

GFC-206 – FUEL GAS PIPE WELDING I

OVERVIEW

- **INTRODUCTION – API 1104**
- **WELDING EQUIPMENT AND MATERIAL**
- **WELDING PROCEDURE**
- **API 1104 ACCEPTANCE CRITERIA**
- **WELDING TESTING**

WHAT IS API 1104?

- American Petroleum Institute
- This standard covers the **gas and arc welding of butt, fillet, and socket welds** in **carbon** and **low-alloy steel** piping used in the compression, pumping, and transmission of crude petroleum, **petroleum products, fuel gases**, carbon dioxide, nitrogen, and where applicable, covers welding on distribution systems. It applies to both new construction and in-service welding.

WELDING EQUIPMENT AND MATERIAL

- Welding equipment, both gas and arc, shall be of a size and type **suitable for the work** and shall be maintained in a condition that ensures acceptable welds, continuity of operation, and safety of personnel. Arc welding equipment shall be operated within the amperage and voltage ranges given in the qualified **welding procedure specification**. Gas welding equipment shall be operated with the flame characteristics and tip sizes given in the qualified welding procedure specification. Equipment that does not meet these requirements shall be repaired or replaced.

What determines the tip size for gas welding equipment?

WELDING EQUIPMENT AND MATERIAL

4.2 Materials

4.2.1 Pipe and Piping Components

This standard applies to the welding of pipe and piping components that conform to material and product specifications including, but not limited to:

- a) API specifications,
- b) ASME International specifications,
- c) ASTM International specifications,
- d) Manufacturers Standardization Society (MSS) specifications,
- e) American National Standards Institute (ANSI) specifications.

This standard also applies to materials with chemical and mechanical properties that comply with one of the specifications listed in Items a) through e) above, even though the material is not manufactured in accordance with the specification.

WELDING EQUIPMENT AND MATERIAL

4.2.2 Filler Metals and Fluxes

4.2.2.1 Types

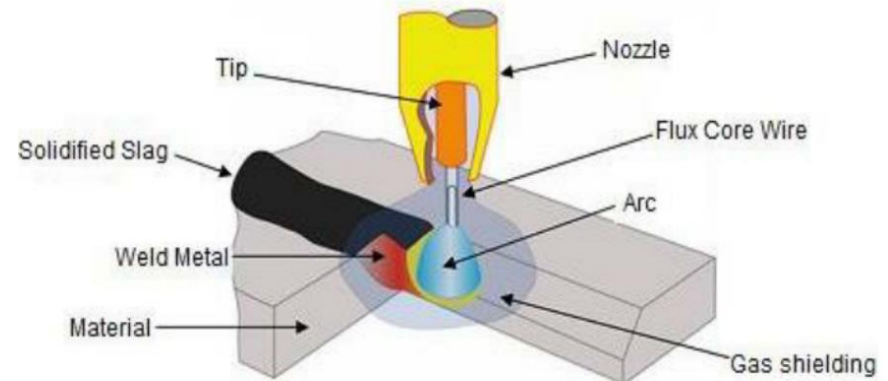
All filler metals and fluxes shall conform to one of the following, except as provided below:

- a) AWS A5.1,
- b) AWS A5.2,
- c) AWS A5.5,
- d) AWS A5.17,
- e) AWS A5.18,
- f) AWS A5.20,
- g) AWS A5.23,
- h) AWS A5.28,
- i) AWS A5.29.

Filler metals and fluxes that do not conform to the specifications above may be used provided the welding procedure specifications involving their use are qualified.

WELDING EQUIPMENT AND MATERIAL

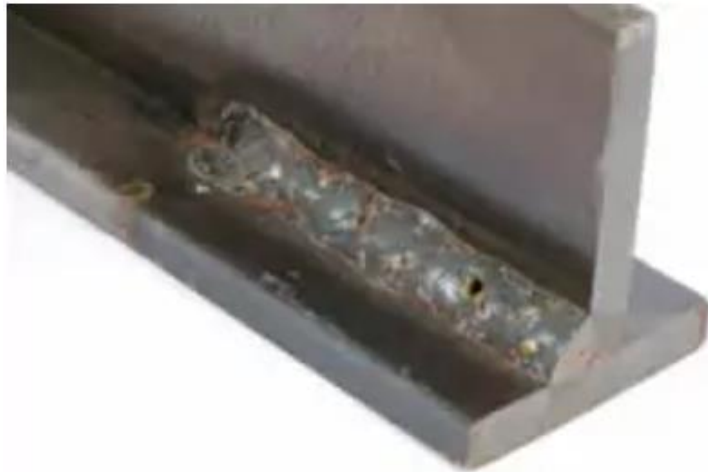
- Filler metals and fluxes shall be stored and handled to avoid damage to them and to the containers in which they are shipped. Filler metals and fluxes in opened containers shall be protected from deterioration, and **filler metals that are coated** shall be protected from **excessive changes in moisture**. Filler metals and fluxes that show signs of damage or deterioration shall not be used.



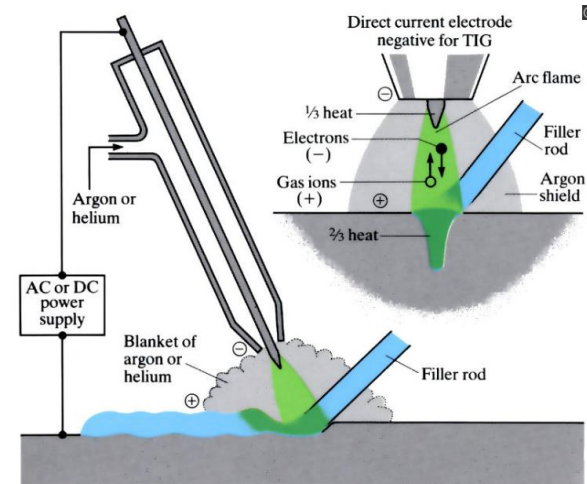
Schematic flux cored arc welding process.

WELDING EQUIPMENT AND MATERIAL

- Shielding gases shall be kept in the containers in which they are supplied, and the containers shall be stored away from extremes of temperature. Gases shall not be **field intermixed** in their containers. Gases of questionable purity and those in containers that show signs of damage shall not be used.



The principles of the TIG welding torch



WELDING PROCEDURE

- Developing a welding procedure specification (WPS).
- Establishing a procedure qualification record (PQR) by identifying the essential variables of that WPS.
- Implementing welder testing to verify that the welders are capable of performing the procedure.
- API 1104 Section 5.1 also requires destructive testing to determine the quality of the welds, unless the company specifically authorizes a different method.
- API 1104 Section 5.2 requires the company to record the complete details of each qualified procedure, and to keep that record as long as the procedure is in use. The section provides sample forms for this purpose. Figure 1 is a sample WPS. Figure 2 is a sample that can be used as a PQR, a WQTR, or both.



WELDING PROCEDURE

WELDING PROCEDURE SPECIFICATION NUMBER _____

For _____ Welding of _____ Pipe and fittings

Process _____

Material _____

Pipe outside diameter and wall thickness _____

Joint design _____

Filler metal and number of beads _____

Electrical or flame characteristics _____

Position _____

Direction of welding _____

Number of welders _____

Time lapse between passes _____

Type and removal of lineup clamp _____

Cleaning and/or grinding _____

Preheat/postweld heat treatment _____

Shielding gas and flow rate _____

Shielding flux _____

Speed of travel _____ Plasma gas flow rate _____

Plasma gas composition _____

Plasma gas orifice size _____

Sketches and tabulations attached _____

Tested _____

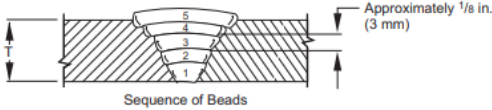
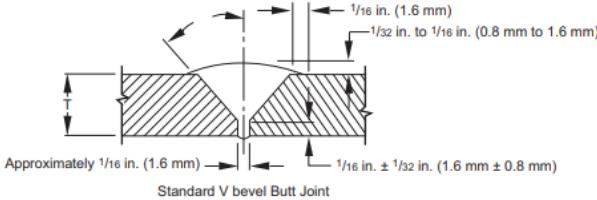
Welder _____

Approved _____

Welding supervisor _____

Adopted _____

Chief engineer _____



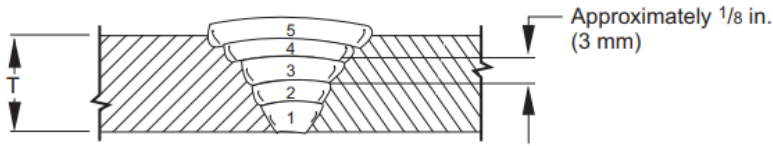
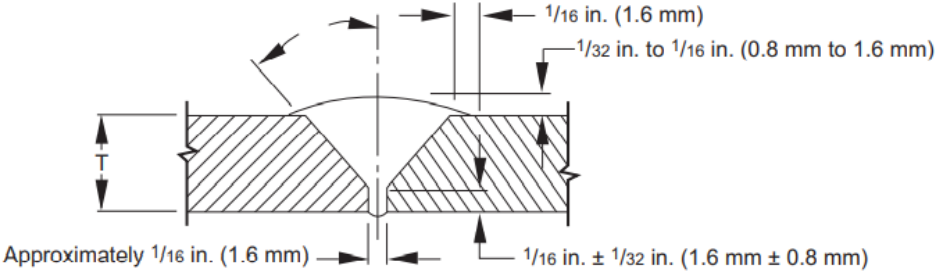
NOTE Dimensions are for example only.

ELECTRODE SIZE AND NUMBER OF BEADS				
Bead Number	Electrode Size and Type	Voltage	Amperage and Polarity	Speed

Figure 1—Sample Welding Procedure Specification Form



WELDING PROCEDURE



NOTE Dimensions are for example only.

ELECTRODE SIZE AND NUMBER OF BEADS				
Bead Number	Electrode Size and Type	Voltage	Amperage and Polarity	Speed

Figure 1—Sample Welding Procedure Specification Form



WELDING PROCEDURE

COUPON TEST REPORT

Date _____ Test No. _____
 Location _____
 State _____ Weld Position: Roll Fixed
 Welder _____ Mark _____
 Welding time _____ Time of day _____
 Mean temperature _____ Wind break used _____
 Weather conditions _____
 Voltage _____ Amperage _____
 Welding machine type _____ Welding machine size _____
 Filler metal _____
 Reinforcement size _____
 Pipe type and grade _____
 Wall thickness _____ Outside diameter _____

	1	2	3	4	5	6	7
Coupon stenciled							
Original specimen dimensions							
Original specimen area							
Maximum load							
Tensile strength							
Fracture location							

Procedure Qualifying test Qualified
 Welder Line test Disqualified

Maximum tensile _____ Minimum tensile _____ Average tensile _____
 Remarks on tensile strength tests _____
 1. _____
 2. _____
 3. _____
 4. _____
 Remarks on bend tests _____
 1. _____
 2. _____
 3. _____
 4. _____
 Remarks on nick break tests _____
 1. _____
 2. _____
 3. _____
 4. _____

Test made at _____ Date _____
 Tested by _____ Supervised by _____

NOTE Use back for additional remarks. This form can be used to report either a procedure qualification test or a welder qualification test.

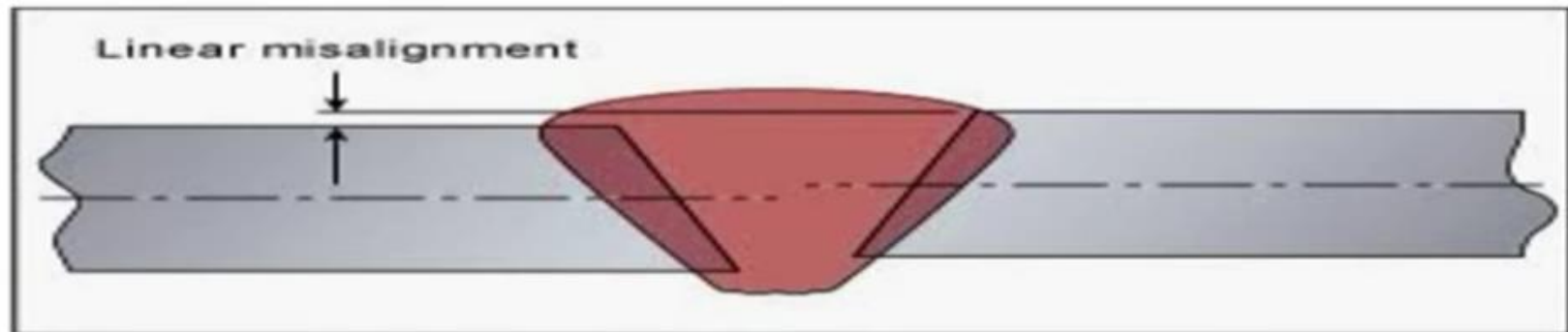
Figure 2—Sample Coupon Test Report

WELDING PROCEDURE

- Filler metals and fluxes shall be stored and handled to avoid damage to them and to the containers in which they are shipped. Filler metals and fluxes in opened containers shall be protected from deterioration, and **filler metals that are coated** shall be protected from **excessive changes in moisture**. Filler metals and fluxes that show signs of damage or deterioration shall not be used.

API 1104 ACCEPTANCE CRITERIA

Defect Type	Acceptance Limits	Remarks
Misalignment	Not Exceeds 3.0 mm	7.2

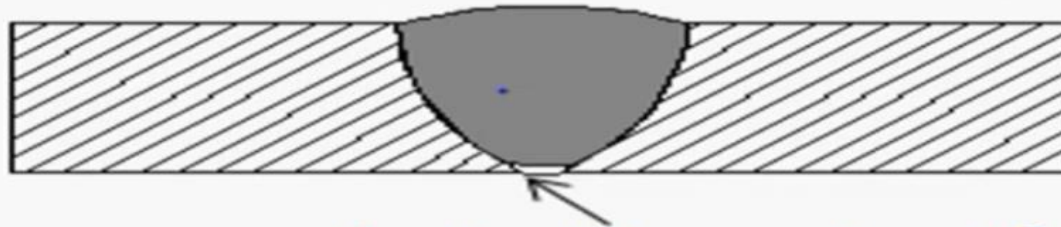


Acceptance Limit : Not Exceed 3 mm , Refer : 7.2 of API 1104

API 1104 ACCEPTANCE CRITERIA

Defect Type	Acceptance Limits	Remarks
Incomplete Penetration Without HI-LO (IP)	Individual IP not exceeds 25 mm Aggregate IP not exceeds 25 mm in 30 cm weld length	9.3.1.a 9.3.1.b

INCOMPLETE PENETRATION without HI-LO



Incomplete Penetration

Acceptance Limit:

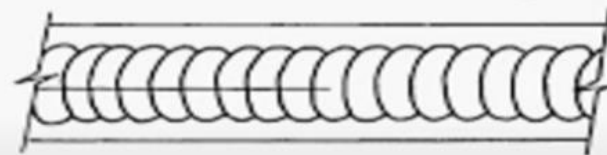
Individual IP not exceeds 25 mm –Refer 9.3.1 a

Aggregate IP not exceeds 25 mm in 30.00 cm weld length –Refer 9.3.1 b

API 1104 ACCEPTANCE CRITERIA

Imperfection Type	Acceptance Limits	Remarks
Incomplete Penetration With HI-LO (IP)	Individual IP not exceeds 50 mm	9.3.2.a
	Aggregate IP not exceeds 75 mm in 30 cm weld length	9.3.2.b

INCOMPLETE PENETRATION with HI-LO



Acceptance Limit :

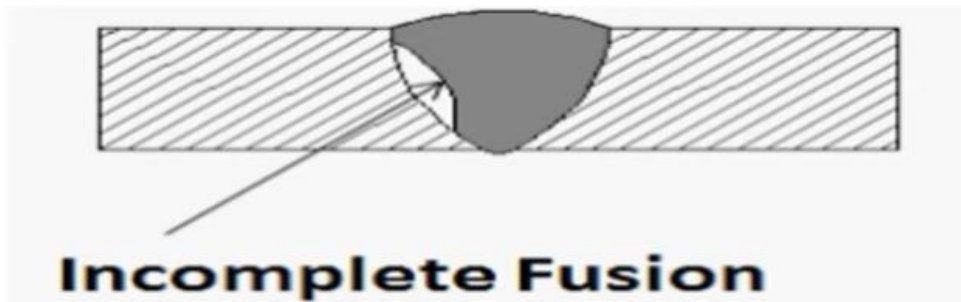
Individual IP not exceeds 50 mm –Refer 9.3.2 a

Aggregate IP not exceeds 75 mm in 30.00 cm weld length-Refer 9.3.2 b

API 1104 ACCEPTANCE CRITERIA

Imperfection Type	Acceptance Limits	Remarks
Incomplete Fusion (IF)	Individual IF not exceeds 25 mm	9.3.4.a
	Aggregate IF not exceeds 25 mm in 30 cm weld length	9.3.4.b

INCOMPLETE FUSION



Acceptance Limit:

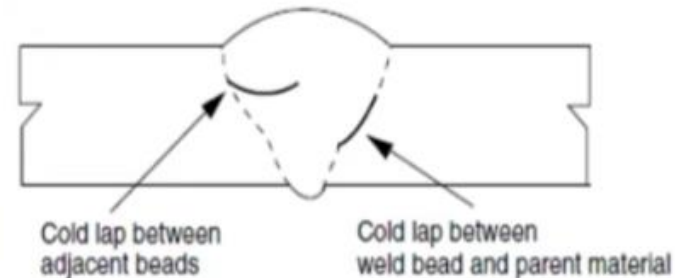
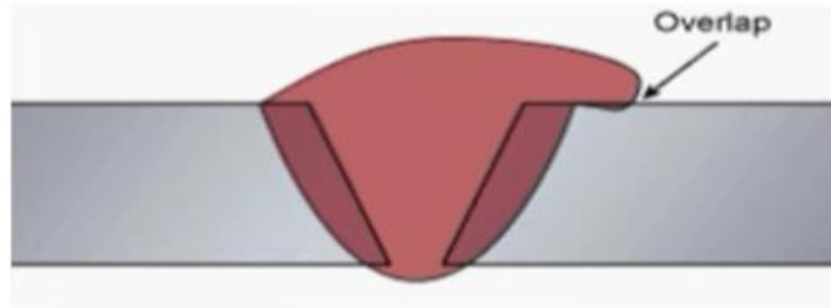
Individual IF not exceeds 25 mm –Refer 9.3.4 a

Aggregate IF not exceeds 25 mm in 30.00 cm weld length –Refer 9.3.4 b

API 1104 ACCEPTANCE CRITERIA

Imperfection Type	Acceptance Limits	Remarks
Cold Lap (CL)	Individual CL not exceeds 50 mm Aggregate CL not exceeds 50 mm in 30 cm weld length	9.3.5.a 9.3.5.b

COLD LAP / OVERLAP



Acceptance Limit :

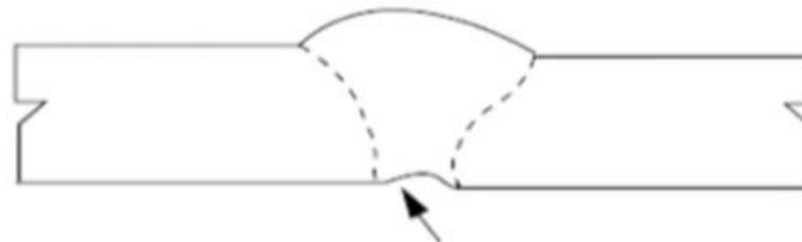
Individual CL not exceeds 50 mm –Refer 9.3.5 a

Aggregate CL not exceeds 50 mm in 30.00 cm weld length -Refer 9.3.5 b

API 1104 ACCEPTANCE CRITERIA

Imperfection Type	Acceptance Limits	Remarks
Internal Concavity (IC)	The density of the concave area shall not exceed the density of the adjacent of the base metal . And if the density is more the burn through acceptance limits should be applied.	9.3.6

INTERNAL CONCAVITY



Root bead is fused to both surfaces, but center of root pass is slightly below the pipe's inside surface.

API 1104 ACCEPTANCE CRITERIA

Imperfection Type	Acceptance Limits	Remarks
Burn Through (BT)	Individual BT not exceeds 6 mm	9.3.7.a
	Aggregate BT not exceeds 13 mm in 30 cm in weld length	9.3.7.b
		9.3.7.c

BURN THROUGH



Acceptance Limit :

Individual BT not exceeds 6 mm

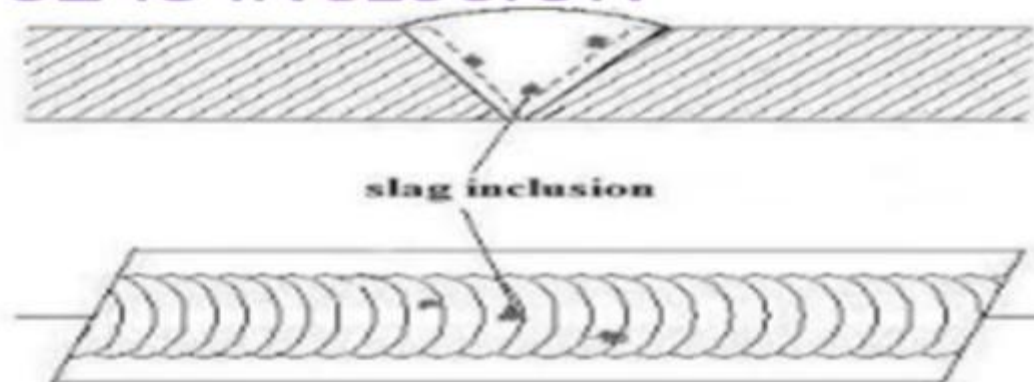
Aggregate BT not exceeds 13 mm in 30.00 cm in weld length

Refer -9.3.7 a, 9.37 b & 9.37 c

API 1104 ACCEPTANCE CRITERIA

Imperfection Type	Acceptance Limits	Remarks
Slag Inclusion (SI)	Individual elongated SI shall not exceed 50 mm in length and 1.6 mm in width. Aggregate elongated SI shall not exceed 50 mm in length in 30 cm weld length.	9.3.8.a 9.3.8.b 9.3.8.c 9.3.8.d

SLAG INCLUSION

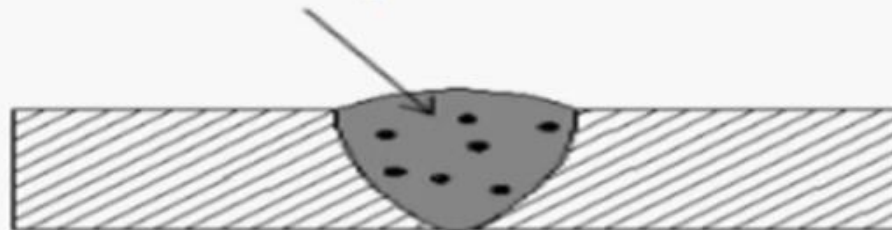


API 1104 ACCEPTANCE CRITERIA

Imperfection Type	Acceptance Limits	Remarks
Porosity (P)	Individual pore size shall not exceed 3 mm Cluster porosity longest diameter shall not exceed 13 mm. Aggregate cluster porosity length shall not exceed 13 mm in 30 cm weld length.	9.3.9

POROSITY

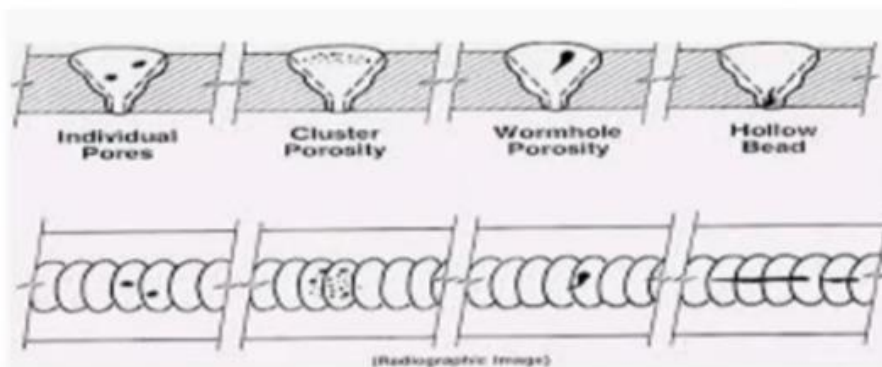
Porosity



API 1104 ACCEPTANCE CRITERIA

Imperfection Type	Acceptance Limits	Remarks
Hollow Bead (HB)	Individual HB shall not exceeds 13 mm length. Aggregate HB shall not exceeds 50 mm in 30 cm in weld length.	9.3.9.4

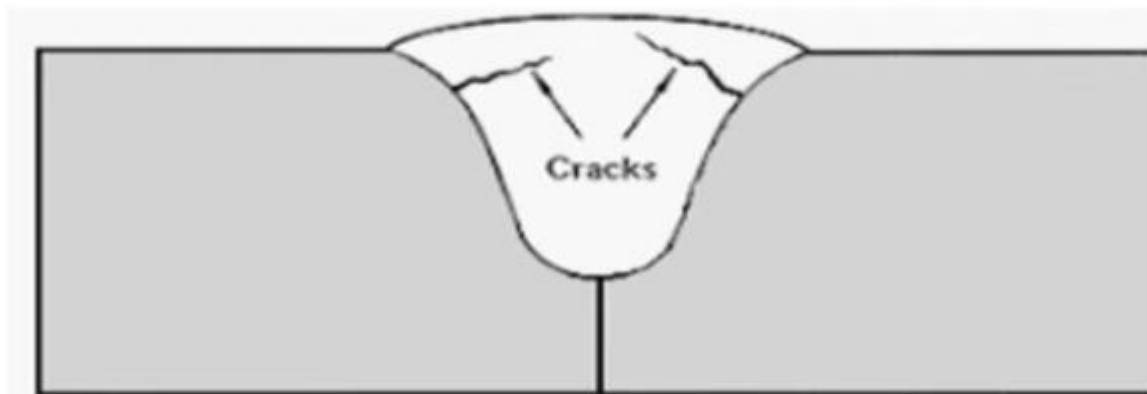
HOLLOW BEAD /Elongated Linear Porosity



API 1104 ACCEPTANCE CRITERIA

Imperfection Type	Acceptance Limits	Remarks
Cracks	Only star cracks and crater cracks are permitted with length shall not exceed 4 mm.	9.3.10

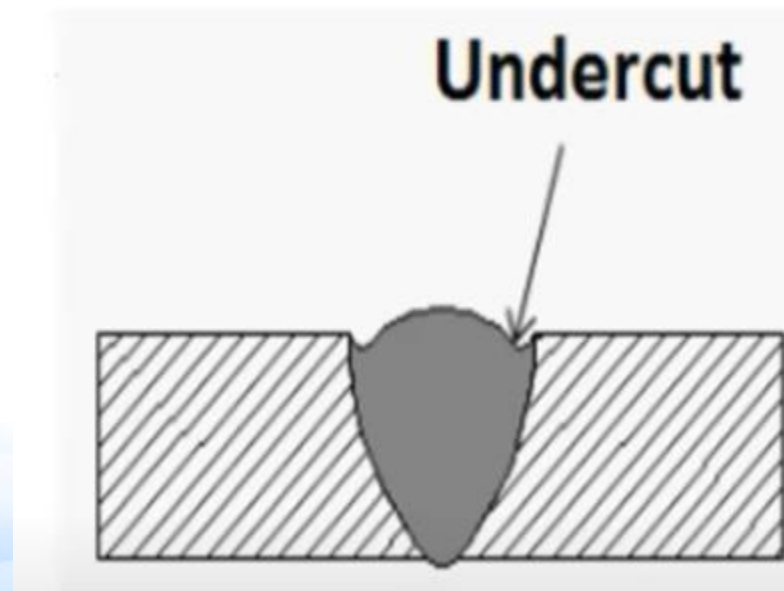
CRACKS



API 1104 ACCEPTANCE CRITERIA

Imperfection Type	Acceptance Limits	Remarks
Undercut (UC)	Undercut length shall not exceed 50 mm in 30 cm weld length.	9.3.11

UNDERCUT



HOW ABOUT WELDING TESTING?

- This standard also covers the procedures for **radiographic**, **magnetic particle**, **liquid penetrant**, and **ultrasonic testing**, as well as the acceptance standards to be applied to production welds tested to destruction or inspected by radiographic, magnetic particle, liquid penetrant, ultrasonic, and visual testing methods.

NON-DESTRUCTIVE TEST - RADIOGRAPHIC



NON-DESTRUCTIVE TEST – MAGNETIC PARTICLE

NON-DESTRUCTIVE TEST – LIQUID PENETRANT

NON-DESTRUCTIVE TEST – ULTRASONIC

THANK YOU

