

# Welding Inspection

Welding Inspection Practical  
Course Reference WIS 5

## Plate . Inspection . Practice

The purpose of this session is to practice the reporting format required by CSWIP in the practical plate examination part of the CSWIP 3.1 Welding Inspectors exam

Remember the responsibilities of a Welding Inspector are:

- **Observe**
- **Report**
- **Compare**

## Observe

To observe welding imperfections you are required to have good close vision acuity

A close vision acuity test will be given to you before your exam to establish if your vision meets the minimum standard required

**Its not just the project that must meet the standard!!**

You will also require a thorough knowledge of welding imperfections and their likely location, causes and implications

## Specialist Welding Gauges

A number of specialist welding gauges are available to measure the various elements that need to be measured in a welded fabrication including

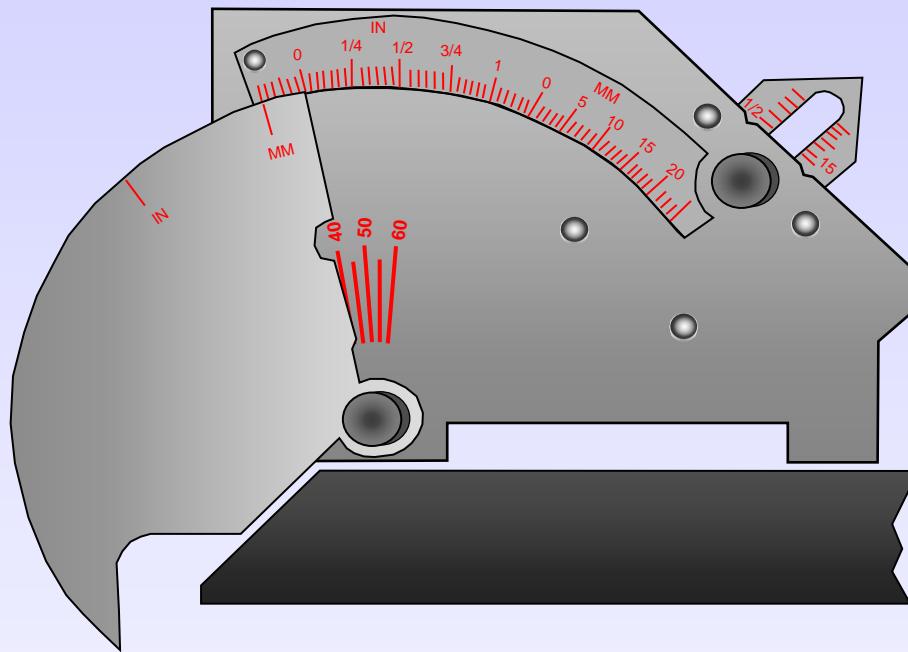
- **TWI Multi-function weld gauge** for measuring many different weld measurements.
- **Fillet weld gauges** for measuring leg lengths and throat thickness.
- **Hi-Lo gauge** for measuring misalignment and root gaps
- **Angle gauges** for measuring weld preparation angles

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## Gauge

WI 3.1



Angle of preparation

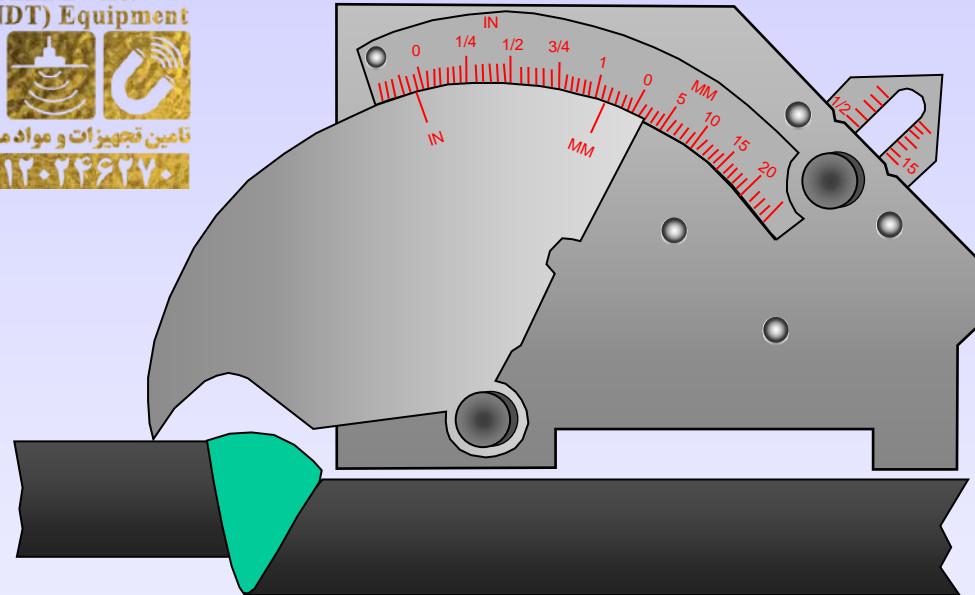
The scale reads from  $0^\circ$  to  $60^\circ$  in steps of  $5^\circ$ .  
The angle is read against the chamfered edge of the segment



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## Gauge

WI 3.1



### Misalignment

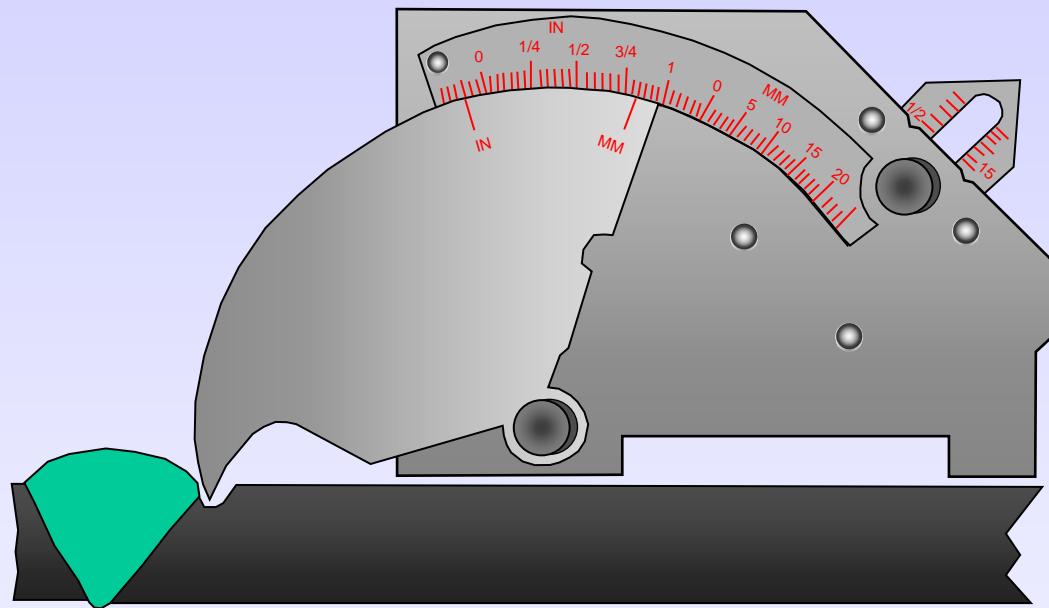
The scale is used to measure misalignment of components by placing the edge of the gauge on the lower one and rotating the segment until the pointer contacts the higher piece

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## Gauge

WI 3.1



### Undercut

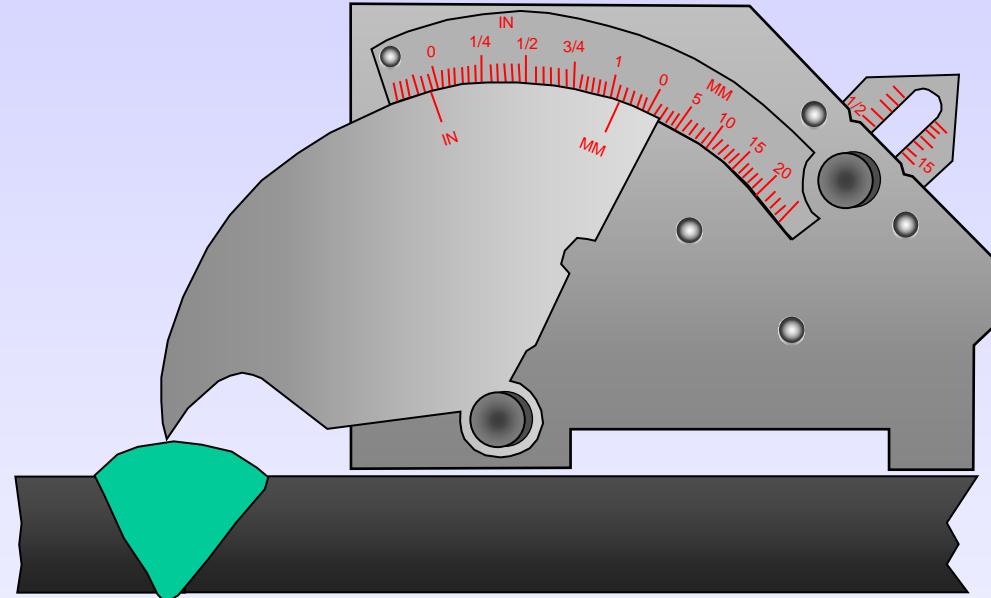
The scale reads from 0 in the negative up to 5m. The segment is rotated until the pointer reaches the full depth of the undercut.

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## Gauge

WI 3.1



Excess weld metal

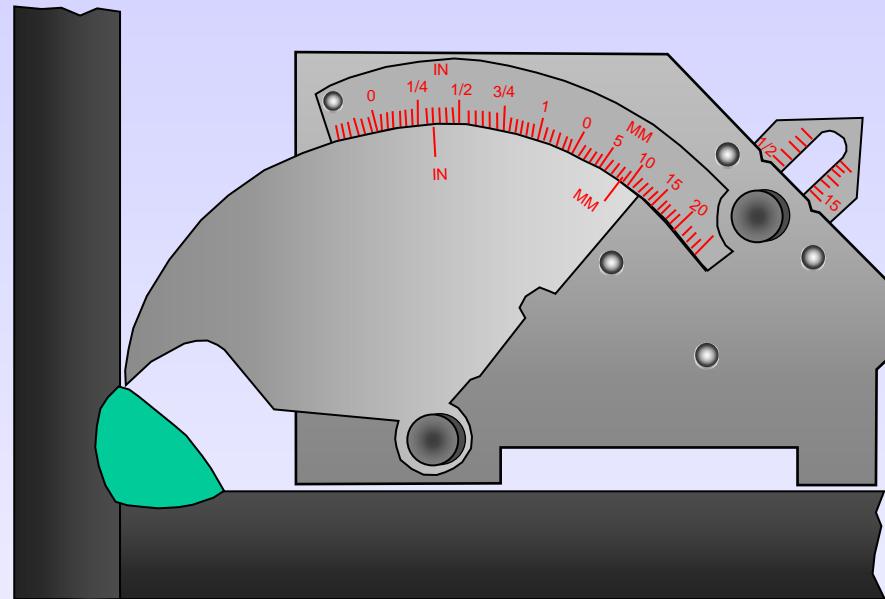
The scale is used to read off these dimensions up to a maximum of 25mm and 1 inch

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## Gauge

WI 3.1



Fillet weld leg length

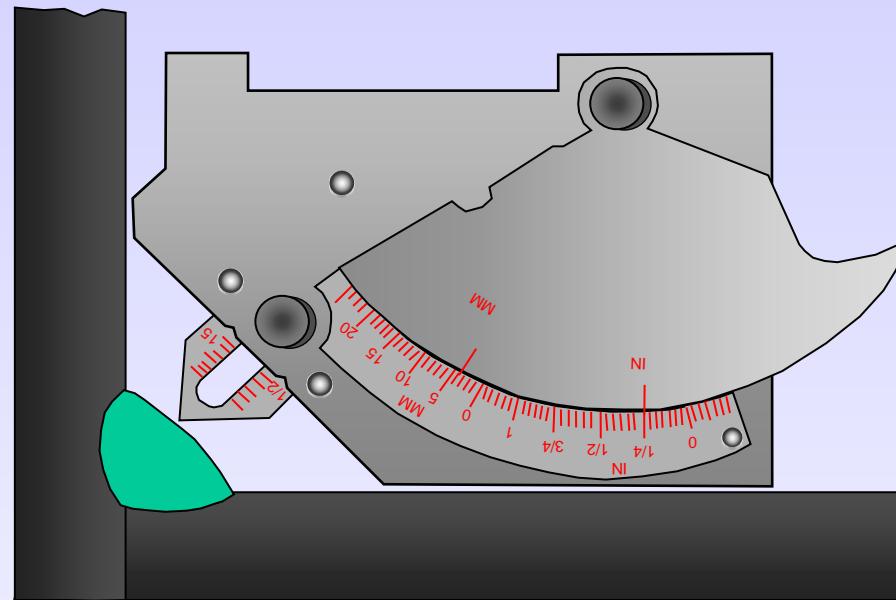
The scale is used to read off these dimensions up to a maximum of 25mm and 1 inch.

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## Gauge

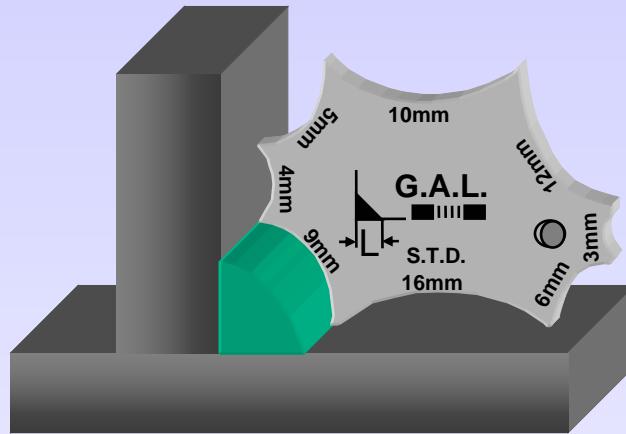
WI 3.1



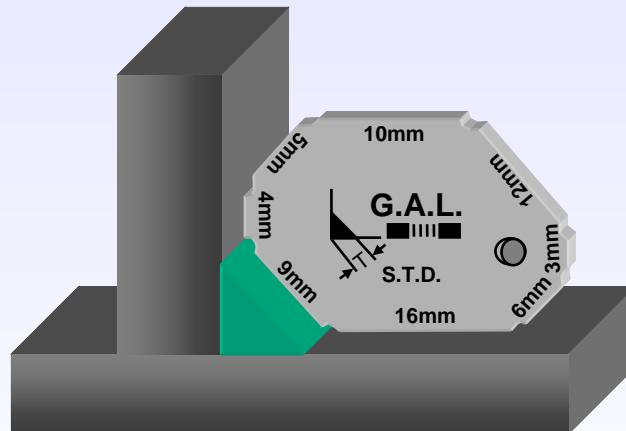
### Fillet throat thickness

The sliding pointer reads up to 20mm and 3/4 inch. In measuring throat thickness it is assumed that the fillet weld has normal root penetration

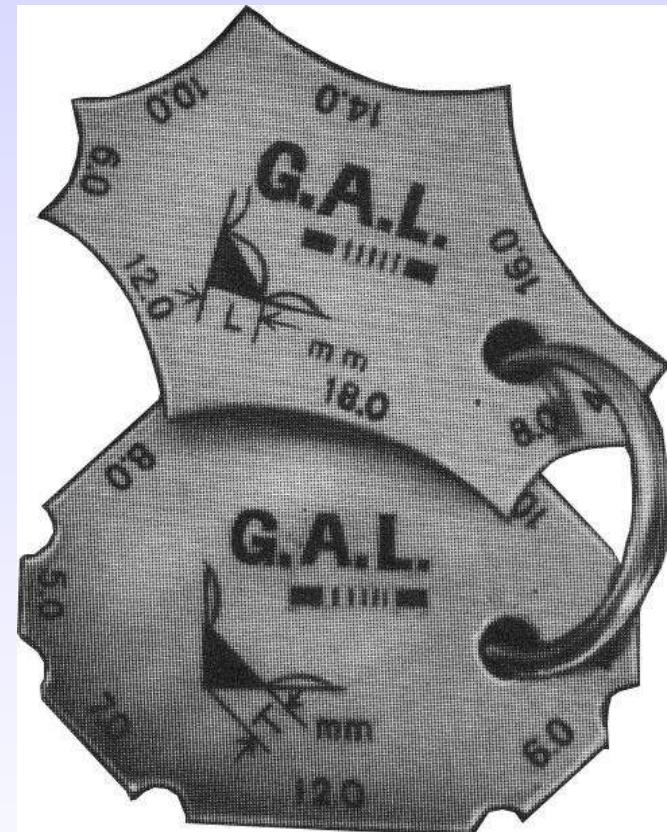
# Fillet Weld Gauges



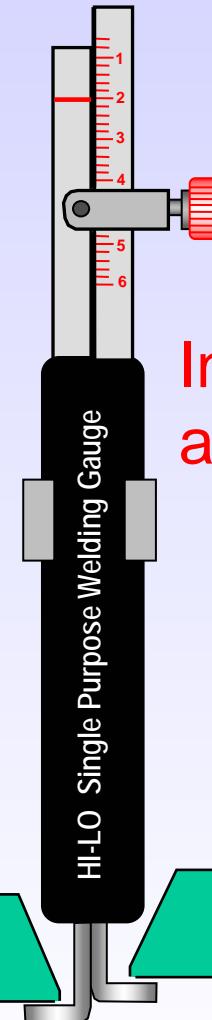
Leg Length Gauge



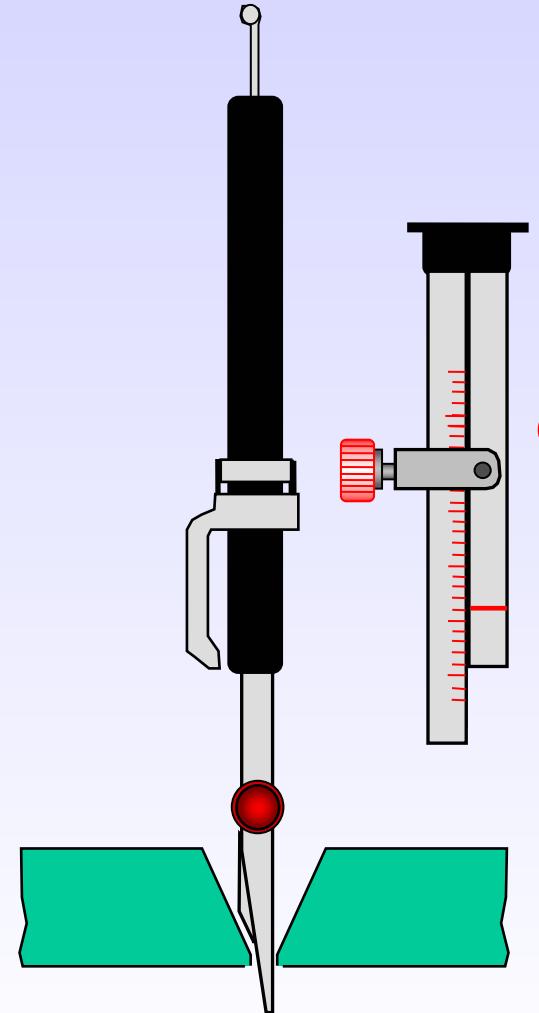
Throat Thickness Gauge



## HI ~ LO Welding Gauge



Internal alignment



Root gap dimension

# Plate ~ Pipe Inspection



## Plate . Inspection . Practice

Remember in the CSWIP 3.1 Welding Inspectors examination you are required to conduct a practical examination of a plate test weld, complete a thumb print sketch and a final report on your findings

- Time allowed 1 hour and 15 minutes
- The code is provided



## Plate . Inspection . Points

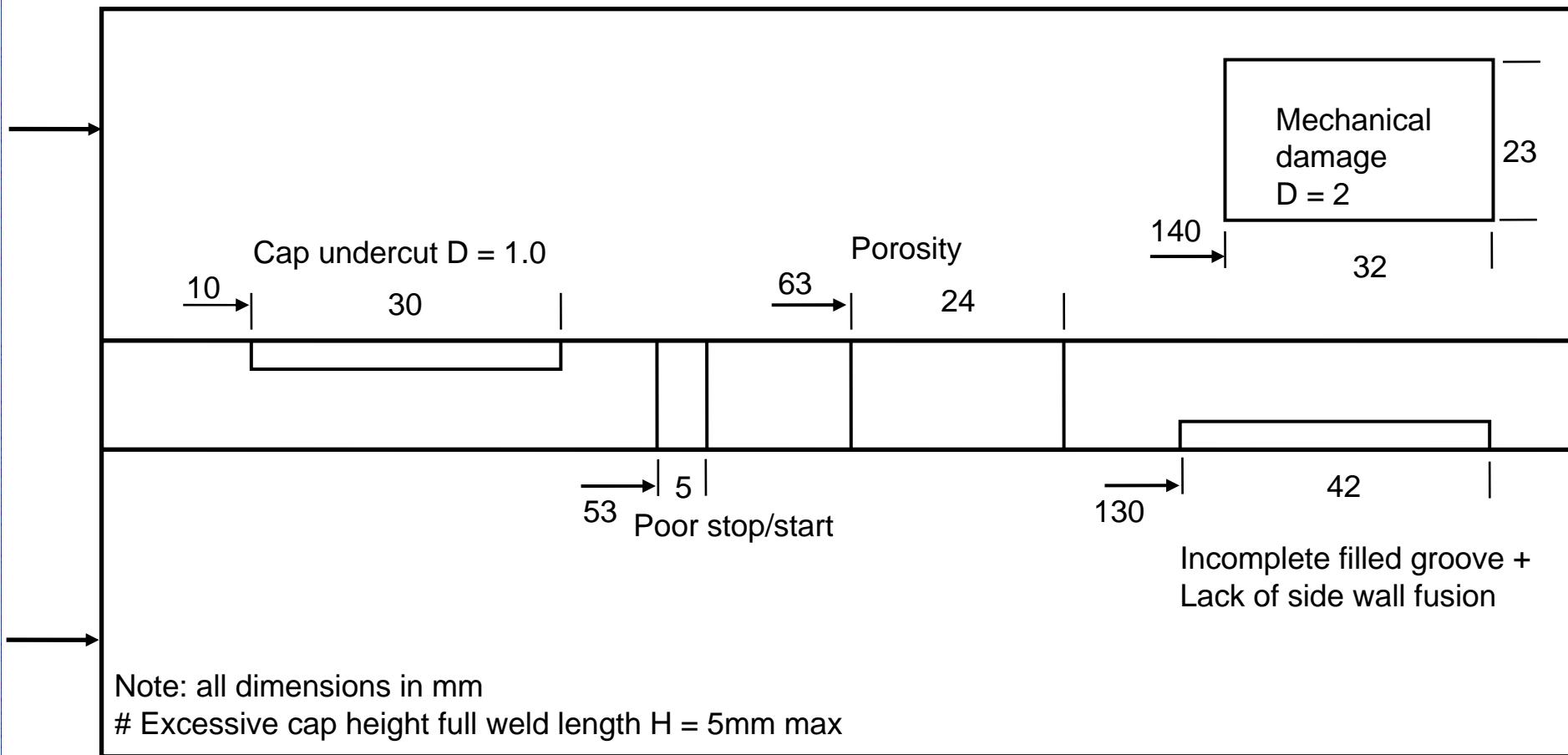
- 1) Use a pencil for the arrow lines, but make all written comments and measurements in **ink only**
- 2) Report **everything** that you can observe
- 3) Do not forget to **compare and sentence** your report
- 4) Do not forget to **date & sign** your report
- 5) Make any observations, such as recommendations for further investigation for crack-like imperfections.

## Thumb . Print . Report . Sketch

After you have observed an imperfection and determined its type, you must be able to take measurements and complete the thumb print report sketch

The first thumb print report sketch should be in the form of a repair map of the weld. (i.e. **All** observations are **Identified Sized and Located**)

The thumb print report sketch used in CSWIP exam will look like the following example.

**Example**Name (Block capitals) Joe BLOGGSSignature Joe BloggsTest piece identification ExampleCode used PH6/WI/00Welding process MMA (SMAW)Joint type Single V ButtWelding position Flat 1G/PALength & thickness L=300mm D = 12.5mmDate 16/07/02

## . Final . Report

After you have completed your thumb print report sketch of your test plate the next step is to complete your final report again the report must be **completed in ink (no pencil).**

The report must be completed to your thumb print sketch, do not leave any boxes empty, **every box must be completed or dashed out.** You must also make any comments you feel are necessary regarding any defects observed.

The report form used in CSWIP will look like the following example.

# Plate.Final.Report.Example

EXTERNAL DEFECTS		Defects Noted	Code or Specification Reference		
Defect Type	Plate/Pipe Section	Accumulative Total	Maximum Allowable	Section No	Accept/Reject
Reinforcement (Height)	<i>A - C</i>	<i>L = 300 H=2.5 max</i>	<i>2.0 mm</i>	<i>14</i>	<i>Reject</i>
Reinforcement (Appear)	<i>A - C</i>	<i>L=300 Not smooth</i>	<i>Smooth</i>	<i>14</i>	<i>Reject</i>
Incomplete filling	<i>A - B</i>	<i>L=24</i>	<i>None</i>	<i>13</i>	<i>Reject</i>
Inadequate weld width	<i>A - C</i>	<i>None</i>	—	—	<i>Accept</i>
Slag Inclusions	<i>A - C</i>	<i>None</i>	—	—	<i>Accept</i>
Undercut	<i>A - B</i>	<i>L=24 D=1.5 sharp</i>	<i>10% t</i>	<i>2</i>	<i>Reject</i>
Surface Porosity	<i>A - C</i>	<i>None</i>	—	—	<i>Accept</i>
Cracks/Cracklike Defect	<i>A - B</i>	<i>L=8mm</i>	<i>None</i>	<i>6</i>	<i>Reject</i>
Lack of fusion	<i>A - C</i>	<i>None</i>	—	—	<i>Accept</i>
Arc Strike	<i>A - B</i>	<i>2 Areas</i>	<i>None</i>	<i>4</i>	<i>Reject</i>
Mechanical Damage	<i>A - B</i>	<i>2 Areas smooth</i>	<i>Seek Advice</i>	<i>15</i>	<i>Refer</i>
Laminations	<i>A - C</i>	<i>None</i>	—	—	<i>Accept</i>
Misalignment	<i>A - C</i>	<i>None</i>	—	—	<i>Accept</i>
Longitudinal Seams	<i>A - C</i>	<i>None</i>	<i>Pipe only</i>	—	<i>Accept</i>

# Plate.Final.Report.Example

## ROOT DEFECTS

Misalignment	<i>A - C</i>	<i>None</i>	—	—	<i>Accept</i>
Excessive Penetration	<i>B - C</i>	<i>L=24 D=2.5mm</i>	<i>2.0 mm</i>	<i>1</i>	<i>Reject</i>
Lack of Penetration	<i>B - C</i>	<i>L=10</i>	<i>25 mm</i>	<i>11</i>	<i>Accept</i>
Lack of Root Fusion	<i>A - C</i>	<i>None</i>	—	—	<i>Accept</i>
Root Concavity	<i>A - C</i>	<i>None</i>	—	—	<i>Accept</i>
Root Undercut	<i>A - B</i>	<i>L= 27 D=0.5 sharp</i>	<i>10% t</i>	<i>2</i>	<i>Accept</i>
Crack/Cracklike Defect	<i>A - C</i>	<i>None</i>	—	—	<i>Accept</i>
Slag Inclusions	<i>A - C</i>	<i>None</i>	—	—	<i>Accept</i>
Porosity	<i>A - C</i>	<i>None</i>	—	—	<i>Accept</i>

This Pipe/plate has been examined to the requirements of [code/specification] .....*BW/VI/00*.....  
 And is accepted/rejected accordingly.

Signature ..... *MSRogers* ..... Date ..... *14/9/02* .....

**Use the other side for comments**

# Pipe . Inspection . Practice

Remember in the CSWIP 3.1 Welding Inspectors examination you are required to conduct a practical examination of a pipe test weld, complete a thumb print sketch and a final report on your findings

- Time allowed 1 hour and 45 minutes
- The code is nominated e.g API 1104



# Pipe.Thumb.Print.Report.

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## Example

WI 3.1

Page 1 of 3

**VISUAL INSPECTION PIPE REPORT****Name [Block capitals]** \_\_\_\_\_ **Signature** \_\_\_\_\_ **Pipe Ident#** \_\_\_\_\_**Code/Specification used** \_\_\_\_\_ **Welding Process** \_\_\_\_\_ **Joint type** \_\_\_\_\_**Welding position** \_\_\_\_\_ **Outside Ø & Thickness** \_\_\_\_\_ **Date** \_\_\_\_\_

A


B

--

C

--

C


D

--

A

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**Complete as per plate report form**

# Pipe . Code : . API . 11 ~ 4

Reinforcement Height:	7.8.2	page 20	Misalignment:	Not referenced
Reinforcement Appear:	7.8.2	page 20	Longitudinal seams:	Not referenced
Incomplete groove:	7.8.2	page 20	Excess penetration:	Not referenced
Inadequate weld width:	7.8.2	page 20	Lack of penetration:	9.3.1/9.3.2 page 21
Slag inclusions:	9.3.8	page 22	Lack of root fusion:	9.3.5 page 21
Undercut:	9.3.11	page 22	Concave root:	9.3.6 page 22
Porosity:	9.3.9	page 24	Burn through:	9.3.7 page 22
Cracks:	9.3.10	page 24		
Lack of fusion:	9.3.4	page 22		
Arc strikes/arc burns:	A.5.3	page 55		
Mechanical damage:	Not referenced			
Lamination:	Not referenced			

# Macro Inspection



## Macro . Inspection . Practice

Remember in the CSWIP 3.1 Welding Inspectors examination your are required to conduct a visual examination of two macro samples

- Time allowed 45 minutes
- Code ISO 5817 Level stringent B



# Marco Inspection.

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## Instructions

WI 3.1

### **PLEASE READ CAREFULLY**

You have been provided with one or two macro samples and the report sheets you are required to complete the following

1. Ensure that you record your name and the date on the report sheet
2. Ensure that you sign the report sheet
3. Visually inspect the specimens and report:  
The defects type  
The defects size, length, depth and height if applicable
4. Comment on each defect e.g accept, reject or refer in accordance with  
**ISO 5817 stringent B**

ALL LINE DRAWING & WRITING MUST BE COMPLETED IN INK

ALL MEASUREMENT IN MM / **PHOTOGRAPH AT 10X MAGNIFICATION.**

DIVDE ALL MEASUREMENTS BY 10 AND RECORD ON REPORT PROVIDED

NO LIQUID PAPER OR CORRECTION FLUID PERMITTED. CORRECTIONS MUST BE CROSSED OUT AND THE CORRECTION MADE

**TIME ALLOWED FOR TWO MARCS 45 MINUTES**

### 3.2 Weld thickness

**3.2.1 fillet weld thickness,  $a$ ; nominal throat thickness:** Height of the largest isosceles triangle that can be inscribed in the weld section (see ISO 2553).

NOTE 1 In countries in which the leg length,  $z$ , is used as the dimension of a fillet weld, the limits for imperfections may be reformulated so that they refer to the leg length.

**3.2.2 butt weld thickness,  $s$ :** Minimum distance from the surface of the part to the bottom of the penetration, which cannot be greater than the thickness of the thinner of the parts (see ISO 2553).

**3.3 short imperfections:** One or more imperfections of total length not greater than 25 mm in any 100 mm length of the weld or a maximum of 25 % of the weld length for a weld shorter than 100 mm.

**3.4 long imperfection:** One or more imperfections of total length greater than 25 mm in any 100 mm length of the weld or a minimum of 25 % of the weld length for a weld shorter than 100 mm.

**3.5 projected area:** Area given by length of weld examined multiplied by the maximum width of weld.

**3.6 surface crack area:** Area to be considered after fracture.

### 4 Symbols

The following symbols are used in table 1.

- $a$  nominal fillet weld throat thickness (fillet thickness)
- $b$  width of weld reinforcement
- $d$  diameter of pore
- $h$  size (height or width) of imperfection
- $l$  length of imperfection
- $s$  nominal butt weld thickness or, in the case of partial penetration, the prescribed depth of penetration
- $t$  wall or plate thickness
- $z$  leg length of fillet welds (in case of isosceles right angle triangular section  $z = a\sqrt{2}$ )

### 5 Evaluation of welds

Limits for imperfections are given in table 1.

A welded joint should normally be evaluated separately for each individual type of imperfection (Nos. 1 to 25).

Different types of imperfection occurring at any cross-section of the joint may need special consideration (see No. 26).

Maximum pore diameter 3mm or  
pore diameter shall be less than or  
equal to 0.3 X plate thickness

Table 1 – Limits for imperfections

No.	Imperfection designation	ISO 5520 reference	Remarks	Limits for imperfections for quality levels		
				Moderate D	Intermediate C	Stringent B
1	Cracks	100	All types of cracks except micro cracks ( $d \leq 0.1 \text{ mm}^2$ ), crater cracks, etc.			Not permitted
2	Crater crack	104		Permitted		Not permitted
3	Porosity and gas pores	2011 2012 2014 2017	<p>The following conditions and limits for imperfections shall be fulfilled:</p> <p>Maximum dimension of the summation of the projected or surface crack area of the imperfection</p> <p>b) Maximum dimension of a single pore for</p> <ul style="list-style-type: none"> <li>– butt welds</li> <li>– fillet welds</li> </ul> <p>c) Maximum dimension for a single pore</p>		2 % $d \leq 0.4 \text{ s}$ 0.5 $\sigma$ 5 mm	1 % $d \leq 0.3 \text{ s}$ 0.3 $\sigma$ 3 mm
4	Localized (clustered) porosity	2013	<p>The total pore area within the cluster should be summed and calculated as a percentage of the greater of the two areas: an envelope surrounding all the pores or a circle with a diameter corresponding to the weld width.</p> <p>The permitted porous area should be local. The possibility of masking other imperfections should be taken into consideration.</p> <p>The following conditions and limits for imperfections shall be fulfilled:</p> <p>a) Maximum dimension of the summation of the projected or surface crack area of the imperfection</p> <p>b) Maximum dimension of a single pore for</p> <ul style="list-style-type: none"> <li>– butt welds</li> <li>– fillet welds</li> </ul> <p>c) Maximum dimension for localized clustered porosity</p>	16 % $d \leq 0.5 \text{ s}$ 0.5 $\sigma$ 4 mm	8 % $d \leq 0.4 \text{ s}$ 0.4 $\sigma$ 3 mm	4 % $d \leq 0.3 \text{ s}$ 0.3 $\sigma$ 2 mm

M. S. Rogers

Acceptance levels B,C,D  
For the CSWIP 3.1 exam  
stringent B

# ISO 5817. Exercise

- Using ISO 5817 determine the acceptability of the defects listed. Under the column headed specimen thickness, insert A,R and X
- Use the acceptance category stringent B when making your assessment assume specimens to be plate butt welds

**A = Accept**

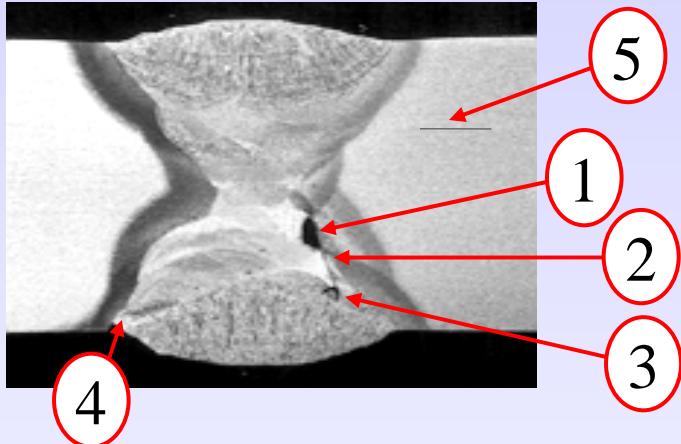
**R = Reject**

**X = Refer**

		Specimen Thickness(mm)			
Defect	Dimensions	8	15	30	60
Overlap	H = 1.5	R	R	R	R
Incomplete penetration	L = 2.0	R	R	R	R
Lack of sidewall fusion	L = 2.0	R	R	R	R
Gas pore	D = 2.5	R	A	A	A
Slag inclusion	1.0 x 2.0	A	A	A	A
Elongated cavity	0.5 x 1.5	A	A	A	A
Linear misalignment	H = 1.8	R	R	A	A
Cap undercut	D = 0.4	A	A	A	A
Crack	L = 1.5	R	R	R	R
Spatter	D = 1.8	X	X	X	X

# Marco . Report . Example

CHECK PHOTOGRAPH IDENT MATCHES FORM SUPPLIED. **ALL LINE DRAWING & WRITTING MUST BE IN INK.** ALL MEASUREMENTS IN MM / PHOTOGRAPH AT X10 MAGNIFICATION



RECORD DEFECTS AS YOU SEE THEM  
THESES MACROS HAVE BEEN MASTERED FROM  
THE PHOTOGRAPHS

INTERPRETATION DIFFICULTIES HAVE BEEN  
 RECORDED.

**COMMENT ONLY IF A DEFINITE UNCERTAINTY  
 EXISTS: i.e SLAG/GAS IN SOME CASES**

	DEFECT	SIZE	ACCEPT/REJECT
1	Lack of sidewall fusion + Slag	3 x 4 mm	Reject
2	Lack of sidewall fusion	3 mm	Reject
3	Slag inclusion	1.5 mm	Accept
4	Cap undercut	0.5 mm	Accept
5	Plate lamination	5.2 mm	Refer*
6			
7			
8			
10			
11	<b>Excess weld metal</b>	4 mm	Reject
12	<b>Excess root penetration</b>	None	Accept

**COMMENTS:** \*Materials  
 defect acceptance  
 dependent on application.  
 Seek advice.

**Name:** Mark Rogers

**Signature:** M S Rogers

**Date:** 20/03/03

# Any . Questions

