Sanitary Weld Review & Acceptability

American Welding Society Contributions

Dick Avery
Nickel Institute

3-A – AWS affiliation
How it started

- In mid 1990's 3-A approached AWS for technical help on tube/pipe welding
  - concern was acceptability of ID tube/pipe welds not accessible visually
- AWS D18 committee formed including Larry Hanson, Dick Smith & Dick Avery
- AWS D18.1 completed ~ 2 years, a record for AWS documents

AWS Documents Developed for Sanitary (Hygienic) Applications

- **AWS D18.1** *Welding of Austenitic Stainless Steel Tube and Pipe Systems in Sanitary (Hygienic) Applications*
- **AWS D18.2** *Guide to Weld Discoloration Levels on Inside of Austenitic Stainless Steel Tube*
- ***AWS D18.3*** *Welding of Tanks, Vessels, and Other Equipment in Sanitary (Hygienic) Applications*

Weld Acceptance Criteria
3-A vs. AWS D18.1 (Tube/Pipe)

- Many weld acceptance criteria are essentially the same, e.g.
  - no incomplete weld penetration, free from cracks & pits etc.
- D18.1 is more explicate on the acceptance of weld features, such as ID convexity, concavity, allowance of slag like deposits on the weld surface

Weld Acceptance Criteria (cont)

- D18.1 specifies Gas Tungsten Arc (TIG) or Plasma Arc – either manual or automatic
- D18.3 allows all common fusion welding processes
- D18.1 & D18.3 require a Welding Procedure Specification and Welder Performance Qualification
  - 3-A does not require qualifications, but most fabricators probably are qualified for other end user applications
  - WPS may be more needed for field weld contractors

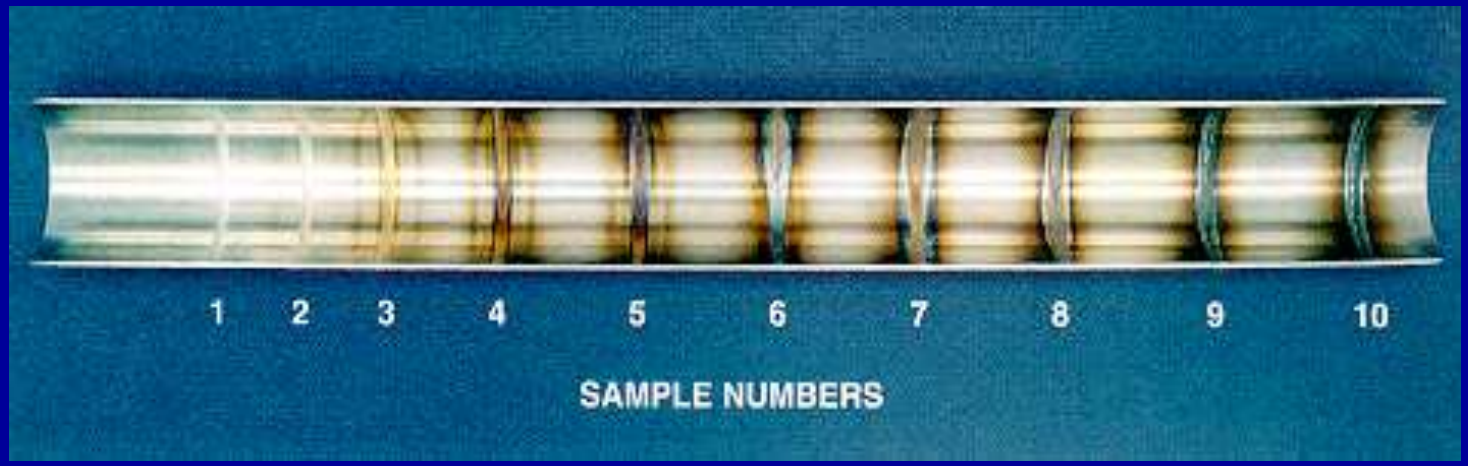
AWS D18.1 Judging ID Weld from OD Weld Appearance

- Some weld ID's inaccessible for viewing
- Manual welders have characteristic "signatures" apparent on OD weld surface
- Welders make 3 Preconstruction Weld Samples (PWS) that meet all visual requirements
- PWS are used to judge acceptability of welds impossible for ID inspection

Factors Influencing Heat Tint (Discoloration) on Weld ID

- Oxygen in backing gas increases HT
- Moisture in backing gas increases HT
- Contaminants such as hydrocarbons increase discoloration
- Hydrogen in backing gas decreases HT
- Metal surface finish can affect HT appearance

AWS D18.2 (1999): *Heat Tint Levels on the Inside of Welded 316L Austenitic Stainless Steel Tube*



The Sample Numbers refer to the amount of oxygen in the purging gas:

No.1- 10ppm No.2 - 25ppm No.3 - 50ppm No.4 - 100ppm
No.5 - 200ppm No.6 - 500ppm No. 7 - 1000ppm No.8 - 5000ppm
No.9 -12500ppm No.10 -. 25000ppm

Note: welds on type 304L SS showed no significant difference in heat tint colour from type 316L.

Nickel Development Institute

Heat Tint Acceptance Levels AWS D18.1

- Acceptance levels are specified in D18.1, not in D18.2 – changes have been made
- D18.1:1999 – Example 5 or higher is unacceptable in the as-welded condition
- D18.1:2009 – Examples 4 through 10 is unacceptable in the as-welded condition, unless agreed upon by the Owner and Fabricator

Obtaining AWS D18.2

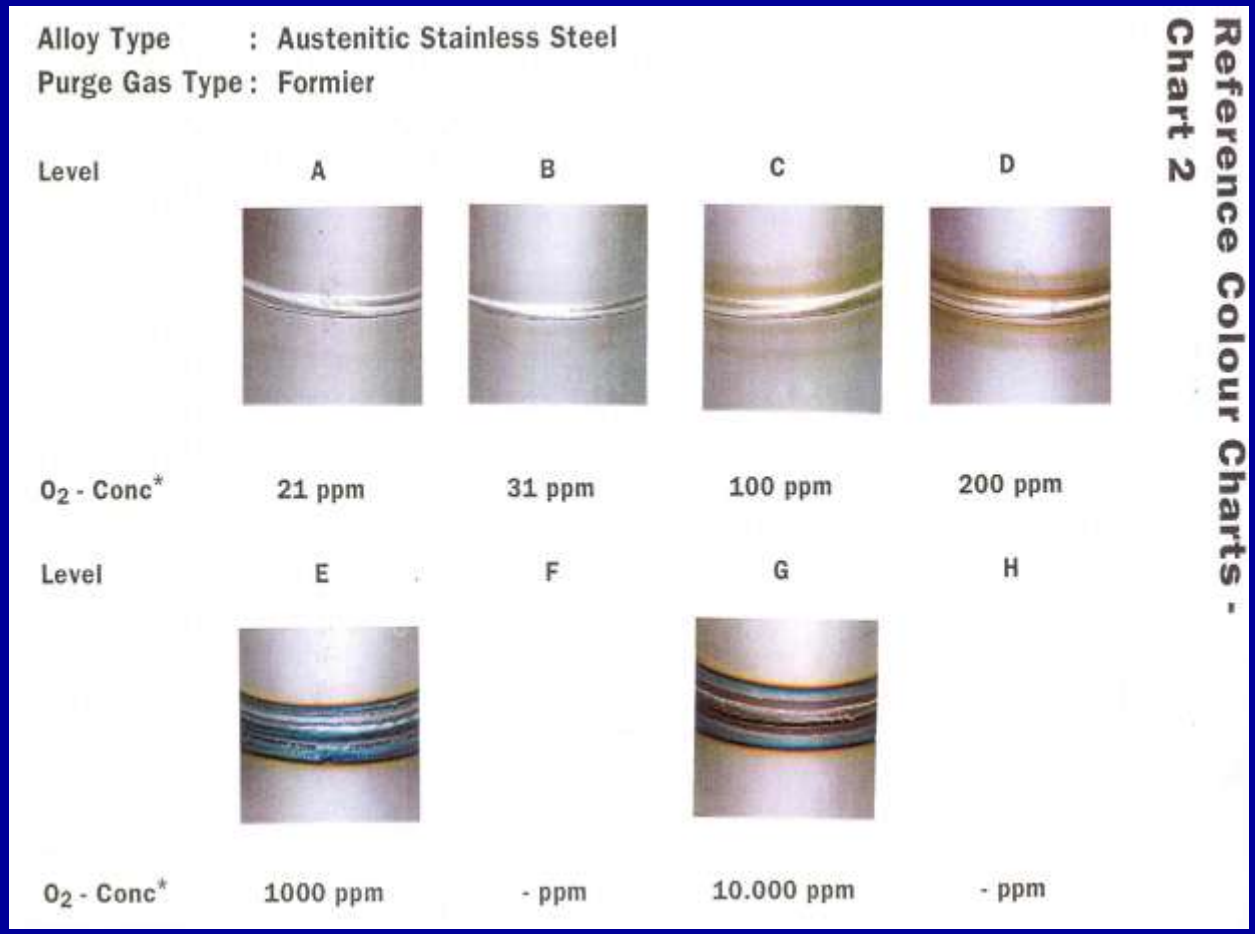
- D18.2 standard size 8 ½ X 11
  non member $40.00
- D18.2 large size 12 X 18 in.
  - same number as smaller size, but must specify the size

  non member $ 52.00
- Ordered from: World Engineering Xchange
  phone North America 888 935 3454

Other Heat Tint Guides

- All guides give O_2 levels for each color level but weld acceptance is based on oxide color not on O_2 level
- ASME BPE 2012 will have set of photos, one with mechanical finish & one with EP
  - longer range to have set taken by boroscope
- FORCE Institute Report 94.34 has 5 sets of various alloys & conditions
- Good option is to make workmanship set for major projects using production material/practices

FORCE Institute



Heat tints on pickled austenitic stainless steel tube butt welds made with *Formier* purging gas (*NH10*) containing known oxygen levels. * Heat input: 0.2-0.3 kJ/mm.

Nickel Development Institute

Relating Heat Tint to Corrosion
BPE work

- 5 backing gas O_2 ppm levels chosen: 10, 25, 35, 50 & 80
- Corrosion resistance of welded samples determined by:
  - ASTM G150 Critical Pitting Temp. test
  - Modified ASTM G61 Cyclic Polarization
- All welds were tested in the as-welded condition with no post-weld conditioning

Heat Tint Acceptance Level - BPE

- Electropolished surface - up to sample #4 (50 ppm O_2) based on corrosion resistance similar to un-welded, EP 316L base metal
- Mechanically polished – up to sample #3 (35 ppm O_2) based on corrosion resistance similar to cold-rolled, mill-finished 316L base metal

Thank you for your attention

Dick Avery