ASME B31.3 Process Piping

Charles Becht IV, PhD, PE
Don Frikken, PE
Instructors

Piping Development Process

1. Establish applicable system standard(s)
2. Establish design conditions
3. Make overall piping material decisions
   - Pressure Class
   - Reliability
   - Materials of construction
4. Fine tune piping material decisions
   - Materials
   - Determine wall thicknesses
   - Valves
5. Establish preliminary piping system layout & support configuration
6. Perform flexibility analysis
7. Finalize layout and bill of materials
8. Fabricate and install
9. Examine and test

12. Fabrication and Installation

- Welder/Brazer Qualification
- Welding Processes
- Weld Preparation
- Typical Welds
- Preheating & Heat Treatment
- Typical Owner Added Requirements
- Installation
- Flange Joints

The Material in This Section is Addressed by B31.3 in:

Chapter V - Fabrication, Assembly, and Erection

Welder Qualification

Welders are required to use an approved procedure in accordance with B&PV Code Section IX

- Prepare the welding procedure specification (WPS)
  - Essential variables (P-no., thickness, PWHT, etc.)
  - Nonessential variables (Groove design, position, technique, etc)
- Procedure Qualification Test – to determine that weldment is capable of having required properties
- Test of procedure, not welder (normally done by good welders)
- Must pass tensile test and bend test
- May be required to pass supplemental tests (e.g. impact)
- The test record is documented as Procedure Qualification Record (PQR), which is retained by the employer

Welder Qualification

Welders are required to be qualified by test in accordance with B&PV Code Section IX

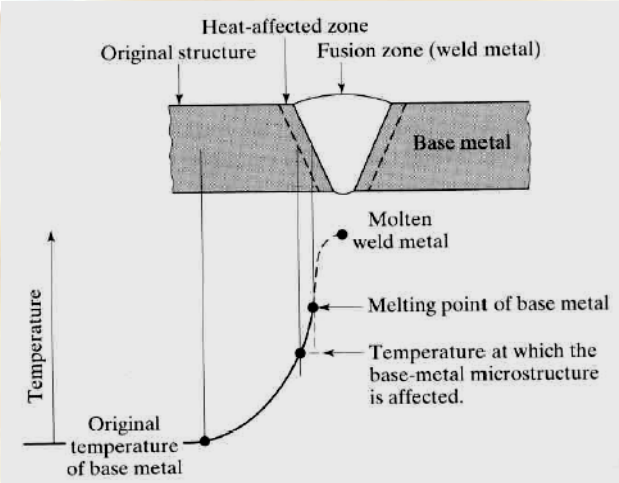
- Performance Qualifications Test – to determine that the welder is capable of depositing sound weld metal
- Additional essential variables, e.g. position, pipe diameter
- The test record is documented as Welder Performance Qualification (WPQ), which is retained by the employer
- Need to weld with manual (or automatic) process periodically, if not for 6 months, re-qualification required (could be on production weld that is X Rayed)
- Procedure and performance qualifications may be by other than the employer under certain conditions if the Inspector approves.

Brazer Qualification

Brazers are required to used an approved procedure and be qualified by test, also in accordance with B&PV Code Section IX

- Prepare the brazing procedure specification (BPS)
- The procedure test record is documented as Procedure Qualification Record (PQR), which is retained by the employer
- The performance test record is documented as Brazer Performance Qualification (BPQ), which is retained by the employer
- The owner may waive these qualifications for Category D Fluid Service.

Welding Processes – Fusion Weld



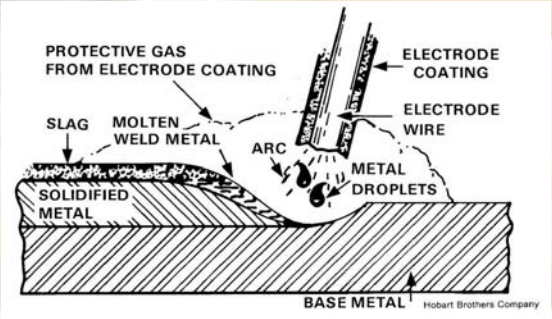
Characteristics of the fusion weld joint

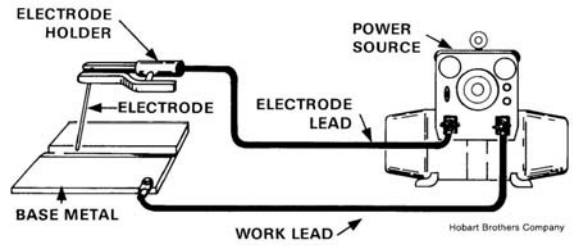
(Manufacturing Engineering and Technology: p820)

Welding Processes – Electric Arc

- Shielded Metal Arc Welding (SMAW), a.k.a. stick welding
- Gas Metal Arc Welding (GMAW), a.k.a. MIG
- Flux Cored Arc Welding (FCAW)
- Gas Tungsten Arc Welding (GTAW), a.k.a. TIG

Shielded Metal Arc Welding

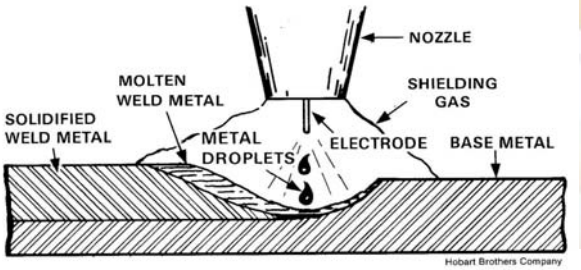


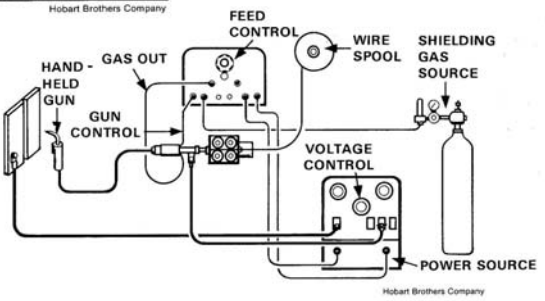


Shielded Metal Arc Welding

- Suitable for windy, outdoor conditions
- Low cost equipment
- All position capabilities
- Good choice for on-site welding

Gas Metal Arc Welding

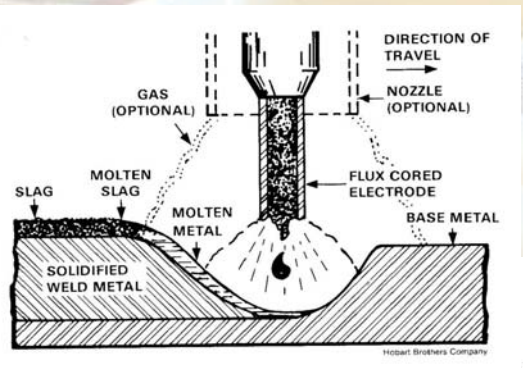


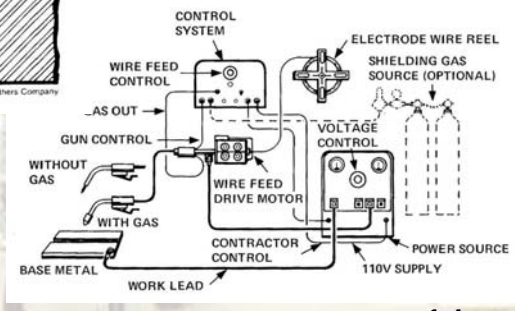


Gas Metal Arc Welding

- Not suitable for windy, outdoor conditions
- Moderate cost equipment
- All position capabilities
- Fast welding speeds possible
- No slag to clean

Flux Cored Arc Welding

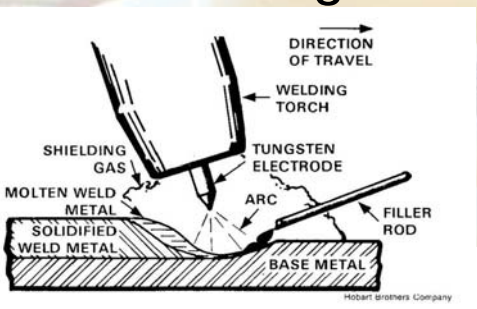


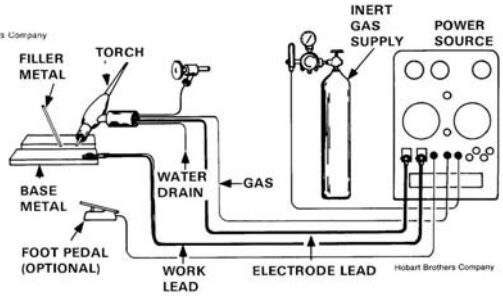


Flux Cored Arc Welding

- Suitable for windy, outdoor conditions
- Same equipment as for GMAW
- Out of position capabilities
- High metal deposition rate

Gas Tungsten Arc Welding





Gas Tungsten Arc Welding

- Not suitable for windy, outdoor conditions
- Moderate cost equipment
- All position capabilities
- Low metal deposition rate
- No slag to clean
- Highest quality, most precise welds

Welding Processes

Process	Materials	Skill Level Required
SMAW	Steel, Stainless Steel	Moderate
GMAW	Steel, Stainless Steel, Aluminum	Low
FCAW	Steel, Stainless Steel	Moderate
GTAW	Steel, Stainless Steel, Aluminum, Titanium, Nickel Alloys	High

Welding Processes Accepted

Process	Generally Accepted for
SMAW	Most fluid services with GTAW root. Sometimes restricted to larger sizes.
GMAW	Like SMAW, but approval of specific process may be required.
FCAW	Like SMAW, but approval of specific process may be required.
GTAW	Everything

Weld Preparation

- Surfaces to be welded are required to be clean
- End preparation required to meet WPS, ASME B16.25 is accepted practice

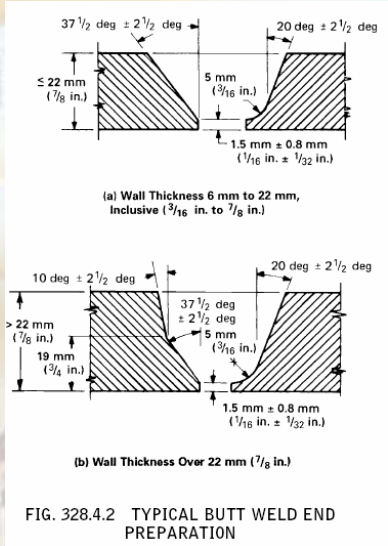
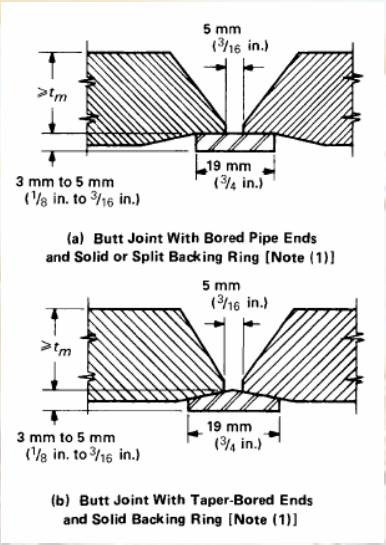


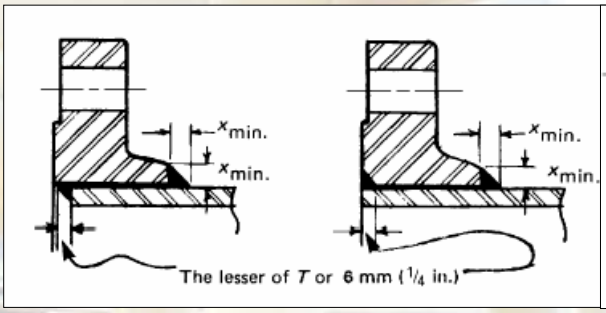
FIG. 328.4.2 TYPICAL BUTT WELD END PREPARATION

Weld Preparation

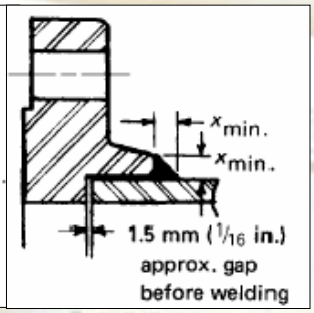
- Use of backing rings is permitted
- Alignment is required to be in accordance with the WPS



Typical Welds

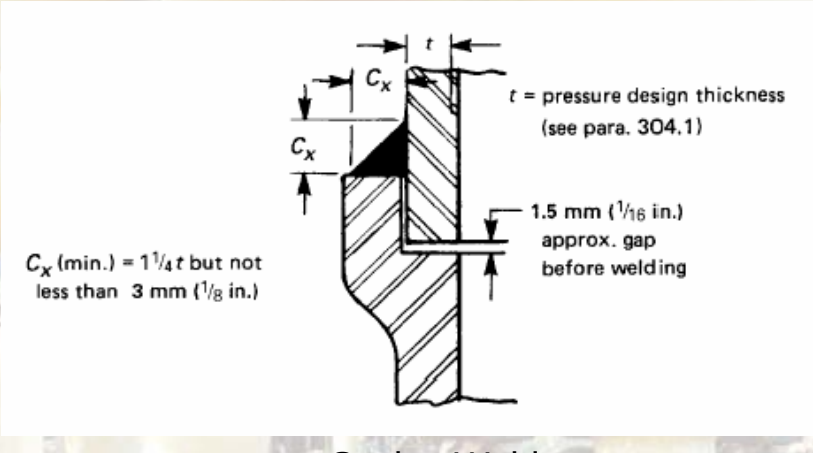


Slip-on Flange



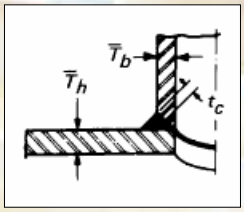
Socket Welding Flange

Typical Welds

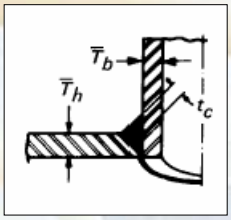


Socket Weld

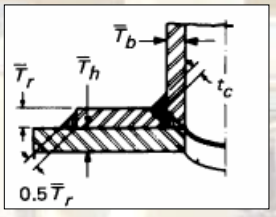
Typical Welds



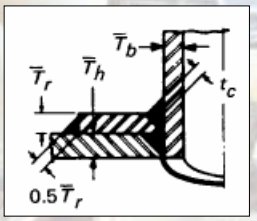
Unreinforced Stubon



Unreinforced Stubin



Reinforced Stubon



Reinforced Stubin

Preheating

Preheating:

- Prevents cracking caused by differential thermal expansion in the area of the weld
- Drives off moisture that could contribute to hydrogen in the welds
- Slows the cooling rate for the deposited weld metal

The Code:

- Recommends preheat to 50ºF (10ºC) for most carbon steels and stainless steels
- Requires preheat to 300ºF (150ºC) or more for low alloy steels

No welding is permitted if water is present in the weld area or if there is excessive wind. See Table 330.1.1.

Heat Treatment

Heat treatment

- Relieves residual stresses caused by welding, bending and forming
- Facilitates diffusion of hydrogen out of the weld

The Code requires heat treatment for:

- Carbon steels thicker than ¾ in. (19 mm)
- Most low alloy steels thicker than ½ in. (13 mm)

See Table 331.1.1.

Typical Owner Added Requirements

- Requirements on use of particular welding processes
- Restrictions on the use of repairs
- Requirements for traceability
- Requirements for marking of piping
  - Stamping not permitted on certain materials
  - Inks containing low melting point metals not permitted on certain materials
- Specific end preparation and alignment requirements

Typical Owner Added Requirements (Continued)

- Requirements for socket welds
- Prohibition of the use of single welded slip-on flanges
- Prohibition on the use of backing rings
- Requirements for fabricated branches
- Bolt hole orientation for flanges
- Dimensional tolerances
- Additional heat treatment requirements

Typical Owner Added Requirements (Continued)

- Requirements for flow meter runs
- Cleaning requirements
- Shipping and storage requirements
- Requirements for records

Installation

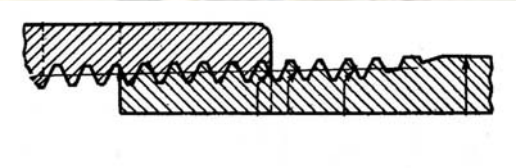
Code Requirements

- Detrimental distortion of piping to bring it into alignment is prohibited
- Examination of installation for errors prior to cold spring is required.
- Flange faces are required to be parallel to design plane within ½% prior to bolt up.
- Flanges are required to be properly tightened
- No more than one gasket can be used
- Bolts can be one thread short of a full nut
- Thread sealant shall be suitable for the service

Installation

Code Requirements

- Threaded joints to be seal welded shall be made up without thread compound
- Threaded joints that leak during testing may be seal welded provided compound is removed from exposed threads
- Seal welds shall cover all exposed threads



Installation

Typical Owner Added Requirements

- Maximum distance a bolt can extend through a nut
- Requirements for connecting to in-service piping
- Cleanliness requirements
- Requirements for installation of isolation kits
- Require threads to conform to ASME B1.20.1
- Requirements for thread sealant(s)
- Prohibition of the use of seal welds
- Prohibit use of gasket compounds

Installation

Typical Owner Added Requirements (cont.)

- Requirements for use of bolt lubricants
- Requirements for use (or not) of washers
- Requirements for flanged joint tightening
- Requirements for valve orientations
- Requirements for alignment by heating (rose budding)
- Requirements for bolting to rotating equipment; e.g., in accordance with API 686

Typical Owner Added Requirements (cont.)

- Requirements for support, including prohibition of supporting piping from other piping

Flange Joints

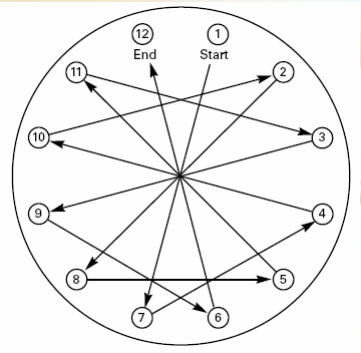
Guidelines for installation are provided in ASME PCC-1 – *Guidelines for Pressure Boundary Bolted Flange Joint Assembly.*
Topics addressed include:

- Qualification of assemblers
- Gasket contact surfaces
  - Correct facing finish
  - Good condition
- Flange alignment
- Correct gasket type, size & placement

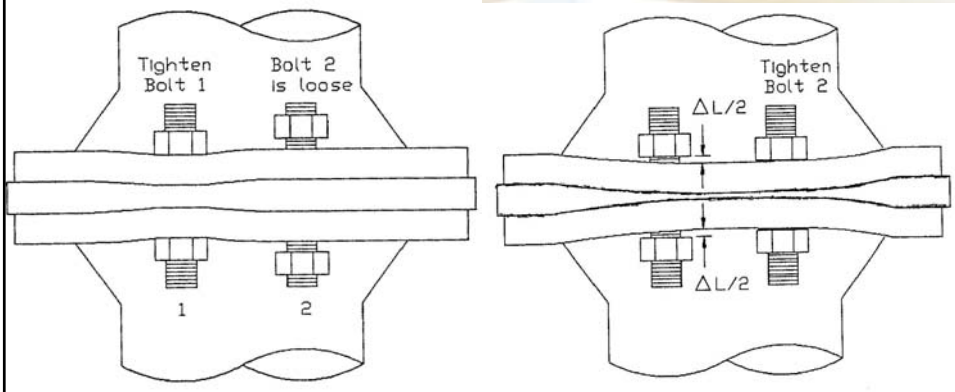
Flange Joints

More topics addressed:

- Lubrication of bolting, back facing
- Numbering of bolts
- Tighten bolting uniformly in criss-cross pattern is small steps
- Target bolt stress is typically 50 ksi (340 MPa)

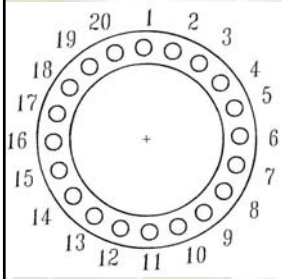


Flange Joints

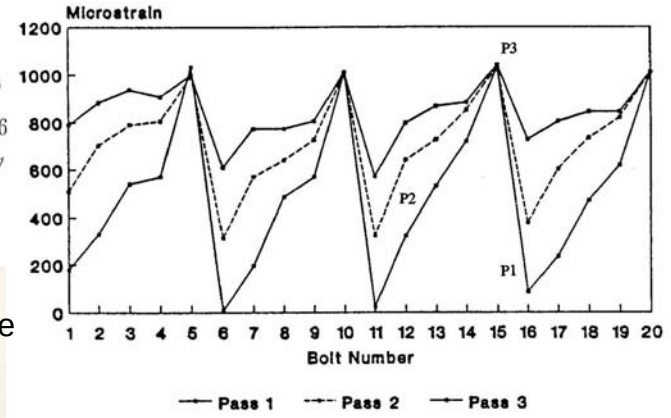


Elastic Interaction
(WRC Bulletin 408)

Flange Joints



NPS 16
Class 300 Flange



Bolt Tension after 1, 2 and 3 Passes
(WRC Bulletin 408)

Flange Joints

ASME PCC-1 describes bolt-up procedure using torque to gage bolt tension

- Snug up bolting
- Tighten to 20% of target torque using cross pattern
- Tighten to 50 to 70% of target torque using cross pattern
- Tighten to 100% of target torque using cross pattern
- Continue tightening to 100% target torque using rotational pattern until no movement
- Wait 4 hours or longer and repeat rotational pattern to 100% target torque until no movement

Flange Joint

Target torque for 50 ksi (345 MPa) bolt stress:

Bolt Size	Non-Coated Bolts in-lb – N-m		Coated Bolts in-lb – N-m	
1/2	60	80	45	60
5/8	120	160	90	120
3/4	210	280	160	220
7/8	350	470	250	340
1	500	680	400	540
1-1/8	750	1000	550	750
1-1/4	1050	1400	800	1100
1-3/8	1400	1900	1050	1400
1-1/2	1800	2450	1400	1900