Background Statement for SEMI Draft Document 6122
Reapproval of SEMI F78-0611, PRACTICE FOR GAS TUNGSTEN ARC (GTA) WELDING OF FLUID DISTRIBUTION SYSTEMS IN SEMICONDUCTOR MANUFACTURING APPLICATIONS

Notice: This background statement is not part of the balloted item. It is provided solely to assist the recipient in reaching an informed decision based on the rationale of the activity that preceded the creation of this Document.

Notice: Recipients of this Document are invited to submit, with their comments, notification of any relevant patented technology or copyrighted items of which they are aware and to provide supporting documentation. In this context, “patented technology” is defined as technology for which a patent has issued or has been applied for. In the latter case, only publicly available information on the contents of the patent application is to be provided.

Background
Per SEMI Regulations ¶ 8.9.1, the Originating TC Chapter shall review its Standards and decide whether to ballot the Standards for reapproval, revision, replacement, or withdrawal by the end of the fifth year after their latest publication or reapproval dates.

The Facilities & Gases NA TC Chapter reviewed and recommended to issue for reapproval ballot.

Per SEMI Procedure Manual (NOTE 21), a reapproval Letter Ballot should include the Purpose, Scope, Limitations, and Terminology sections, along with the full text of any paragraph in which editorial updates are being made.

Voter requests for access to the full Standard or Safety Guideline must be made at least three business days before the voting deadline. Late requests may not be honored.

The ballot results will be reviewed and adjudicated at the meetings indicated in the table below. Check www.semi.org/standards under Calendar of Events for the latest update.

### Review and Adjudication Information

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<th>Task Force Review</th>
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<td><strong>Group:</strong></td>
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| **Date:** | **Monday, April 3, 2017**
**Tuesday, April 4, 2017** |
| **Time & Time Zone:** | **09:00 – 10:00 PST**
**09:00 – 12:00 Noon PST** |
| **Location:** | **SEMI Headquarters**
**SEMI Headquarters** |
| **City, State/Country:** | **Milpitas, California/USA**
**Milpitas, California/USA** |
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This meeting’s details are subject to change, and additional review sessions may be scheduled if necessary. Contact Standards staff for confirmation.

Telephone and web information will be distributed to interested parties as the meeting date approaches. If you will not be able to attend these meetings in person but would like to participate by telephone/web, please contact Standards staff.
1 Purpose

1.1 The purpose of this Practice is to provide procedures for welding stainless steels and other corrosion resistant metals and alloys (CRAs) for fluid (liquid or gas) distribution systems in semiconductor manufacturing applications. Welds performed following these procedures are of sufficient quality to provide the required system purity, weld integrity, and weld strength for use in semiconductor manufacturing applications.

2 Scope

2.1 This Practice provides procedures for gas tungsten arc (GTA) autogenous butt joint welds of stainless steel and other CRAs in fluid distribution systems. The fluid distribution system includes tubing, pipe, fittings, valves, subassemblies and components that contain and distribute fluid.

NOTICE: SEMI Standards and Safety Guidelines do not purport to address all safety issues associated with their use. It is the responsibility of the users of the documents to establish appropriate safety and health practices, and determine the applicability of regulatory or other limitations prior to use.

3 Limitations

3.1 The stainless steels covered by this practice are limited to the austenitic and superaustenitic grades of stainless steel.

3.1.1 Corrosion resistant metals and alloys covered by this practice are limited to solid solution grades of nickel alloys and solid solution grades of titanium alloys.

3.1.2 This practice applies only to autogenous GTA circumferential butt joint welds performed on fluid distribution system components 15.24 cm (6 inches) or less in diameter.

3.1.3 This practice applies only to automatic, mechanized, or machine GTA welding processes.

3.1.4 This practice applies only to welds performed with no fillers and no fluxes.

3.1.5 This practice does not apply to pressure vessel or process chamber welds.

4 Referenced Standards and Documents

NOTE 1: The following documents become part of the practice to the extent that they are included herein.

4.1 SEMI Standards and Safety Guidelines

SEMI F20 — Specification for 316L Stainless Steel Bar, Forgings, Extruded Shapes, Plate, and Tubing for Components Used in General Purpose, High Purity and Ultra-High Purity Semiconductor Manufacturing Applications


4.2 ANSI Standards

ANSI Z49.1 — Safety in Welding, Cutting, and Allied Processes

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1 American National Standards Institute, 25 West 43rd Street, New York, NY 10036, USA; Telephone: 212.642.4900, Fax: 212.398.0023, http://www.ansi.org
4.3 ASME Standards

ASME BPE — Bioprocessing Equipment Standard
ASME B16.25 — Buttwelding Ends
ASME B31.3 — Process Piping Design
Boiler and Pressure Vessel Code — Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators

4.4 ASTM Standards

ASTM A269 — Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A450 (§ 25) — Standard Specification for General Requirements for Carbon, Ferritic Alloy, and Austenitic Steel Tubes
ASTM A632 — Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing (Small-Diameter) for General Service

4.5 AWS Standards

AWS A3.0 — Standard Welding Terms and Definitions Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying

NOTICE: Unless otherwise indicated, all documents cited shall be the latest published versions.

5 Terminology

5.1 Definitions

5.1.1 angular misalignment — the condition that exists when the tubing angle is changed at the weld.

5.1.2 autogenous weld — a fusion weld made without filler metal.²

5.1.3 automatic arc welding downslope — the time during which the welding current is reduced continuously from the final level until the arc is extinguished.

5.1.4 axial misalignment — the offset caused by tubing being in line but not coaxial at the weld.

5.1.5 backing gas — an inert gas (or gas mixture) on the interior of the weld joint used to prevent or reduce formation of oxides and other detrimental surface substances during welding, and to provide pressure for weld profile.

5.1.6 bead — non-standard term for weld bead.²

5.1.7 bead overlap — in a pulsed weld the amount of coverage of a weld pulse of the previous weld pulse, usually measured in percentage of the diameter of the pulse.

5.1.8 bead variation — the amount of change of ID bead width from one area to another.

5.1.9 bead width — the width of the weld bead on the ID, normally measured in units of \( T \), where \( T \) is the nominal tube wall thickness.

5.1.10 center line shrinkage — a profile-reducing defect or discontinuity normally formed by shrinkage during solidification.

5.1.11 color — the darkness of the oxidation of the weld or adjacent surfaces. Non-standard term for discoloration.

³ American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA; Telephone: 610.832.9585, Fax: 610.832.9555, http://www.astm.org
⁴ American Welding Society, 550 N.W. LeJeune Road, Miami FL 33126, USA; Telephone: 800.443.9353; http://www.aws.org
⁵ The terminology has been derived from the following sources: (1) Webster’s New World College Dictionary Fourth Edition, (2) ANSI/AWS A3.0 Standard Welding Terms and Definitions, (3) ASME BPE Bioprocessing Equipment Standard.
5.1.12 color line — acceptance criteria of the maximum amount of discoloration allowed on the weld or adjacent surfaces.

5.1.13 concavity — a condition in which the surface of a weld is depressed relative to the surface of the tube or pipe. Concavity is measured as a maximum distance from the outside or inside diameter surface of a weld along a line perpendicular to a line joining the weld toes.  

5.1.14 convexity — a condition in which the surface of a weld is extended relative to the surface of the tube or pipe. Convexity is measured as a maximum distance from the outside or inside diameter surface of a weld along a line perpendicular to a line joining the weld toes. 

5.1.15 coupon — weld sample which is inspected to insure that the weld meets specifications.

5.1.16 coupon-in — first coupon prior to production welding.

5.1.17 coupon-out — last coupon after production welding.

5.1.18 discoloration — any change in surface color from that of the base metal. Usually associated with oxidation occurring on the weld and heat affected zone on the outside and inside diameter of the weld joint as a result of heating the metal during welding. Colors may range from pale bluish-gray to deep blue, and from pale straw color to a black crusty coating. 

5.1.19 downslope — see automatic arc welding downslope.

5.1.20 dross — non-standard term for slag.

5.1.21 electrode — non-standard term for tungsten electrode.

5.1.22 enclosed weld head — weld head in which the weld joint is held and welded within a closed chamber containing a shielding purge gas.

5.1.23 encroachment — non-standard term for ID convexity.

5.1.24 examiner — a person who performs examination of a particular object, or evaluates an operation, for compliance to a given standard. The examiner performs quality control for the manufacturer, fabricator, or erector.

5.1.25 fluid — liquid or gas.

5.1.26 gas — the fluid form of a substance in which it can expand indefinitely and completely fill its container; form that is neither liquid or solid.

5.1.27 gas tungsten arc welding (GTAW) — an arc welding process that uses an arc between a tungsten electrode (nonconsumable) and the weld pool. The process is used with a shielding gas.

5.1.28 halo — non-standard term for discoloration resulting from welding procedure.

5.1.29 haze — non-standard term for discoloration resulting from welding procedure.

5.1.30 heat-affected zone (HAZ) — the portion of the base metal whose mechanical properties or microstructure have been altered by the heat of welding.

5.1.31 heat tint/color — non-standard term for discoloration resulting from welding procedure.

5.1.32 inclusion — entrapped foreign solid material, such as slag, flux, tungsten, or oxide.

5.1.33 inert gas — a gas that normally does not combine chemically with materials. A protective atmosphere.

5.1.34 lathe welding — automatic or machine welding of tubes or pipes in which the electrode is stationary and the weld joint rotates. Lathe welding as defined here is a fusion process without the addition of filler.

5.1.35 liquid — having its molecules moving freely with respect to each other so as to flow readily, unlike a solid, but because of cohesive forces not expanding infinitely like a gas.

5.1.36 meandering — of or pertaining to a weld bead that deviates from side to side across the weld joint rather than tracking the joint precisely.
5.1.37 **orbital welding** — automatic or machine welding of tubes or pipes in-place with the electrode rotating (or orbiting) around the work. Orbital welding, as it applies to this standard, is a fusion process without the addition of filler.\(^3\)

5.1.38 **oxidation** — the formation of an oxide layer on a metal surface. When excessive oxidation occurs as a result of welding, it is visible as **discoloration**.\(^3\)

5.1.39 **oxide island** — non-standard term for **slag**.

5.1.40 **pressure cylinder** — a metal cylinder used to store gases under pressure.

5.1.41 **profile defect** — any defect or discontinuity that reduces the wall thickness below that of the parent metal.

5.1.42 **pulsed gas tungsten arc welding** — a gas tungsten arc welding process variation in which the current is varied in regular intervals.

5.1.43 **purge** — the application of an inert gas or gas mixture to the OD or ID surface of the weld joint to displace non-inert atmospheric gases. A block purge is a non-flowing purge with positive pressure.

5.1.44 **purge gas** — an inert gas or gas mixture used to displace the ambient atmosphere from the inside (ID) of the weld joint.

5.1.45 **root** — non-standard term for **root surface**.

5.1.46 **root surface** — the exposed surface of a weld opposite the side from which the welding was done.\(^2\)

5.1.47 **rotation delay** — time delay between when the arc is initiated and the rotor begins to turn.

5.1.48 **shield gas** — inert gas or gas mixture that protects the electrode and molten puddle from atmosphere and provides the required arc characteristics.

5.1.49 **slag** — a non-metallic product resulting from the mutual dissolution of non-metallic impurities in some welding processes.\(^2\)

5.1.50 **tack weld** — a weld made to hold the parts of a weldment in proper alignment until the final welds are made.\(^2\)

5.1.51 **tail-out** — non-standard term for automatic arc welding downslope.\(^2\)

5.1.52 **tungsten** — non-standard term for **tungsten electrode**.

5.1.53 **tungsten electrode** — a component of the electrical circuit that terminates at the arc, molten conductive slag, or base metal. A non-filler electrode made principally of tungsten and used in arc welding.\(^2\)

5.1.54 **undercut** — a groove adjacent to the base metal at the edge of the weld left unfilled by weld metal.\(^2\)

5.1.55 **underfill** — a groove weld condition in which the weld face or root surface is below the adjacent surface of the base metal.\(^2\)

5.1.56 **weld bead** — a weld resulting from a weld pass.\(^2\)

5.1.57 **weld level** — a segment or portion of a weld schedule in which one or more weld parameters can be changed independently; part of a weld sequence.

5.1.58 **weld sequence** — a series of steps executed by the welding power supply to make a particular orbital weld.

5.1.59 **welder** — a person who does welding (sometimes used to refer to a welding machine or power supply).

5.1.60 **welding equipment** — power supply, weld heads, torches, and associated cables and accessories used for welding.

5.1.61 **welding operator** — a person who wields with an orbital or machine welding system.

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