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CONFIDENTIAL

SET A

UNIVERSITI KUALA LUMPUR

MALAYSIA FRANCE INSTITUTE

FINAL EXAMINATION

JANUARY 2014 SESSION

SUBJECT CODE	:	**FWB 22403**
SUBJECT TITLE	:	**WELD DEFECTS**
LEVEL	:	**BACHELOR**
TIME / DURATION	:	**2.5 HOURS**
DATE	:	

INSTRUCTIONS TO CANDIDATES

1. **Please read the instructions given in the question paper CAREFULLY.**
2. **This question paper is printed on both sides of the paper.**
3. **Please write your answers on the answer booklet provided.**
4. **Answer should be written in blue or black ink except for sketching, graphic and illustration.**
5. **This question paper consists of TWO (2) sections, section A and B. Answer both section.**
6. **Answer all questions in English.**

THERE ARE 3 PRINTED PAGES OF QUESTIONS, EXCLUDING THIS PAGE

SECTION A (Total: 40 marks)

INSTRUCTION: Answer ALL questions
Please use the answer booklet provided.

Question 1

Sketch the lack of penetration **(LOP)** in single V butt weld and in the double V butt weld. Explain **THREE (3)** main cause of this defect in the welding process.

(8 marks)

Question 2

Explain with your own what is the star crack or start-stop crack all about?

(8 marks)

Question 3

Explain with own word why crack is not repairable in most construction codes except for star crack.

(8 marks)

Question 4

Explain type of defect caused by tungsten material that used in non consumable electrode in Tungsten inert gas **(TIG).** Why the color of defect is again the color of normal porosities

(8 marks)

Question 5

Few types of crack may found in the weld metal, heat affected zone and base metal. Illustrate With the aid of sketches the location of crater crack, lamellar tearing, solidified and hydrogen induced cold cracking.

(8 marks)

SECTION B (Total: 60 marks)

INSTRUCTION: Answer TWO (2) questions only

Please use the answer booklet provided.

Question 1

Figure 1 show the image of suck back concavity occurred at the root of the weld joint.

i. Sketch this defect and state THREE (3) cause of this defect.

(6 marks)

ii. Explain the cause of suck back in Tungsten inert gas welding (TIG), why?

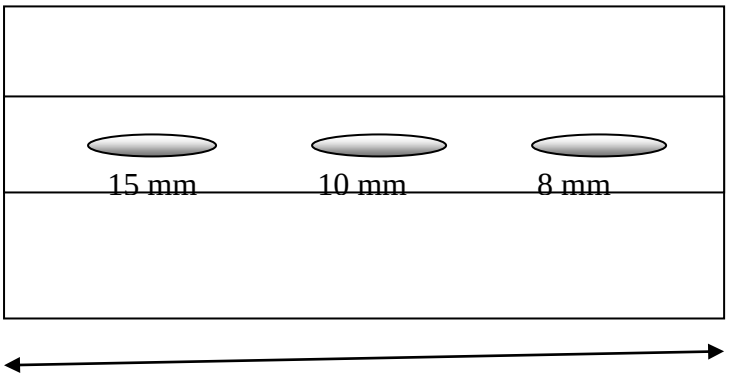
(8 marks)

iii. Determine the maximum allowable limit for suck back if found in 6 inch outside diameter pipe.

(8 marks)

iv. Evaluate the suck back accordance to code provided in attachment. The densities of the suck back **not exceed** the density of minimum adjacent base metal.

(8 marks)



Question 2

Radiographic inspection is a common method widely used to inspect internal butt weld for pipe and plate. Figure 3 show the weld film produced by radiographic inspection.

i. Sketch and name the parts of basic of x-ray tube

(6 marks)

ii. Explain the mechanism how x-ray is produced.

(8 marks)

iii. Explain the source of radioactive if the inspectors choose to use radioactive material instead of x-ray for inspection.

(8 marks)

iv. Explain TWO (2) radiographic techniques that use to inspect weld joint in a pipe.

(8 marks)

Question 3

Base and weld metal defect may be repair by the qualified procedure.

i. List THREE (3) defect for base and FOUR (4) for weld metal.

(6 marks)

ii. Discuss in general why weld repair or others repair are needed in steel fabrication.

(8 marks)

iii. Explain how to repair a defect such as lack of fusion in the weld joint

(8 marks)

iv. Explain and give your reason why an arc strike found in base metal of high strength steel considered as major defect.

(8 marks)

END OF QUESTIONS

Attachment- Acceptance criteria

9.3.3 Inadequate Cross Penetration

Inadequate cross penetration (ICP) is defined as a subsurface imperfection between the first inside pass and the first outside pass that is caused by inadequately penetrating the vertical land faces. This condition is shown schematically in Figure 15. ICP shall be considered a defect should any of the following conditions exist:

a. The length of an individual indication of ICP exceeds 2 in. (50 mm).

b. The aggregate length of indications of ICP in any continuous 12-in. (300-mm) length of weld exceeds 2 in. (50 mm).

9.3.4 Incomplete Fusion

Incomplete fusion (IF) is defined as a surface imperfection between the weld metal and the base material that is open to the surface. This condition is shown schematically in Figure 16. IF shall be considered a defect should any of the following conditions exist:

a. The length of an individual indication of IF exceeds 1 in. (25 mm).

b. The aggregate length of indications of IF in any continuous 12-in. (300 mm) length of weld exceeds 1 in. (25 mm).

c. The aggregate length of indications of IF exceeds 8% of the weld length in any weld less than 12 in. (300 mm) in length.

9.3.5 Incomplete Fusion Due to Cold Lap

Incomplete fusion due to cold lap (IFD) is defined as an imperfection between two adjacent weld beads or between the weld metal and the base metal that is not open to the surface. This condition is shown schematically in Figure 17. IFD shall be considered a defect should any of the following conditions exist:

a. The length of an individual indication of IFD exceeds 2 in. (50 mm).

b. The aggregate length of indications of IFD in any continuous 12-in. (300 mm) length of weld exceeds 2 in. (50 mm).

c. The aggregate length of indications of IFD exceeds 8% of the weld length.

9.3.6 Internal Concavity

Internal concavity (IC) is defined in 3.2.7 and is shown schematically in Figure 18. Any length of internal concavity is acceptable, provided the density of the radiographic image of the internal concavity does not exceed that of the thinnest adjacent parent material. For areas that exceed the density of the thinnest adjacent parent material, the criteria for burn-through (see 9.3.7) are applicable.

9.3.7 Burn-Through

9.3.7.1 A burn-through (BT) is defined as a portion of the root bead where excessive penetration has caused the weld puddle to be blown into the pipe.

9.3.7.2 For pipe with an outside diameter greater than or equal to 2.375 in. (60.3 mm), a BT shall be considered a defect should any of the following conditions exist:

a. The maximum dimension exceeds $^1/_4$ in. (6 mm) and the density of the BT's image exceeds that of the thinnest adjacent parent material.

b. The maximum dimension exceeds the thinner of the nominal wall thicknesses joined, and the density of the BT's image exceeds that of the thinnest adjacent parent material.

c. The sum of the maximum dimensions of separate BTs whose image density exceeds that of the thinnest adjacent parent material exceeds $^1/_2$ inch (13 mm) in any continuous 12-in. (300-mm) length of weld or the total weld length, whichever is less.

9.3.7.3 For pipe with an outside diameter less than 2.375 in. (60.3 mm), a BT shall be considered a defect when any of the following conditions exists:

a. The maximum dimension exceeds $^1/_4$ in. (6 mm) and the density of the BT's image exceeds that of the thinnest adjacent parent material.

b. The maximum dimension exceeds the thinner of the nominal wall thicknesses joined, and the density of the BT's image exceeds that of the thinnest adjacent parent material.

c. More than one BT of any size is present and the density of more than one of the images exceeds that of the thinnest adjacent parent material.

9.3.8 Slag Inclusions

9.3.8.1 A slag inclusion is defined as a nonmetallic solid entrapped in the weld metal or between the weld metal and the parent material. Elongated slag inclusions (ESIs)—e.g., continuous or broken slag lines or wagon tracks—are usually found at the fusion zone. Isolated slag inclusions (ISIs) are irregularly shaped and may be located anywhere in the weld. For evaluation purposes, when the size of a radiographic indication of slag is measured, the indication's maximum dimension shall be considered its length.

9.3.8.2 For pipe with an outside diameter greater than or equal to 2.375 in. (60.3 mm), slag inclusions shall be considered a defect should any of the following conditions exist:

a. The length of an ESI indication exceeds 2 in. (50 mm).

Note: Parallel ESI indications separated by approximately the width of the root bead (wagon tracks) shall be considered a single indication unless the width of either of them exceeds $^1/_{32}$ inch (0.8 mm). In that event, they shall be considered separate indications.

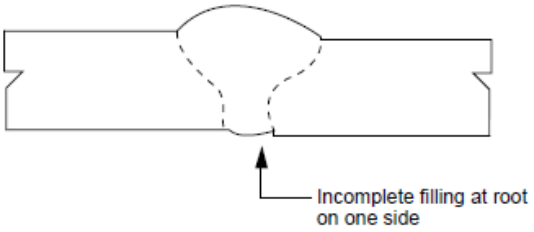


Figure 14—Inadequate Penetration Due to High-Low (IPD)

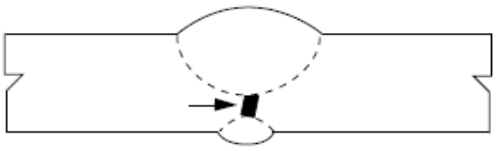


Figure 15—Inadequate Cross Penetration (ICP)

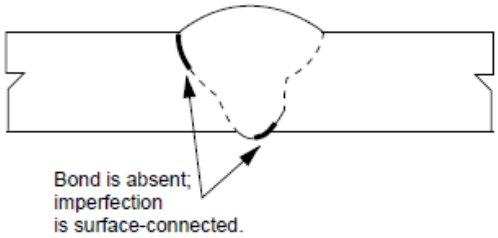
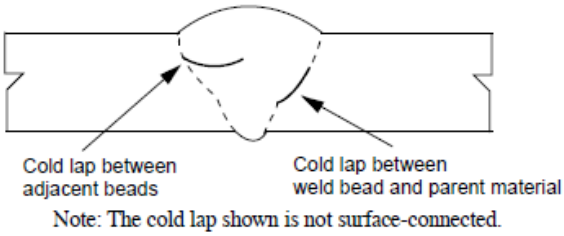


Figure 16—Incomplete Fusion at Root of Bead or Top of Joint (IF)



Note: The cold lap shown is not surface-connected.

Figure 17—Incomplete Fusion Due to Cold Lap (IFD)

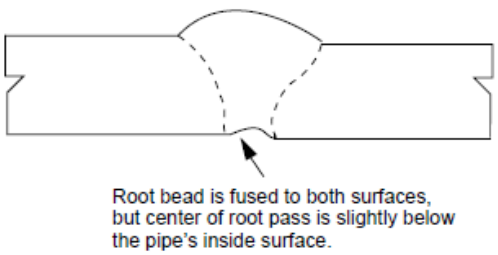


Figure 18—Internal Concavity (IC)

b. The aggregate length of ESI indications in any continuous 12-in. (300-mm) length of weld exceeds 2 in. (50 mm).
c. The width of an ESI indication exceeds $^1/_{16}$ in. (1.6 mm).
d. The aggregate length of ISI indications in any continuous 12-in. (300-mm) length of weld exceeds $^1/_2$ in. (13 mm).
e. The width of an ISI indication exceeds $^1/_8$ in. (3 mm).
f. More than four ISI indications with the maximum width of $^1/_8$ in. (3 mm) are present in any continuous 12-in. (300-mm) length of weld.
g. The aggregate length of ESI and ISI indications exceeds 8% of the weld length.

9.3.8.3 For pipe with an outside diameter less than 2.375 in. (60.3 mm), slag inclusions shall be considered a defect should any of the following conditions exist:

a. The length of an ESI indication exceeds three times the thinner of the nominal wall thicknesses joined.

Note: Parallel ESI indications separated by approximately the width of the root bead (wagon tracks) shall be considered a single indication unless the width of either of them exceeds $^1/_{32}$ in. (0.8 mm). In that event, they shall be considered separate indications.

b. The width of an ESI indication exceeds $^1/_{16}$ in. (1.6 mm).
c. The aggregate length of ISI indications exceeds two times the thinner of the nominal wall thicknesses joined and the width exceeds one-half the thinner of the nominal wall thicknesses joined.
d. The aggregate length of ESI and ISI indications exceeds 8% of the weld length.

9.3.9 Porosity

9.3.9.1 Porosity is defined as gas trapped by solidifying weld metal before the gas has a chance to rise to the surface of the molten puddle and escape. Porosity is generally spherical but may be elongated or irregular in shape, such as piping (wormhole) porosity. When the size of the radiographic indication produced by a pore is measured, the maximum dimension of the indication shall apply to the criteria given in 9.3.9.2 through 9.3.9.4.

9.3.9.2 Individual or scattered porosity (P) shall be considered a defect should any of the following conditions exist:

a. The size of an individual pore exceeds $^1/_8$ in. (3 mm).
b. The size of an individual pore exceeds 25% of the thinner of the nominal wall thicknesses joined.
c. The distribution of scattered porosity exceeds the concentration permitted by Figures 19 or 20.

9.3.9.3 Cluster porosity (CP) that occurs in any pass except the finish pass shall comply with the criteria of 9.3.9.2. CP that occurs in the finish pass shall be considered a defect should any of the following conditions exist:

a. The diameter of the cluster exceeds $^1/_2$ in. (13 mm).
b. The aggregate length of CP in any continuous 12-in. (300-mm) length of weld exceeds $^1/_2$ in. (13 mm).
c. An individual pore within a cluster exceeds $^1/_{16}$ in. (2 mm) in size.

9.3.9.4 Hollow-bead porosity (HB) is defined as elongated linear porosity that occurs in the root pass. HB shall be considered a defect should any of the following conditions exist:

a. The length of an individual indication of HB exceeds $^1/_2$ in. (13 mm).
b. The aggregate length of indications of HB in any continuous 12-in. (300-mm) length of weld exceeds 2 in. (50 mm).
c. Individual indications of HB, each greater than $^1/_4$ in. (6 mm) in length, are separated by less than 2 in. (50 mm).
d. The aggregate length of all indications of HB exceeds 8% of the weld length.

9.3.10 Cracks

Cracks (C) shall be considered a defect should any of the following conditions exists:

a. The crack, of any size or location in the weld, is not a shallow crater crack or star crack.
b. The crack is a shallow crater crack or star crack with a length that exceeds $^5/_{32}$ in. (4 mm).

Note: Shallow crater cracks or star cracks are located at the stopping point of weld beads and are the result of weld metal contractions during solidification.

9.3.11 Undercutting

Undercutting is defined as a groove melted into the parent material adjacent to the toe or root of the weld and left unfilled by weld metal. Undercutting adjacent to the cover pass (EU) or root pass (IU) shall be considered a defect should any of the following conditions exists:

a. The aggregate length of indications of EU and IU, in any combination, in any continuous 12-in. (300-mm) length of weld exceeds 2 in. (50 mm).
b. The aggregate length of indications of EU and IU, in any combination, exceeds one-sixth of the weld length.

Note: See 9.7 for acceptance standards for undercutting when visual and mechanical measurements are employed.

9.3.12 Accumulation of Imperfections

Excluding incomplete penetration due to high-low and undercutting, any accumulation of imperfections (AI) shall be considered a defect should any of the following conditions exist:

a. The aggregate length of indications in any continuous 12-in. (300-mm) length of weld exceeds 2 in. (50 mm).
b. The aggregate length of indications exceeds 8% of the weld length.