm-up:

1. If no weld has been made for more than one hour, then one acceptable weld coupon is required for warm-up.
2. The Contractor shall keep track of each weld and mark the welding machine trace with the weld number. The Welding Inspector shall verify that this was completed.

## G. Weld Identification

1. A permanent identification mark is normally required near each weld for the purpose of initial weld acceptance and subsequent system validation.
2. The identification marking shall be made using one or more of the currently acceptable methods:
  - a. Permanent black marking pen, certified by the manufacturer to contain less than 200 ppm halogens.
  - b. Mechanical marking, using a vibrating etching tool, where the markings made penetrate the tubing surface less than 0.13mm (.005").
  - c. Electrolyte discharge stencil marking, which leaves a smooth, dark colored stain on the outer surface of the tube.
3. The Owner shall concur with the marking scheme chosen to facilitate his periodic in-service inspection and validation program.
4. Vibro-etching may be used, in general, on any tubing which will be insulated. Where tubing is exposed and subject to routine cleaning or wipe-down of the external surface, the Owner may require that polished surfaces cannot tolerate scratch-marking and in those cases another marking method shall be used.
5. Where vibro-etching is used, the Contractor shall maintain documented proof that the tool is stored in a manner which prevents the tool from being in contact with carbon steel or other contaminants.

## 3.02 WELD INSPECTION

### A. Sanitary tube welding inspection shall be performed as follows:

1. 100 percent ID & OD inspection of all weld coupons.
2. 100 percent OD inspection of all welds.
3. 100 percent borescopic inspection of the first 55 consecutive welds per machine and welder. No rejections are to be encountered.
4. The frequency of borescopic inspection will be reduced to 25 percent (two of every eight welds, no two consecutive welds to be inspected) when:
  - a. The welder has initially completed fifty-five (55) consecutive welds which received 100 percent borescopic inspection and no rejections were encountered.
  - b. If a defect is found when inspecting at the reduced rate, the welder must return to 100 percent inspection for the next fifty-five (55) consecutive accessible welds before again being eligible for working under the 25 percent rate of borescopic inspection.
  - c. When a failure is encountered the previous weld is to be borescoped. This will continue until an acceptable weld is found.
5. All welds which appear to be difficult should be borescoped as well.
6. If the weld has correctable flaws a second weld pass may be made to try to correct them only after the weld has reached ambient temperature for at least 30 minutes (refer to 3.02 D.1). If the rewelding does not remove the flaw,

the weld shall be rejected and cut out. This is a one time only option. Inspection results for each weld shall be recorded on the Weld Inspection Log.

- B. The outside of the weld is visually inspected after the spool is removed from the welding machine.
  - 1. The weld bead should be full and even on the inside, with no sign of oxidation. Occasionally you will notice a light blue tint outside the weld (dark bluing or black in or adjacent to the weld is unacceptable and will be cause for rejection).
  - 2. The pulse rate and pulse width should be even and symmetrical with no signs of being erratic.
- C. 5 percent random radiography of the welds is a customer option and may be used if other than 100 percent Boroscopic Inspection is employed.
- D. Weld Flaws/Defects:
  - 1. The following flaws are examples for which rewelding may be attempted:
    - a. Incomplete penetration:
    - b. Overlap
    - c. Excessive penetration: 10 percent of nominal wall thickness is maximum allowable.
  - 2. The following defects shall be rejected and cut out:
    - a. Lack of penetrations.
    - b. Cracks.
    - c. Undercut.
    - d. Crater Crack.
    - e. Burn Through.
    - f. Lack of Fusion.
    - g. Icicles.
    - h. Crater Porosity.
    - i. Arc Strikes.
    - j. Loose Oxidation.
    - k. O.D. Reinforcement: 0.38mm (.015") maximum on butt welds. (Attachment C)
    - l. O.D. Concavity: 10 percent of nominal wall thickness (Attachment C)
    - m. I.D. Concavity: 10 percent of nominal wall thickness (Attachment C)
- E. Tube section from rejected welds may be reused after the heat affected zone is cut off. The heat affected zone shall be considered to extend to the limit of the discoloration adjacent to(not less than 1.3mm (1/2") from the weld. Fittings shall not be reused if the welding head cannot be attached properly.

- F. If a weld cannot be visually inspected inside, because it is an unreachable closure weld, test coupons of the same heat number or range shall be made using the same parameters as the closure weld immediately prior to and immediately subsequent to the closure weld (blind weld). The closure weld will be acceptable if both test coupons pass visual examination and the exterior surface of the closure weld is judged similar to that of the test coupons passing inspection.
- G. Tack welds shall be rejected if cracked, burned, misaligned, sugared, or penetration extends to the inside surface. Misalignments shall be judged on a case basis. Tolerances shall meet A-269, 270 requirements.
- H. If a weld is cut out, the replacement weld shall have the same weld number followed by an alphabetic suffix (e.g., a, b, c, etc.). A new weld check list shall be completed for the replacement weld. The initial weld check list shall be stapled to the new list as a permanent weld history.

### 3.03 PROTECTION OF SPOOLS

- A. All openings shall be kept plugged at all times with the approved plastic caps and taped.
- B. Clamp ends and flange face shall be protected from damage in handling by approved protective devices.
- C. During handling and storage other than on work tables, spool shall be on wooden skids or coated racks in a protected area. Exposure to carbon steel during storage is prohibited.
- D. When a spool is completed it shall be clean and dry. If a visual exam proves otherwise, efforts to clean and dry the spool shall be made.
- E. Owner shall have the right to reject any material for installation or already installed material that has been improperly stored or handled.

### 3.04 ACCEPTANCE

- A. The Contractor shall complete the Weld Verification Check List (Attachment A-1). When it has been completed, it shall be signed and dated. If at any place the weld is rejected, the reason for rejection shall be recorded in the Welding Inspection Log (Attachment B-1). The welding inspector shall sign each check list at the time the weld is inspected.
- B. The client or his representative, may also sign the check list. This signature does not verify the recorded data, but rather, verifies that it is mechanically complete.



### 3.05 OTHER REQUIREMENTS

- A. All tools and or machines required to fabricate in accordance with this specification are the responsibility of the Contractor.
- B. All material (tubing and fittings) required is the responsibility of the Vendor. Inspection of same for conformity to specifications is responsibility of the Contractor. The third party inspector shall spot check the materials to assure Contractor inspection meets the intent of the specification. A 5 percent reinspection of material not included in the Contractor's inspection should be sufficient to assure quality.
- C. Materials of non-conformance to specifications are to be replaced, at no cost to the Owner or their representative, by the Vendor.
- D. Any testing or cost for same which is required due to suspected material composition, make-up deficiency or non-conformance to mill specifications is sole responsibility of the Vendor.
- E. All welds are to be labeled by number using an appropriate permanent marking method other than electro or mechanical etching which clearly identifies each and every weld and does not interfere with the integrity of the system specification.
- F. It is the intent of any welding on stainless steel system for a Biopharmaceutical facility to meet all of the requirements as set forth in CGMP, FDA Validation Requirements.

### 3.06 SUBMITTALS

- A. For the purpose of engineering checkout and validation, the Contractor shall provide the following:
  - 1. Weld Inspection Records, including isometric weld maps.
  - 2. Weld Procedure Specifications.
  - 3. Weld Procedure Qualification and Welder Qualification Records
  - 4. Material Documentation.
  - 5. Welding equipment description and calibration certificates.
  - 6. Certificate of Analysis for purge gas purity.

**END OF SECTION**

**WELD VERIFICATION CHECK LIST  
PROJECT 00271**

\_\_\_\_\_  
Date

1. **Dwg. and Weld No.:** \_\_\_\_\_ 2. **Welder's Symbol:** \_\_\_\_\_

3. **Location:** Fab Shop      Field      4. **Machine No.:**      1      2

5. <b>Component</b>	to	Component	6. <b>Size:</b>
Tube		Tube	13 (1/2")      63 (2-1/2")
Elbow		Elbow	19 (3/4")      76 (3")
Tee		Tee	25 (1")      102 (4")
Reducer		Reducer	38 (1-1/2")      152 (6")
Ferrule		Ferrule	51 (2")

7. **Tube Length:** OK      8. **Components Cleaned:**

9. <b>Tube End:</b>	10. <b>Tacking:</b>	11. <b>Alignment:</b>
Machined	Not used	Centered on electrode
Deburred	Accepted	End gap OK
Roundness OK	Rejected	

\_\_\_\_\_  
INSPECTOR

\_\_\_\_\_  
DATE