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No Perfect Weld

A technical approach to assessment of weld faults

Objectives

1. Review: Weld Faults, Discontinuities, Defects
2. Examine: Weld Service Requirements
3. Introduce: The Human Factor
4. Describe: ISO 5817 (2014)
5. Apply: Case Study - Technical Assessment of Excessive Weld Reinforcement

No Perfect Welds

- As the saying goes, there are “no perfect welds”, that is, weld faults are inevitable in welded products.
- There are about 26 types of weld faults for different welding processes, and for different weld joint designs.
- Weld faults can be found on the surface of the weld, inside the weld, or even in the HAZ.

What is a Weld Fault?

- A weld fault can be generally defined as any deficient quality of a weld.

https://education.lincolnelectric.com/materials-equipment/training-materials/posters-decals/

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Types of Weld Faults

- Weld faults fall into three categories:

    1. Dimensional (size, shape, type)
    2. Structural (voids, inclusions)
    3. Defective Properties (strength, toughness)

- Weld faults can be further categorized as:

    - Discontinuities
    - Defects

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Discontinuity

- An interruption of the typical structure of a material, such as a lack of homogeneity in mechanical, metallurgical, or physical characteristics.

- A discontinuity is not necessarily a defect.

https://www.galgage.com/measuring_pits.html

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Defect

- A discontinuity or discontinuities that by nature or accumulated effect render a part or product unable to meet minimum applicable quality Standards.
- The term designates rejectability.

https://www.sentara.com/hampton-roads-virginia/healthwellness/data/blogs/thumbs-down-to-arthritis.aspx

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Nature vs. Accumulation

- Weld defects by nature are not permitted:

Cracks are not permitted.

- Weld defects by accumulation exhibit a threshold limit:

Weld reinforcement shall not exceed 3 mm.

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Service Requirements

- Understanding the relationship between service requirements and weld fault assessment is essential:
  - Every Code or Standard has an intended use (scope).
  - This scope is almost always applied to a specific product classification, designed to be used in a specific service.
  - The same weld fault could be considered a discontinuity in one Standard, defect in another.

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Fitness-for-Purpose

- Fitness-for-Purpose describes the ability of a product, process, or service to serve a defined purpose under specific conditions.

"Something that is fit for purpose is good enough to do the job it was designed to do."

https://www.macmillandictionary.com/dictionary/british/fit-for-purpose

Example

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Technical Assessment Challenge

- Question 1:

How do we consistently and fairly apply values to discontinuities in welds produced by students?

- Question 2:

How do we consistently and fairly set discontinuity-to-defect limits in welds produced by students?

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The Human Factor

- These are all factors that can affect an individual's performance:
  - Lack of Communication
  - Complacency
  - Lack of Knowledge
  - Distraction
  - Lack of Teamwork
  - Fatigue
  - Lack of Resources
  - Pressure
  - Lack of Assertiveness
  - Stress
  - Lack of Awareness
  - Norms

https://www.tc.gc.ca/media/documents/ca-standards/hpf_elementary.pdf

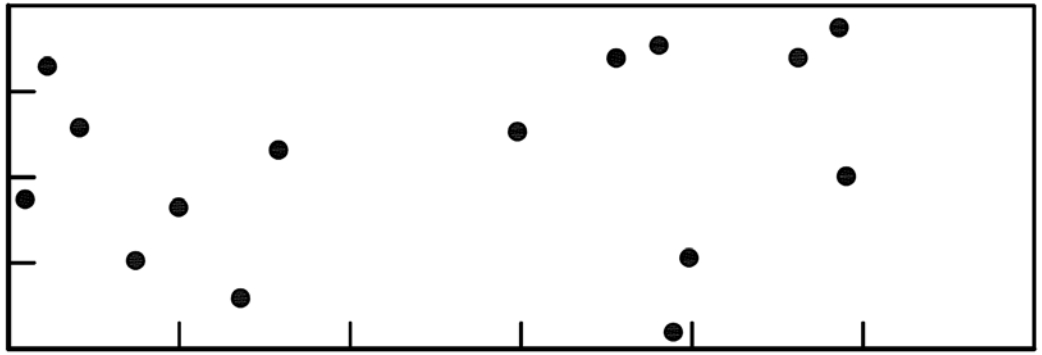
Weld Quality Level

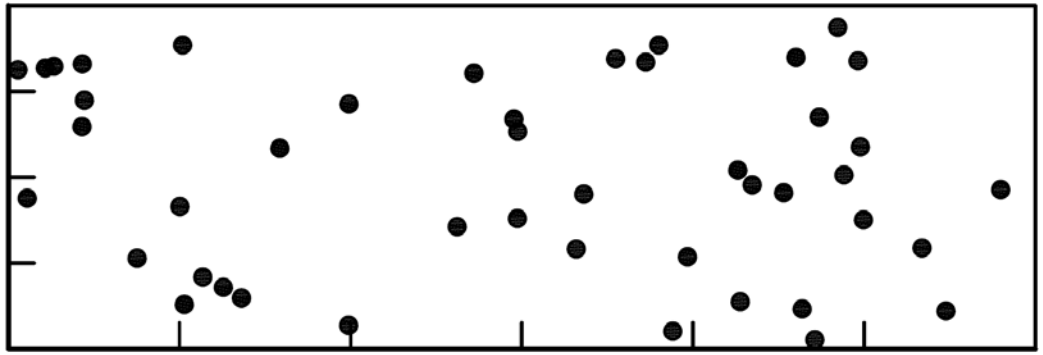
- To properly assess the workmanship of students, we must first determine a quality level sufficient for practical examinations.

- The quality level selected for welding students in Canada must be consistent and independent of existing Codes or Standards.

Weld Quality Level

- Weld quality level is the description of the quality of a weld on the basis of type, size, and amount of selected imperfections.





Assigning Weld Quality Level

- The choice of quality level for any application should account for:
  - Design Considerations
  - Subsequent Processing
  - Mode of Stressing
  - Service Conditions
  - Consequences of Failure
  - Economic Factors

Existing Standards

- Codes and Standards govern almost every welded product in Canada.

- With mobility and Red Seal top-of-mind, it would be a disadvantage to students if one Industry Standard (quality level) was to govern weld fault assessments.

Red Seal

"Welders may specialize in certain types of welding such as custom fabrication, ship building and repair, aerospace, pressure vessels, pipeline, structural welding, and machinery and equipment repair."

http://www.red-seal.ca/trades/weld/2014n.4.1_01_.4v.2rv.3.2w-eng.html

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Technical Assessment Solution

- Possible Solution:

Adopt a recognized general Standard for assessment of weld quality under normal welding conditions.

Use this Standard to guide assessment of workmanship for welds produced by students.

ISO 5817

- ISO 5817 is an excellent Standard for assigning basic quality levels to weld faults.

- The Standard is designed to be used as a reference in the drafting of application Codes and/or other application Standards.

Standard to develop Standards

Why ISO 5817?

1. ISO 5817 contains a simplified selection of weld faults.
2. The document scope includes both full-penetration groove and fillet welds.
3. Quality levels are not specifically related to any particular application (service requirement).
4. The Standard is widely adopted Internationally (34 Countries)
5. The Standard is directly applicable to visual testing of welds (no supplemental NDT required).

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ISO 5817 Weld Quality Levels

- ISO 5817 provides three general weld quality levels:
  - B (highest quality)
  - C (average quality)
  - D (lowest quality)

https://goodcleanersfinder.nl/

Example

- Excessive Weld Reinforcement

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Example

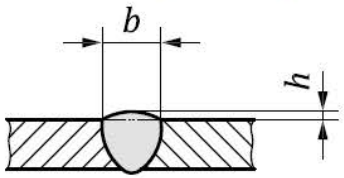
- Current State:
  - CWBA Rubric and Individual Student Report Card:

Excessive Reinforcement: /10 No underfill is permitted= zero pts.

Reinforcement greater than 3mm (1/8) constitutes failure of complete assembly.

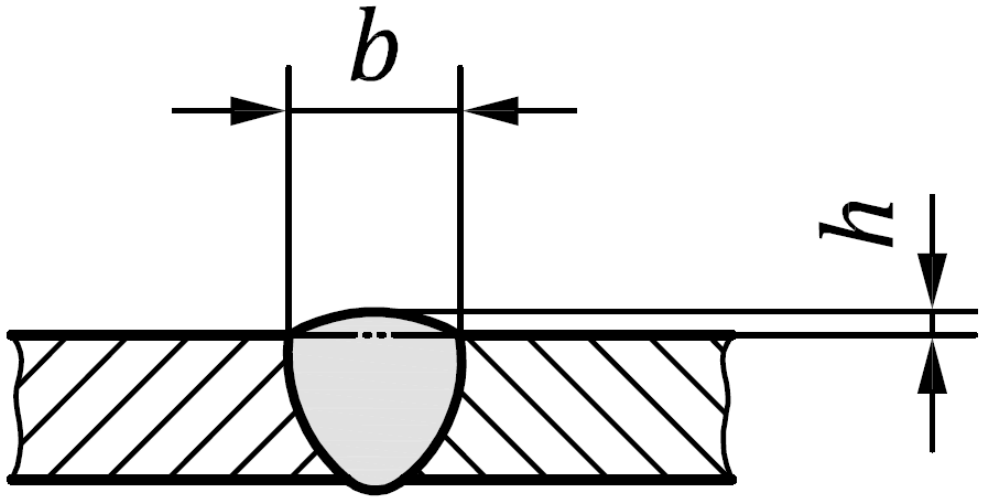
Example

- Possible Annex or Additional Criteria:
  - ISO 5817 – Table 1, Surface Imperfections:

No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
1.9	502	Excess weld metal (butt weld)	Smooth transition is required. 	≥ 0,5	$h \leq 1$ mm + 0,25 b, but max. 10 mm	$h \leq 1$ mm + 0,15 b, but max. 7 mm	$h \leq 1$ mm + 0,1 b,but max. 5 mm

Example

- F3/F4 SMAW Groove Weld on Plate, where:
  - h = 10 mm
  - b = 15 mm



Solution

- Current State:

  - Reinforcement > 3 mm = Defect — Defect

- Possible State:

  - B: $h \leq 1\ \text{mm} + 0.1\ b$ or 2.5 mm
  - C: $h \leq 1\ \text{mm} + 0.15\ b$ or 3.25 mm
  - D: $h \leq 1\ \text{mm} + 0.25\ b$ or 4.75 mm

  } Discontinuity Values

Defect

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Technical Assessment

- Possible Assessment:

• B:	≤ 2.5 mm	10/10	Discontinuity Values
• C:	≤ 3.25 mm, > 2.5 mm	7/10	
• D:	≤ 4.75 mm, > 3.25 mm	5/10	

Defect

*Remember, this is a 10-point scale***

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Technical Assessment Result

- We consistently and fairly applied values to discontinuities in welds produced by students.
- We consistently and fairly set discontinuity-to-defect limits in welds produced by students.
- We have reduced the effect of the Human Factor.
- We have a marking rubric that is based on an Internationally recognized Standard.

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Thank You!

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