



# WELDING

## BASIC INFORMATION

### POCKET CARD



Rev.0 Dated 01 March 2017

## Materials

### Structural Materials

Material	Grade		Impact Temperature °C
Type	ABS & LR	DNV-GL	
Normal Strength	A/B/D/E	VL A/B/D/E	20/0/-20/-40
High Strength	AH32/36/40	VL A32/36/40	0
	DH32/36/40	VL D32/36/40	-20
	EH32/36/40	VL E32/36/40	-40
	FH32/36/40	VL F32/36/40	-60
Extra High Strength	AH42/46/50/69	VL A420/460/500/690	0
	DH42/46/50/69	VL D420/460/500/690	-20
	EH42/46/50/69	VL E420/460/500/690	-40
	FH42/46/50/69	VL F420/460/500/690	-60

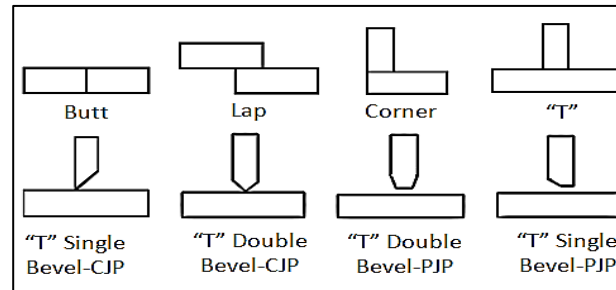
### Piping Materials

Material Std	Grade	Type
ASTM A106	Gr B	CS
API 5L	Gr B/X52/X65	CS
ASTM A333	Gr 6	LTCS
ASTM A312	TP 316L	SS
ASTM A790	UNS 31803	DSS
ASTM A928	UNS 32750	SDSS
ASTM A488	UNS C70600	Cu Ni

## Welding Processes

1. SMAW : Shielded Metal Arc Welding (Electrode)
2. FCAW : Flux Cored Arc Welding (Flux-Cored)
3. GMAW : Gas Metal Arc Welding (MIG/MAG)
4. GTAW : Gas Tungsten Arc Welding (TIG)
5. SAW : Submerged Arc Welding Process (Auto)

## Weld Joint Types

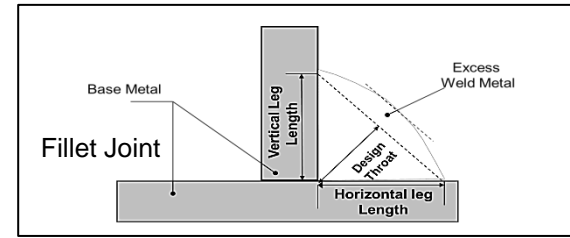
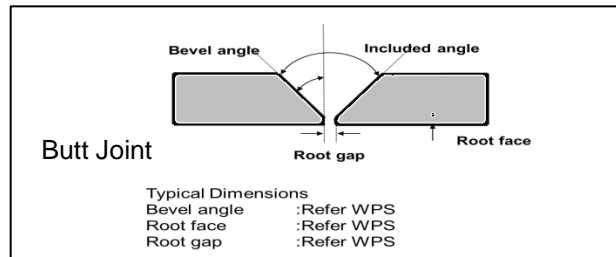


## Fillet Weld Size – Formula

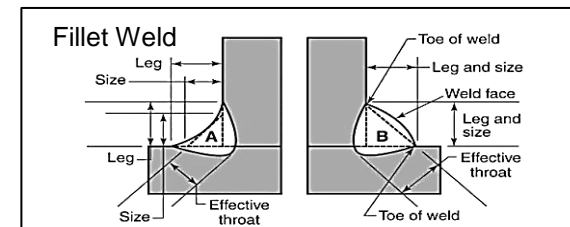
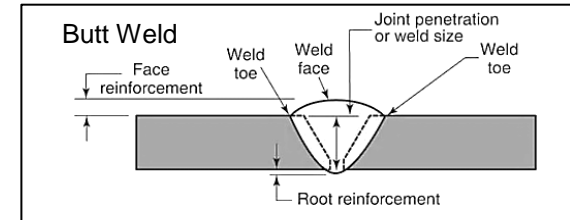
$$\text{Leg Length} = \text{Design Throat Thickness} \times 1.4$$

$$\text{Design Throat Thickness} = \text{Leg Length} \times 0.7$$

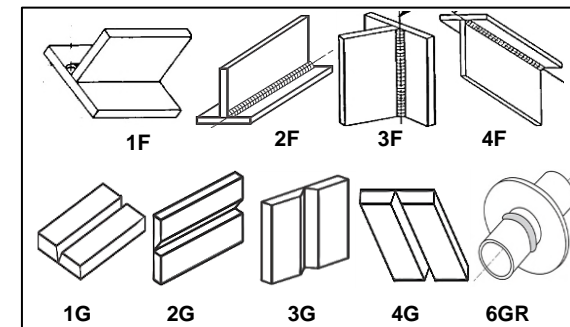
## Joints Details



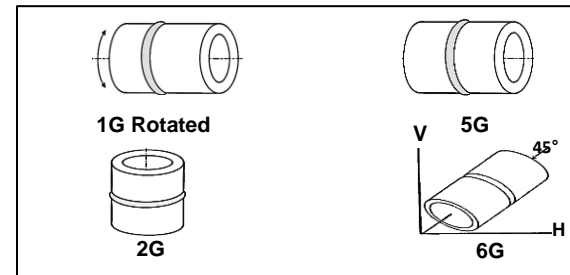
## Weld Terminology



## Welding Positions – Plate & Tubular



## Welding Position – Pipe



## Welder Qualification Test (WQT)

### Welder

A person who performs manual or semiautomatic welding.

### Welding Operator:

A person who operates machine or automatic welding equipment.

### Tack Welder

A person who performs manual or semiautomatic welding to produce tack weld.

### Brazer

A person who performs a manual brazing operation.

## Welder Performance Qualification

The demonstration of a welder's or welding operator's ability to produce welds meeting prescribed standards.

## Expiration and Renewal of Qualification

When the welder did not weld with a process during a period of 6 months or more, his qualification for that process shall expire.

## Reasons for Welder Re-qualification

Doesn't have welding continuity record, poor welding performance, and poor welding skills.

## Welding Procedure Specification (WPS)

WPS is a document to provide the required welding variables for a specific application.

## Procedure Qualification Records (PQR)

PQR is a record of welding variables used to produce an acceptable test weldment to qualify a welding procedure specification (WPS).

## Air Carbon Arc Gouging

It's a thermal gouging that uses an arc cutting process variation to form a bevel or groove by using compressed air.

## Preheating

Preheating is an immediate heating process application to the base metal before a welding operation to achieve a specified minimum recommended temperature as per WPS. Preheating will remove moisture, slowdown cooling rate, prevent porosity and weld cracking.

## Interpass Temperature

Interpass temperature is the temperature of the weld area between weld passes in a multipass weld. Continuous monitoring of Interpass temperature will maintain and improve the material mechanical properties.

## Weld Interpass Cleaning

Before welding over previously deposited weld metal, all slag shall be removed and the weld and adjacent base metal shall be cleaned by brushing or by other suitable means.

## Post Heating

Any heat treatment around 250°C immediately after welding, Post Heating will prevent fast cooling rate and hydrogen cold cracking.

## Post Weld Heat Treatment (PWHT)

PWHT is a heat treatment subsequent to welding process, PWHT will relief residual stress and improve hardness of the weld metal.

## Shielding Gas

Shielding gas is a protective gas, shielding gas will protect weld metal from atmosphere and prevent from atmospheric contamination.

## Backing Gas

Backing gas (Purging Gas) is a root shielding gas in the form of shielding gas primarily to remove from the vicinity of the joint, oxygen water vapour and other gases or vapours that is harmful to a welding joint being welded and immediately after welding.

## Tack Weld

Tack weld is a weld made to hold the parts of a weldment in proper alignment until the final welds are made.

## Backing

It is a material placed against the backside of the joint adjacent and or to the joint root side to support and shield molten weld metal. The material may be partially fused during welding and the backing material may be either metal or non-metal. (Ex. Backing Strip, Ceramic Backing).

## Back gouging

Back gouging is the weld metal and base metal removal process from the welded joint root side to facilitate complete fusion and complete joint penetration upon subsequent welding from other side by using of grinding, chipping, air carbon arc gouging.

## Buttering

The addition of material by welding on one face or both faces of a joint prior to the preparation of the joint for final welding.

## Welding consumable

Welding consumable is an electrode; wire and flux are used in a welding process for joining metals.

## Flux cored wire

Flux cored wire is a composite tubular filler metal wire consisting of a metal sheath and a core of various powdered materials, producing an extensive slag cover on the face of a weld bead.

## Flux (Welding / Brazing)

A material used to dissolve, prevent, and facilitate the removal of oxides or other undesirable surface substances. It may act to stabilize the arc, shield the molten pool.

## Welding Electrode Control Plan

Low Hydrogen Electrodes Baking and Holding Temperature

Electrode type	Baking in °C	Time	Holding in °C
70 Series	300 ~ 350	1 hour	100 ~ 150
80 Series	350 ~ 400		100 ~ 150
90 Series	350 ~ 400		100 ~ 150
110 Series	350 ~ 400		100 ~ 150

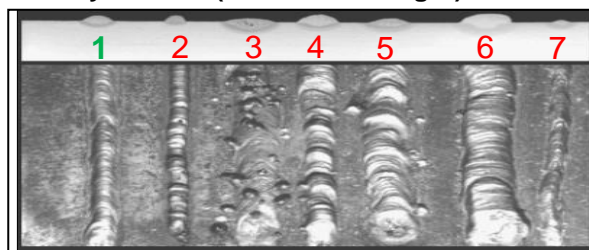
SAW Flux Backing and Holding Temperature

SAW Flux – Product Name	Baking in °C	Time	Holding in °C
Hyundai - Superflux/55ULT/S-460Y	300 ~ 350	1 Hour	100 ~ 150
Lincoln - 8500 SRB			
Oerlikon - OP 121TT			

## How to keep electrodes in good condition

- Store electrodes in a low humidity area
- Low hydrogen type electrodes should be followed as per welding consumable control plan. The electrode must be kept in a portable holding oven (Quiver) with a temperature of 50°C~70°C.
- Welders should bring an appropriate amount of electrodes for 4½ hours use at sites in order to prevent electrodes from atmosphere and moistures.
- Follow proper electrode handling to avoid electrode damages.
- Re-backing electrodes shall be coloured with black at bottom of the electrode near its grip end.

## Quality of Weld (From Left to Right)



### Good weld - as per WPS

1. Current, Arc length and Travel speed normal

### Bad Weld – Not as per WPS

2. Current too low

3. Current too high

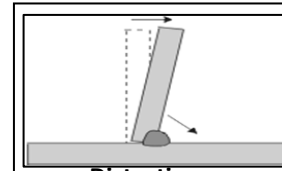
4. Arc length too short

5. Arc length too long

6. Travel speed too slow

7. Travel speed too high

## WELD DEFECTS



Distortion



Porosity



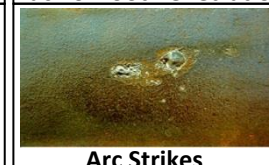
Lack of root fusion



Lack of root Penetration



Spatters



Arc Strikes



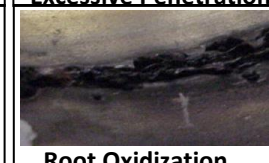
Suck Back



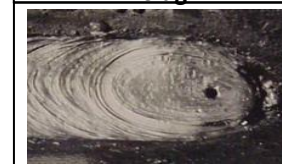
Excessive Penetration



Slag



Root Oxidization



Crater Pipe



Crater Crack



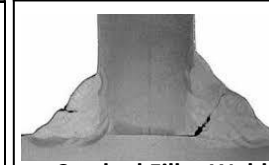
Pin Hole



Undercut



Weld Under Size



Cracked Fillet Weld

## IMPORTANT STEPS

### Before Welding

- Review drawings and standards
- Check material type / grade
- Check welding consumable control procedure is in place
- Select appropriate WPS
- Check welding procedures, individual welder qualifications,
- Check welding process and positions.
- Check condition of welding equipment
- Check quality and condition of base and filler materials to be used
- Check weld preparations, joint fit-up and suitability of alignment
- Check weld joint cleanliness
- Check preheat, when required (Measure by using Tempilstik or Laser Gun)

### During Welding

- Check welding variables for compliance with welding procedure
- Check quality of individual weld passes
- Check interpass cleaning (wire brush, chipping hammer and grinding)
- Check interpass temperature (Measure by using Tempilstik or Laser Gun)
- Check placement and sequencing of individual weld passes
- Check back gouged surfaces
- Monitor in-process NDT, if required.
- Check portable ovens (Quiver) are working in good condition
- Do not weld over cracked tack welds.
- Avoid over welding... or Undersized.

### After Welding

- Check finished weld appearance
- Check weld size, weld length and dimensional accuracy of weldment
- Monitor additional NDT, if required
- Monitor post weld heat treatment, if required
- Good housekeeping
- Prepare inspection reports