QA/QC

1) BPVC code & Standard
2) Material code & Standard & grade.
3) Welding code & Standard
4) Drawing.
5) Structure drawing.
6) ASME Sec. IX
7) ASME Sec. 2 Part A
   Part B
   Part C
8) Process Piping.

WELDING & QA/QC

ASME Section / BPVC Section.

ASME Sec. 1 Rules for construction of Power boiler.

ASME Sec. 2 Materials.
Part A → Ferrous Materials.
Part B → Non-ferrous "
Part C → Specification of electrodes & welding.
Part D → Mech. property.

ASME Sec. III Rule for construction of Nuclear components.

ASME Sec IV Rules for construction of Heating boiler.

ASME Sec. V Non-destructive testing.

ASME Sec. VI Rules for care & operation of heating boiler.

ASME Sec. VII Rule of care of Power boiler

ASME Sec. VIII Rule for construction of pressure vessels
div-1, 0 to 3000 psi
div-2, 30000 to 10k psi
div-3, >10k psi.

ASME Sec. IX welding & brazing qualification.

ASME Sec. X Plastics fibre pressure vessel

ASME Sec. XI inspection of Nuclear Power Plant

ASME Sec. XII Rule for construction transmission tank.

ASME Section II Part C

- Deals with specification for.
  1) welding rods
  2) welding electrodes
  3) filler Metals
  4) welding flux.
- AWS specification

	SMAW	GTAW	FCAW	SAW
1) CS	A5.1	A5.18	A5.2	A5.17
2) SS	A5.4	A5.9	A5.22	A5.9
3) CAS	A5.5	A5.28	A5.29	A5.23
4) Ni	A5.11	A5.14		A5.14
5) Al	A5.3	A5.1		

- AWS Specifications

Specific filler wire Analysis (SFA)

1) SFA-5.01 → filler Metal
2) SFA-5.12 → tungsten & it's alloy electrode for Arc welding & cutting.
3) SFA-5.13 → electrode for SMAW
4) SFA-5.15 → electrode & rods for cast iron.
5) SFA-5.21 → Base electrods & rods
6) SFA-5.16 → Titanium & it's alloys welding electrode & rods
7) SFA-5.7 → copper & it's alloys electrode & rods.

AWS classification for electrode (CS)

E7018

- E → electrode
- 70 → tensile strength PSI
- 1 → welding position all
- 8 → flux composition.
- 18 → polarity. (DCEP)

for electrode (LAS)

E8018-B2

- E → electrode
- 80 → tensile strength PSI
- 1 → welding position All.
- 8 → flux composition.
- 18 → polarity (DCEP)
- B2 → Chromium %

electrode (C.S)

E7018-15	DCEP	All Position.
E7018-25	DCEP	H, F
E7018-16	DCEP & AC	All

electrodes & filled wire SMAW (CS)

ER 70S-2

- ER → filled wire
- 70 → PSI
- S → Solide filled Metal.
- 2 → composition of filled wire.

NOTE we GTAW & welding of root only by it. (for CS)

↳ electrode & filler metal (LAS)

ER80S-Ni2

Ni2 → composition of filler wire.

↳ FCAW (CS)

E71T-1

E → electrode
70 → PSI
1 → Position All-
T → flux cored electrode
1 → CO_2 gas
Polarity (DCEP)

↳ FCAW (LAS)

E71T1-A1

T1 → electrode is flux cored.
1 → Classified with CO_2 gas.
A1 → Polarity.

↳ SAW (CS)

Flux → F7A2

Filler wire → EM12K

F → Flux
7 → tensile strength PSI
7x10 = 70 KPSI
A → As welded
'P' PWHT
2 → low temp. compact value.

E → electrode
M → Mn content
M - Medium
12 → carbon content
k → Si killed Steel.

SAW (LAS)

FLUX → F7A2

filler wire → EB3R

B3 → chromium %
R → supplementary design.

electrode & filler wire (S.S)

E308L / ER308L /

E309L → S.S to C.S
ER309L → S.S to C.S
(use for dissimilar Metal)

GMAW

ER70S-6

Note

ASTM A106 gr A (330 MPa)
" " " B (415 MPa)
" " " C (485 MPa)
" " "

Note

AWS D1.1 → Structural Steel
AWS D1.2 → Structural Alluminium.
API 1104 → Pipeline.

ASME B31 code for pressure piping.

1) ASME B31.1 → Power Piping.
2) ASME B31.2 → fuel gas Piping.
3) ASME B31.3 → Process Piping.
4) ASME B31.4 → Pipeline (Hydrocarbon)
5) ASME B31.5 → Refrigeration Piping.
6) ASME B31.8 → gas transmission & distribution Piping Syst.
7) ASME B31.9 → Building service Piping.
8) ASME B31.11 → Slurry transportation Piping System.

ASME Sec. IX

Welding, Brazing qualification.

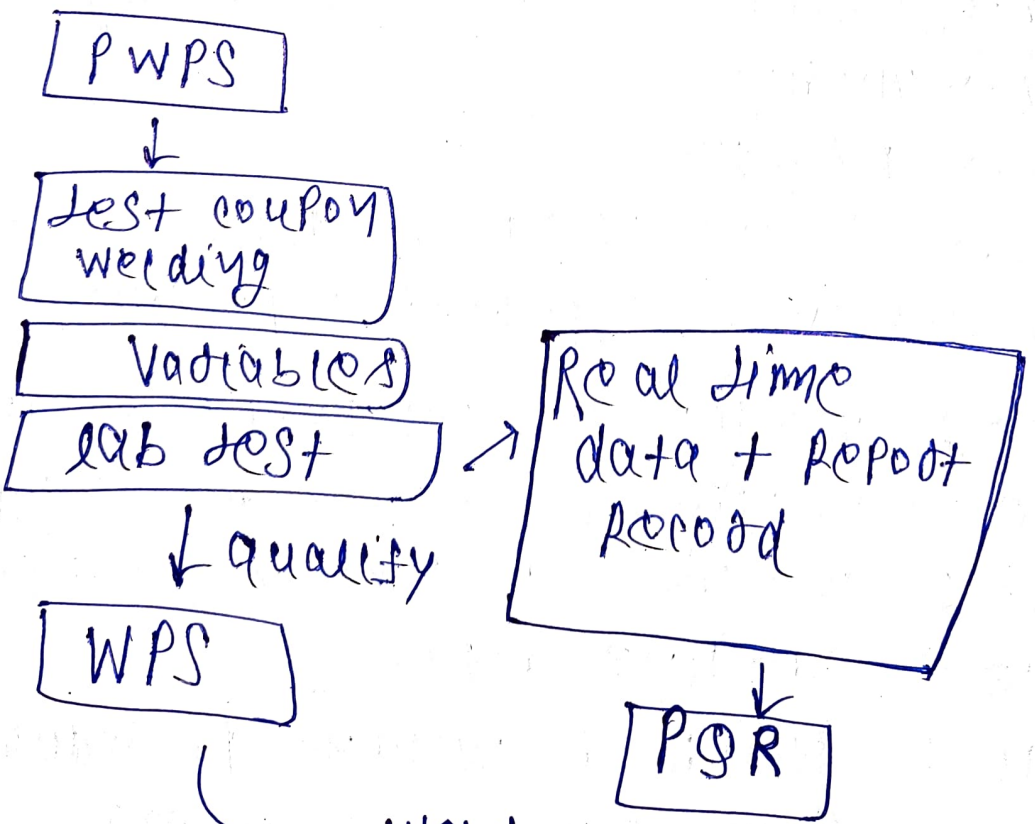
1) QG → general requirement welding.
2) QW → welding.
3) QB → Brazing.
4) QF → forged Plastic welding.

↳ WQT for sec. IX Piping & pressure vessel

↳ Article 1 welding general Requirement
Article 2 welding procedure qualific. (WPS)
Article 3 welding performance qualific.
Article 4 welding data.
Article 5 Standard welding procedure Specification (SWPS)

1) Procedure Specification (QG 101)
2) Procedure qualification record (QG 102)
3) Performance qualification (QG 103)
4) Performance qualification record (QG 104)
5) Variables (QG 105)
   i) essencial variable → Mech. property Δ
   ii) Non-essencial variable → No change
   iii) Supplementary variable → toughness Δ
6) Organisation responsibilities.
7) Ownership transfer.
8) Definitions.

4 WPS (welding Procedure Specification)



→ welder qualification test (WQT) for welder ability test for sound welding.

ASTM code & Standard for following Pipe

Pipe

1) Carbon Steel (CS) Pipe

ASTM A53 gr. A/B
ASTM A106 gr. A/B/C
ASTM A333 gr. 1 & 6

gr. A → 0.25 % C
gr. B → 0.30 % C
gr. C → 0.35 % C

2) Stainless Steel (S.S) Pipe → ER 308L used

ASTM A312 TP 304/ TP 304L/ TP 304H/
TP 308/ TP310/ TP 316/ TP 316L

(L → low carbon %) → ER 316L used
(H → High carbon %)

TP 304 → 0.08 % C
TP 304L → 0.35 % C
TP 316 → 0.08 % C
TP 316L → 0.35 % C

3) Alloy Steel Piping.

ASTM A335 grade. P_1 / P_2 / P_5 / P_{11} / P_{22}

4) Nickel Steel Piping.

ASTM A333 gr. 3 & gr. 8

tube

1) C.S → ASTM A178/ 179/ 192
ASTM A334 gr. 1 & gr. 6

2) S.S → ASTM A213 TP 304/TP304L/TP304H
TP 310/ TP316/ TP316L

Wrought iron fitting (Butt weld)

1) C.S → ASTM A234 gr. WP A/B
ASTM A420 gr. WP L6

2) S.S → ASTM A403 WP 304/ WP 304L/
WP 304H/ WP 310/ WP 316

3) Alloy Steel → ASTM A234 WP_1 / WP_5 / WP_7

↳ Forged fittings (Socket weld)

1) C.S → ASTM A181, ASTM A105
ASTM A350 LF 1/2.

2) S.S → ASTM A182 F6 / F 304 / F 304L
F 304H / F 310 / F 316 / F 316L

3) alloy steel → ASTM A182 F_1 / F_2 / F_{10}

↳ Casting fitting (valves)

1) C.S → ASTM A216, ASTM A352 LCB/C

2) S.S → ASTM A217 CA15, ASTM A296 CA15

3) Alloy Steel → ASTM A217 WC1 / WC6 / WC9

↳ Plates

1) C.S → ASTM A285, ASTM A515 Gr. 60, 70, ASTM A516 Gr. 60, 70

2) S.S → ASTM A240 TP410 / TP 405 / TP430 / TP304 / TP 304L / TP 316 / TP 316L

3) Alloy Steel → ASTM A387 Gr 2 / Gr 5 / Gr 7 / Gr 9 / Gr. 11 / Gr. 12 / Gr. 22

4) Nickel Alloy → ASTM A203 Gr. D / Gr. E
ASTM A353.

Types of flanges (Pipe Attachment base)

1) Slip-on
2) Socket weld
3) welding neck
4) Blind flanges
5) Reducing flanges
6) Integral flanges
7) lap joint
8) Screwed flanges.

→ pressure temperature rating based.
i) 150, 300, 400, 600, 900, 1500, 2500, 3000 class

→ based on facing.

1) Flat face
2) Raised face
3) Tongue & groove face
4) Male & female face
5) Ring type joint.

Types of gaskets

1) Full face
2) Spiral Metallic
3) Ring type
4) Metal Jacket
5) inside bolt circle.
6) Sheet gaskets.

→ compressed Asbestos fibre.
commonly used material gasket.

Types of Valves

1) Gate valve
2) Globe valve
3) Ball valve
4) Butterfly valve
5) Plug valve
6) Piston valve
7) Check valve (NRV)
8) Pin valve.

Types of Support

1) Shoe Support
2) Hanger support
3) Spring anchor support
4) Dummy support
5) T/L support

Types of Pipe

1) Seamless Pipe
2) Seam Pipe (welded)
   1) SAW Pipe
   2) Electric resistance welding Pipe (ERW)
   3) Spiral Pipe.
3) Plain end Pipe
4) Bevel end Pipe
5) Thread end Pipe.

ASME Sec II Part A

deals with ferrous materials.

1) Carbon Steel
2) Stainless steel
3) Cast iron

ASME Sec. II Part B

deals with Non-

i) Nikel alloys
ii) lead
iii) zinc.

ASME Sec. II Part D

deals with mechanical properties.

1) Modulus of elasticity $E = \frac{\sigma}{\varepsilon}$ N/mm²
2) thermal expension
3) Poision's ration $m =$
4) density. $\rho = \frac{M}{V}$

Welding Defects

1) Porosity / clustered Porosity.
2) Undercut
3) Blow holes / Pin holes
4) Spitted
5) Slag inclusion
6) Distortion
7) Cracks
8) lack of Penetration.
9) Arc Strike.
10) Tungsten inclusion.
11) lack of fusion.
12) Burn through.
13) Crate lake.
14)

ASME Sec. IX

Welder qualification test (WQT)

1) Thickness range upto 2T

if welder qualify in thickness T (20 MM) they these welded Automated qualify. in thickness 2T (40 MM) Job.

2) Thickness range mode than 13 MM in Min. 3 Pass

if welder welded mode than 13 MM thickness in minimum 3 Pass (layer) they these welder qualified unlimited.

3) OD Range

i) OD less than 25 MM

if welder qualify upto 25 MM OD they automated qualified less than 25 MM OD Unlimited.

ii) 25 MM to 73 MM OD

if welder qualify upto 73 MM OD they automated qualified between 25 MM to 73 MM OD Dia. Pipe Unlimited.

iii) Mode than 73 MM OD

if welder qualify in mode than 73 MM OD they automated qualified in mode than 73 MM OD unlimited.

1) SMAW

- E 7018 (3.15, 4, 2.5 MM)
- DCEP
- A - 110 to 130 A
- V - 22 to 28 V
- P.O - 150 / 110 A
- M.O - 250 to 300 A

2) SAW

- E - EM12K / EM10K (4 MM)
- F - F7A4 / P4 (Neutral) / F8A4 / P4
- I - 550 to 600 A
- V - 28 to 30 V
- T.S - 330 MM / Min. / 27 CM / Min.
- NPD - 15 MM to 25 MM.

3) GMAW

- E - ER70S-6 (1.2 MM)
- G - CO_2 & 20 Lpm.
- I - 130 A
- V - 22 to 24 V
- T.S -

WELDING TECHNOLOGY

Welding Process

1) SAW (Submerge Arc welding)

- High thickness welded — 15 to 100 MM.
- V → 10 to 50 V, I → 200 to 2000 A (AC/DC)
- High deposition rate → 20 kg/hr. 16 A/MM2
- Copper coated wire electrode are used due to copper good conductor of electricity
- Consumable electrode (4 MM, 2 to 10 MM)
- Solid granular flux used
- Arc is under flux. (Non-visible)
- Min. heat loss & Max. focus on WP
- DCRP with high current is used (DCEP)
- Spitter Not Produce.
- Hight Strength by it.
- $HR = MC\Delta T + ML$
  $HS = I^2RT$
  $\eta_w = \frac{HR}{HS}$
- Copper coated wire electrode used
  i) good conductor of electricity so Provide better current to electrode
  ii) Prevent of mild steel from rusting.

- **Application**

Ship building, Pressure vessel, Domestic LPG
Low carbon & low alloy steel, S.S, Cu, Al
Medium carbon steel, Nikel

- 100% Duty cycle = $\frac{\text{Arc on time}}{\text{Arc on time + ideal time}}$

- NPD → Nozzel to Plate distance (3 to 5 MM)
- Components

  Power Source (AC/DC), Hooped flux delivery syst. Cupped electrode (silled wired), granular flux.
- Advantage

  High deposition rate, High duty cycle, Productivity↑ Controllable penetration, Automated, flux reused.
- Disadvantage

  only flat Position welded, long welding, Post weld slag removal.
- Flux

  Arc stability, deposited weld metal - Mechanical Properties improve.

  Granular flux (fusible) → oxide of MN, Si, Ca, Mg, Al, titanium, zirconium, calcium flotide.

  i) Bonded flux K_2SiO_3
  - Bonded with low Melting compound (Na_2SiO_3)
  - Metalic deoxidised (Prevent weld Porosity)
  - Ferrosilicon, Ferromagnese → S.S / C.S

    Magnese → use in steel making.

    Si, Ca carbide → steel production.

    titanium → steel.

  ii) Fused flux
  - Produce by mixing ingredience (Si, Fe_3O_4, Mg_2O_3) then Melting, cooling & grinding.
  - Provide smoot Arc Stable at 2000 A
  - Should be backed at 900°C to remove moisture.

2) GTAW (Gas tungsten Arc welding) TIG

- Shielding gas used (He, Ar, CO_2)
- DCEN (Straight Polarity) used for all except Al & Mg. (DCEP)
- DCEP (Reverse Polarity) known as the cathodic cleaning
- AC source is use for Al & Mg. (3410°C)
- Non-consumable tungsten electrode is used (1.6 MM, 2 MM, 2.4 MM,
- Filler wire use (T > 5 MM Plate) → ER70S2 C.S
  ER308L, 309L, 316L → S.S { 1.6, 2.0, 2.4, 2.5, 3.15 MM }
  ER 309L → S.S to C.S dissimilar Joint
- electrode (S.S)

  E7018 / C.S , E7018, E6013 / M.S ⟶ C.S
  { 2, 2.4, 3.15 MM }
- I = 200 to 650 A (100 A)
  V = 10 to 35 V
- all position welding process.
- 60 % duty cycle.
- ceramic Nozzel are used.
- thin plate are welded.
- Application

  S.S, M.S, Al, Mg, Cu, Ni, titanium, Air craft, Atomic energy, car body, instrument industry, Aerospace, Automobile industries, Chemical industries
- inert gas (Ar, He) are flow around electrode & weld pool.
- zirconium & thorium use for ↑ M.P of tungsten electrode.

3) GMAW (Gas Metal Arc welding) MIG/MAG

- Droplet transfer at low current → only G.F
  Spray transfer at High current → both gravity + magnetic force (Pinch effect)
- Solid wire in form of consumable electrode is used (1.2, 2.0, 3 mm) 2.5 MM
  ER 70S, ER308L, ER 309 L
- Shielding gas used (He, Ar, CO_2)
- Solid wire is bare or lightly coated.
- Consumable electrode used.
- Ac or DC used.
- Reverse Polarity used (DCEP)
- All Position welding Process
- Hight deposition rate.
- 60% duty cycle.
- Speed 2.5 to 25 M/Min.
- I = 200 to 750 A, V = 10 to 35 V
- Nozzel rate 4 to 10 L/Min.
- APPlication

  ferrous or Non-ferrous Metal, car bodies, Shipbuilding., Pressure vesel, Tanks, Pipe, Aircraft, Al, Mg, S.S