Welding Inspection and Metallurgy

焊接检验与冶金

2014年内部培训

Charlie Chong/Fion Zhang

API 577 – Advanced Welding Inspection & Metallurgy Professional Program

API welcomes highly specialized inspectors, welding engineers, metallurgists and other professionals across the entire petrochemical industry to obtain this certification as a validation of their profound knowledge of welding processes and metallurgy.

Completely optional, yet adding significant value to your professional credentials – it will show your employers and clients that you have obtained a high level of proficiency and understanding in this important field.

API 577 certification is valid for a three-year term.

The Initial Application

Qualification Requirements

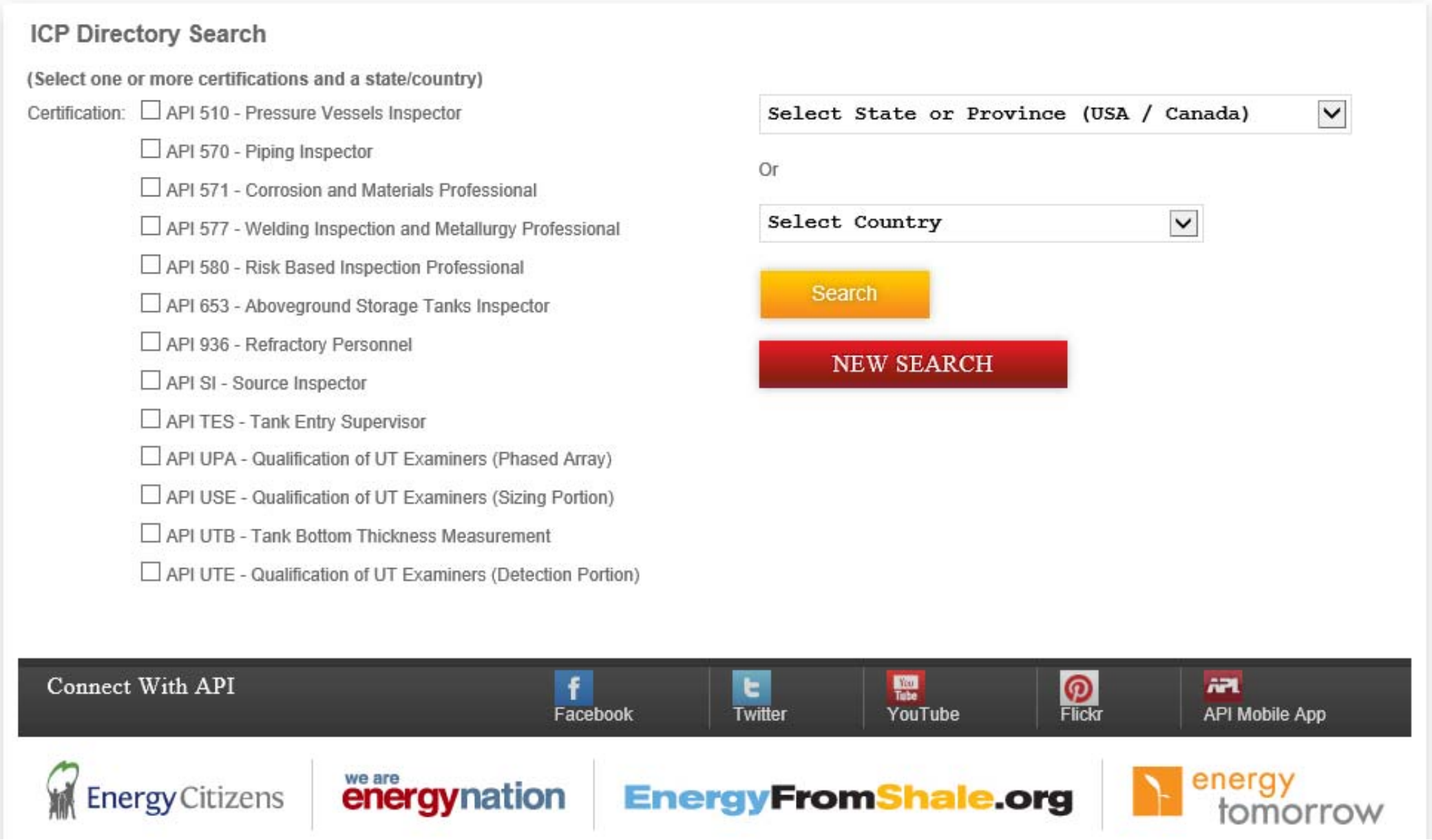
Exam Information (Including Body of Knowledge)

Purchasing Publications

Recertification

Recertification Requirements

http://www.api.org/certification-programs/individual-certification-programs-icp/icp-certifications/api-577



http://myicp.api.org/DirectorySearch/Search.aspx

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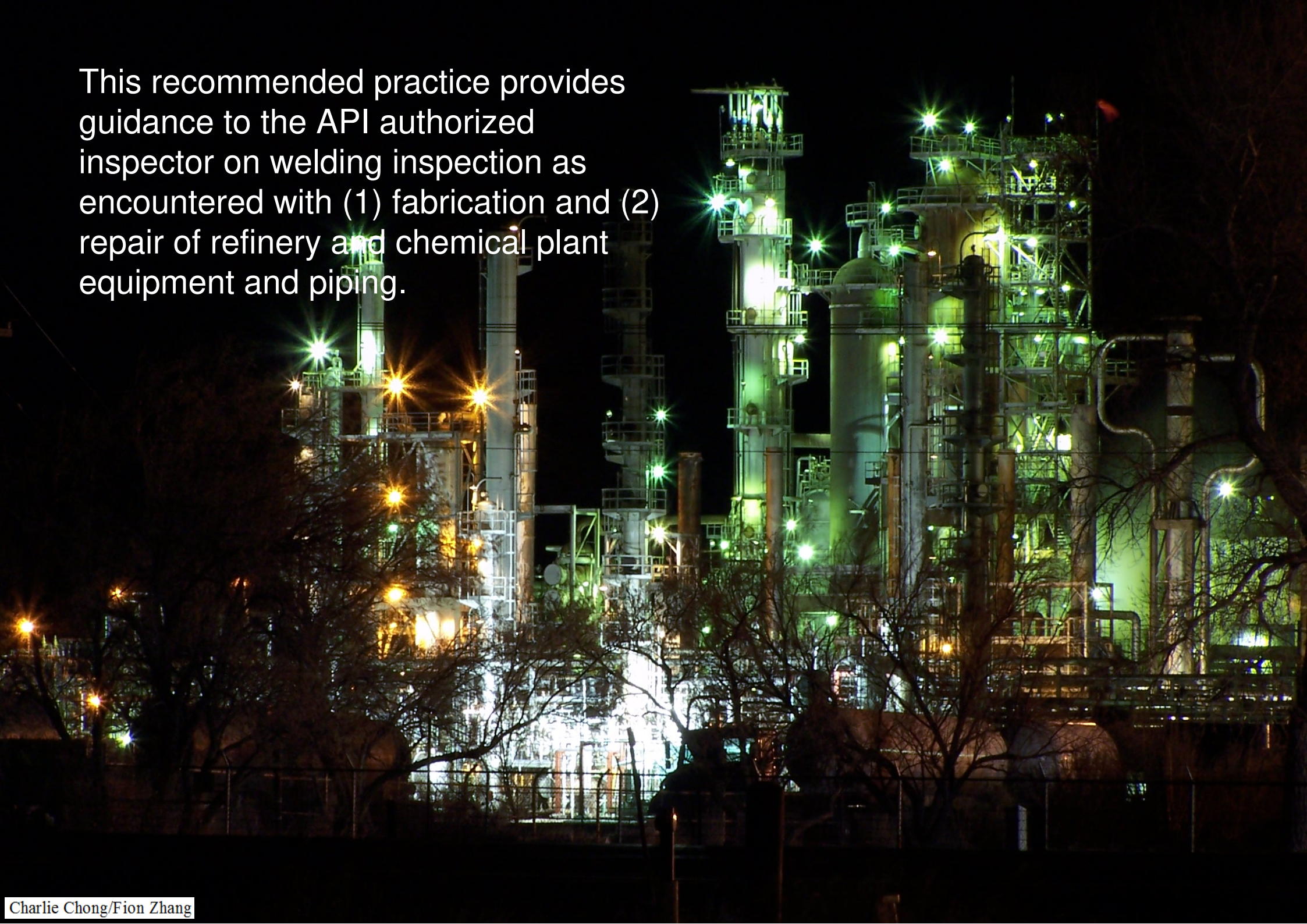
This recommended practice provides guidance to the API authorized inspector on welding inspection as encountered with (1) fabrication and (2) repair of refinery and chemical plant equipment and piping.
Charlie Chong/Fion Zhang

Charlie Chong/Fion Zhang

印度支那不就是 “Indo-China” 吗?, 中华人民共和国 不就是 “People Republic of China”. 这 “China” 或 “支那” 不是歧视字眼.“支那”是个威震四方的大国,以前郑和下西洋的“支那“这是闻之丧胆字眼,现在我们也不渐渐变成”强大支那”了吗?. 小的时候(40年前),友族,善意的叫我“中华人”,我很善意的告诉他,我叫“支那人”,虽然我只是东南亚华裔,但我永远以“支那-China" 引以为荣. 我爱中国,我爱 "China" 我爱"支那".

http://news.ifeng.com/world/detail_2014_03/20/34944726_0.shtml

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TODAY

Speaker: Fion Zhang
2014/5/4

1 Scope

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This recommended practice provides guidance to the API authorized inspector on welding inspection as encountered with fabrication and repair of refinery and chemical plant equipment and piping. Common welding processes, welding procedures, welder qualifications, metallurgical effects from welding, and inspection techniques are described to aid the inspector in fulfilling their role implementing API 510, API 570, API Std 653 and API RP 582. The level of learning and training obtained from this document is not a replacement for the training and experience required to be an American Welding Society (AWS) Certified Welding Inspector (CWI).

This recommended practice provides guidance to the API authorized inspector on welding inspection as encountered with (1) fabrication and (2) repair of refinery and chemical plant equipment and piping.

- Common welding processes,
- welding procedures,
- welder qualifications,
- metallurgical effects from welding, and
- inspection techniques

are described to aid the inspector in fulfilling their role implementing API 510, API 570, API Std 653 and API RP 582.

This recommended practice provides guidance to the API authorized inspector on welding inspection as encountered with fabrication and repair of (a) refinery and (b) chemical plant equipment and piping.


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NOTI
Charlie Chong/Fion Zhang


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Charlie Chong/Fion Zhang

Pressure Vessel Inspection Code: In-Service Inspection, Rating, Repair, and Alteration

API 510
NINTH EDITION, JUNE 2006

Role implementing

Charlie Chong/ Fion Zhang

API 570

Piping Inspection Code: In-service Inspection, Repair, and Alteration of Piping Systems, Third Edition

standard published 11/01/2009 by American Petroleum Institute

Role implementing

Charlie Chong/ Fion Zhang

API Std 653

Tank Inspection, Repair, Alteration, and Reconstruction, Fourth Edition, Includes Addendum 1 (2010), Addendum 2 (2012), Addendum 3 (2013)

Role implementing

Charlie Chong/ Fion Zhang

API RP 582

Recommended Practice Welding Guidelines for the Chemical, Oil, and Gas Industries

standard published 11/01/2009 by American Petroleum Institute

Role implementing

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How this API Standard relates with Exploration and Production (E&P) ?

Charlie Chong/ Fion Zhang

API 510: Petroleum E&P Exploration and Production

SECTION 8—ALTERNATIVE RULES FOR EXPLORATION AND PRODUCTION PRESSURE VESSELS

8.1 SCOPE AND SPECIFIC EXEMPTIONS

This section sets forth the minimum alternative inspection rules for pressure vessels that are exempt from the rules set forth in Section 6 except as referenced in paragraphs 8.4 and 8.5. Except for Section 6, all of the sections in this inspection code are applicable to Exploration and Production (E&P) pressure vessels. These rules are provided because of the vastly different characteristics and needs of pressure vessels used for E&P service. Typical E&P services are vessels associated with drilling, production, gathering, transportation, and treatment of liquid petroleum, natural gas, natural gas liquids, and associated salt water (brine).

The following are specific exemptions:

a. Portable pressure vessels and portable compressed gas

8.2.3 Section 8 vessel: A pressure vessel which is exempted from the rules set forth in Section 6 of this document.

8.3 INSPECTION PROGRAM

Each owner or user of Section 8 vessels shall have an inspection program that will assure that the vessels have sufficient integrity for the intended service. Each E&P owner or user shall have the option of employing, within the limitations of the jurisdiction in which the vessels are located, any appropriate engineering, inspection, classification, and recording systems which meet the requirements of this document.

8.3.1 On-Stream or Internal Inspections

a. Either an on-stream inspection or an internal inspection may be used interchangeably to satisfy inspection require-

API 510:

8.1 SCOPE AND SPECIFIC EXEMPTIONS

This section sets forth the minimum alternative inspection rules for pressure vessels that are exempt from the rules set forth in Section 6 except as referenced in paragraphs 8.4 and 8.5. Except for Section 6, all of the sections in this inspection code are applicable to Exploration and Production (E&P) pressure vessels. These rules are provided because of the vastly different characteristics and needs of pressure vessels used for E&P service. **Typical E&P services are vessels associated with drilling, production, gathering, transportation, and treatment of liquid petroleum, natural gas, natural gas liquids, and associated salt water (brine).**

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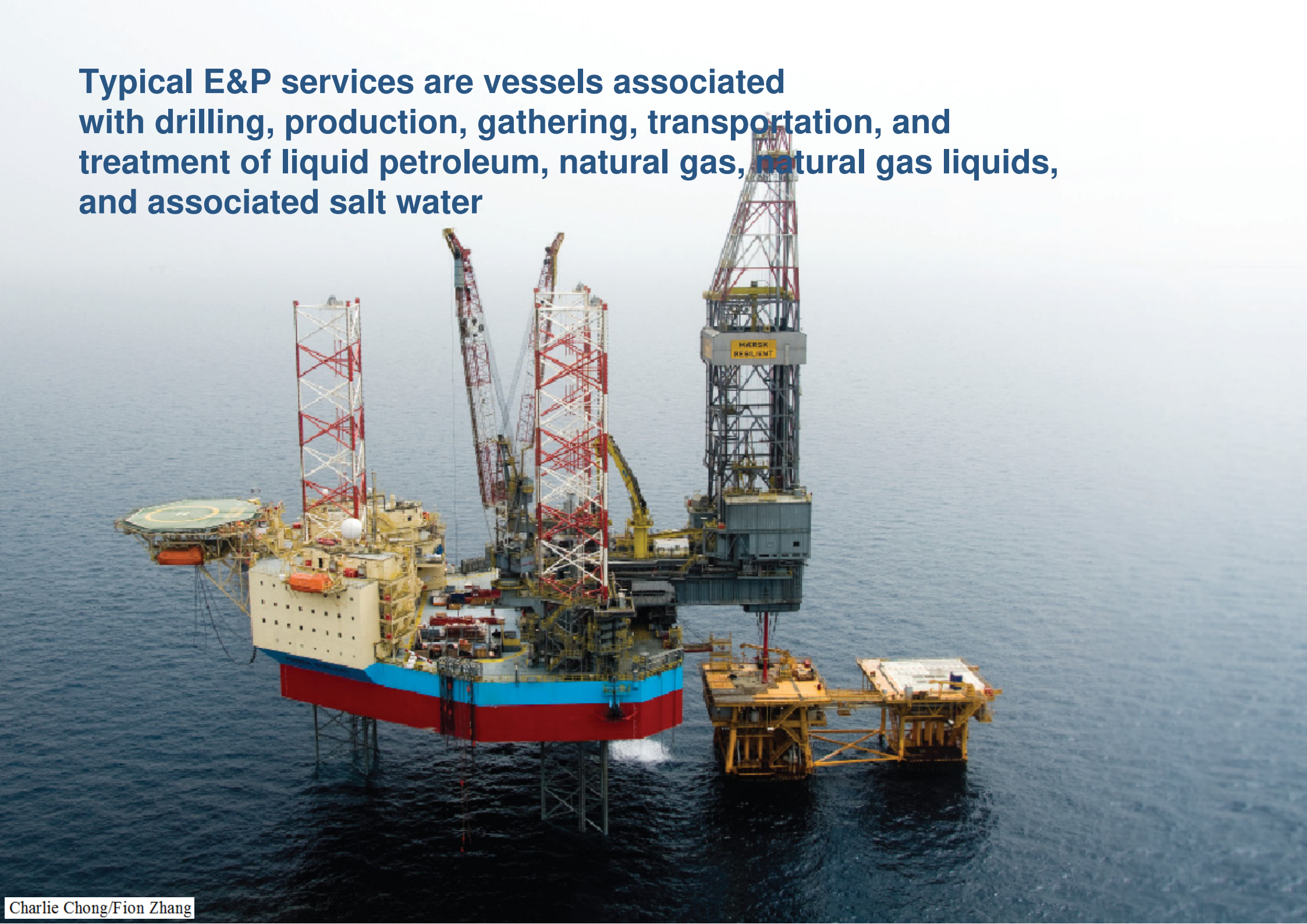

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Typical E&P services are vessels associated with drilling, production, gathering, transportation, and treatment of liquid petroleum, natural gas, natural gas liquids, and associated salt water

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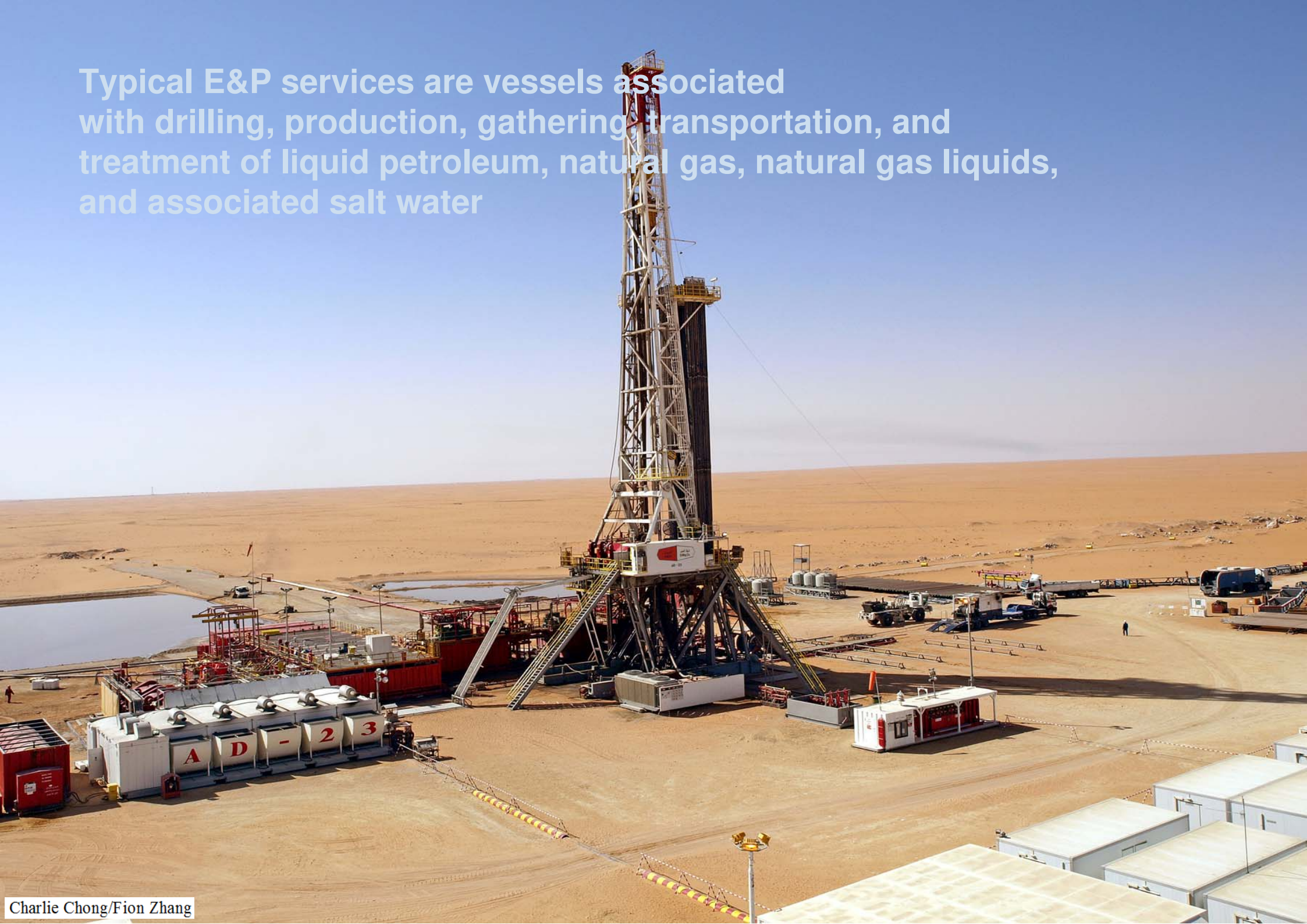
Typical E&P services are vessels associated with drilling, production, gathering, transportation, and treatment of liquid petroleum, natural gas, natural gas liquids, and associated salt water
A D - 2 3
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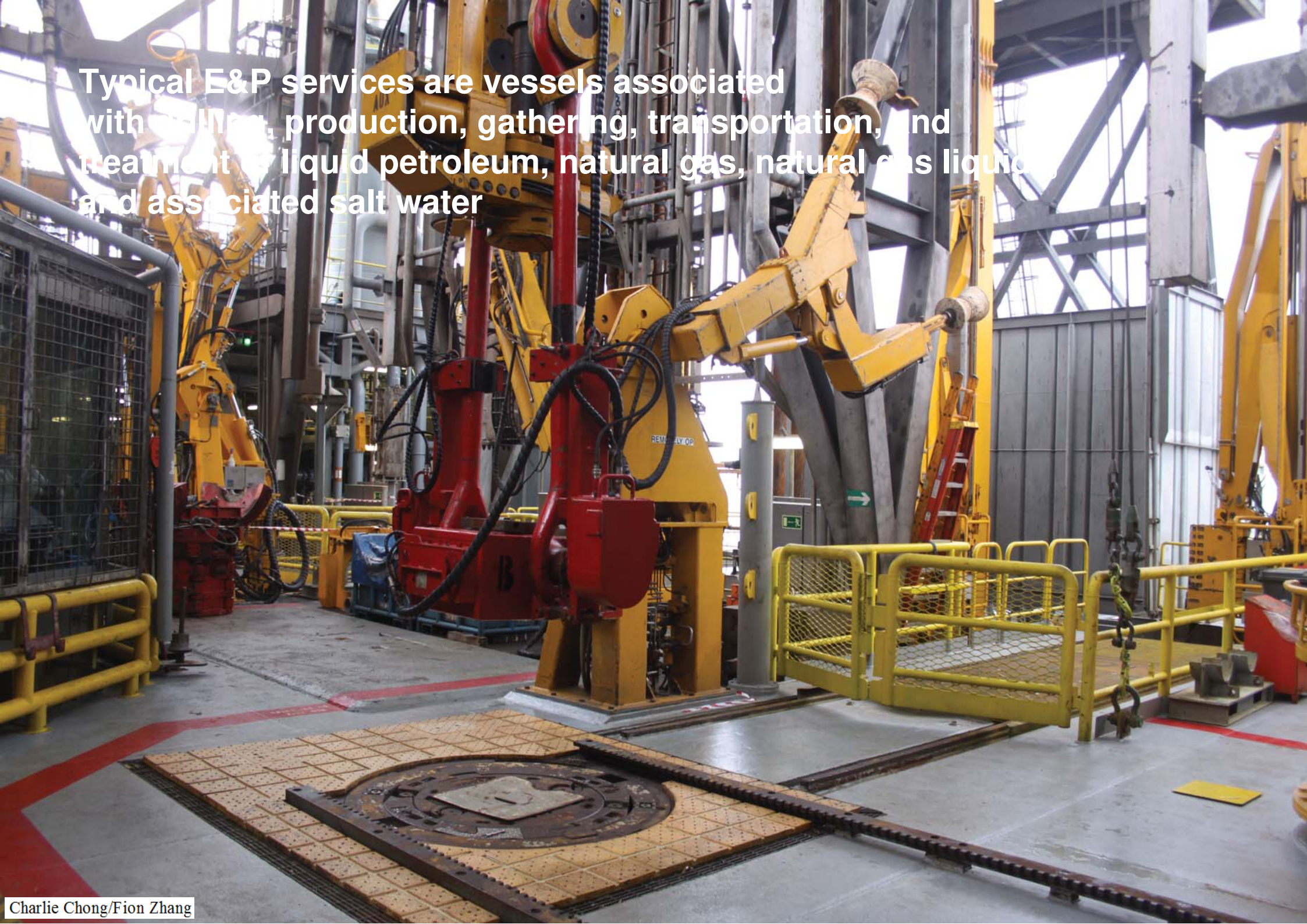
Typical E&P services are vessels associated
with drilling, production, gathering, transportation, and
treatment of liquid petroleum, natural gas, natural gas liquids,
and associated salt water
Charlie Chong/Fion Zhang



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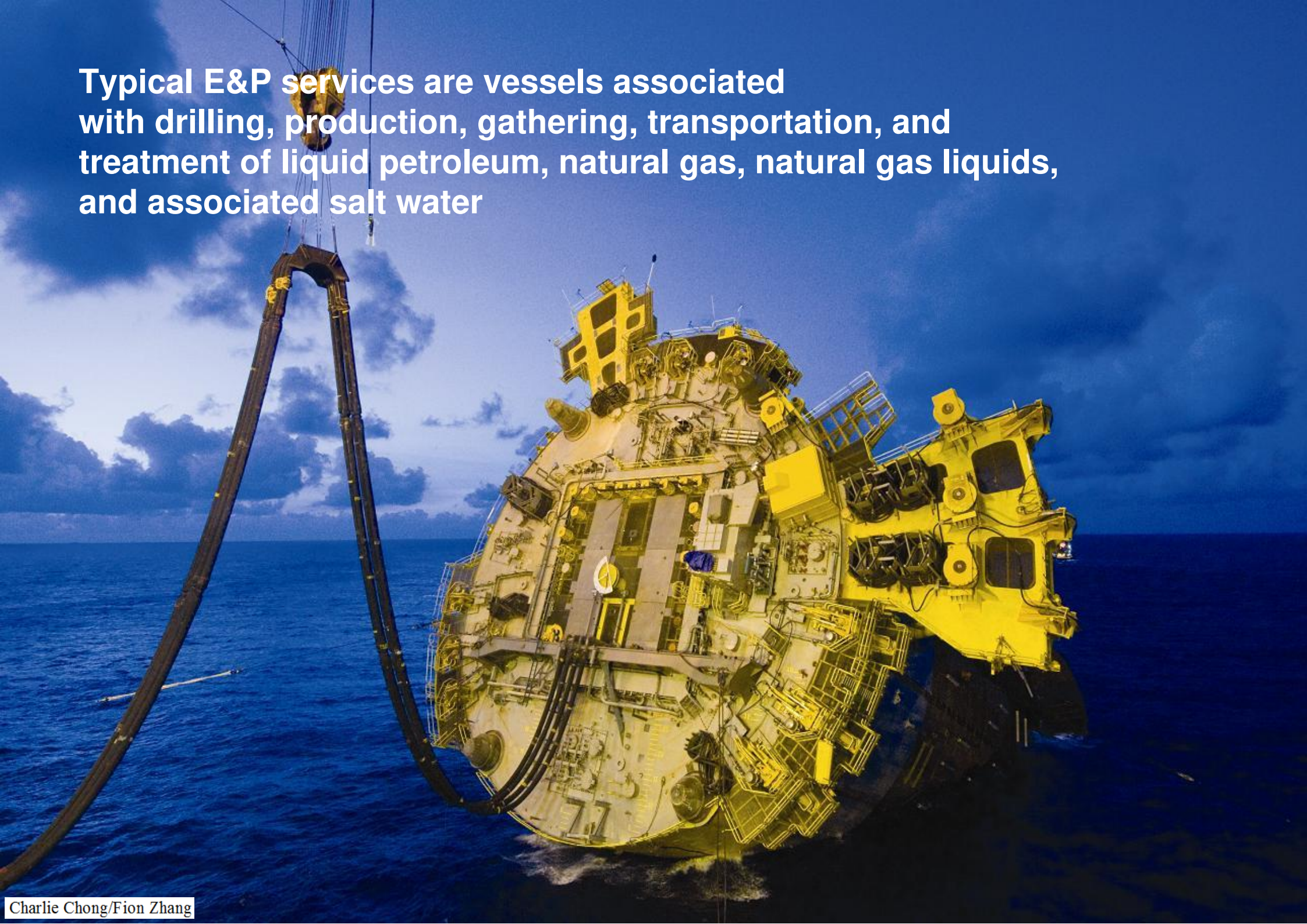

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API Individual Certification Programs

certifies that

Te-Fu Weng

has met the requirements to be a certified

API-510 Pressure Vessel Inspector

Certification Number *29763*

Original Certification Date *January 31, 2007*

Current Certification Date *January 31, 2013*

Expiration Date *January 31, 2016*

Tina Briskin
Manager, Individual Certification Programs

ICP

2012-038 | 10M | Printed in the USA |

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Rafael Andres Escalona

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API-510 Pressure Vessel Inspector

Certification Number *34614*

Original Certification Date *January 31, 2009*

Current Certification Date *January 31, 2012*

Expiration Date *January 31, 2015*

Tina Briskin

Manager, Individual Certification Programs

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2011-053 | 15M | Printed in the USA

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API Individual Certification Programs

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API-653 Above Ground Storage Tank Inspector

Certification Number 46394

Original Certification Date November 30, 2012

Current Certification Date November 30, 2012

Expiration Date November 30, 2015

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Manager, Individual Certification Programs

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AMERICAN PETROLEUM INSTITUTE
INDIVIDUAL CERTIFICATION PROGRAMS

API Individual Certification Programs

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Rafael Andres Escalona

has met the requirements to be a certified

API-570 Piping Inspector

Certification Number 40156

Original Certification Date January 31, 2011

Current Certification Date January 31, 2011

Expiration Date January 31, 2014

Tina Briskin

Manager, Individual Certification Programs

ICP

2011-053 | 15M | Printed in the USA

The level of learning and training obtained from this document is not a replacement for the training and experience required to be an American Welding Society (AWS) Certified Welding Inspector (CWI).

http://www.aws.org/w/a/certification/index.html

American Welding Society

Certifies that Welding Inspector

Larry T Dowd, Jr.

has complied with the requirements of Section 6.1 of the AWS Standard for Qualification and Certification of Welding Inspectors QC1-96

00100281
CERTIFICATE NUMBER

October 2006
VALID DATE

EMPLOYER: REFER TO WALLET CARD FOR VALIDITY AND EXPIRATION DATE

AMERICAN WELDING SOCIETY INCORPORATED 1932 NEW YORK

Damian J. Kotecki
PRESIDENT AWS

CHAIRMAN QUALIFICATION COMMITTEE

CHAIRMAN CERTIFICATION COMMITTEE

Charlie Chong/Fion Zhang

This recommended practice does not require all welds to be inspected; nor does it require welds to be inspected to specific techniques and extent. Welds selected for inspection, and the appropriate inspection techniques, should be determined by the welding inspectors, engineers, or other responsible personnel using the applicable code or standard. The importance, difficulty, and problems that could be encountered during welding should be considered by all involved. A welding engineer should be consulted on any critical, specialized or complex welding issues.


This recommended practice does not require all welds to be inspected; nor does it require welds to be inspected to specific techniques and extent. 此规范不需要全部的焊缝百分百的检验， 也并不设定任何的检验方法与检验范围.
Charlie Chong/Fion Zhang

Welds selected for inspection, and the appropriate inspection techniques, should be determined by the (1) welding inspectors, (2) engineers, or (3) other responsible personnel **using the applicable code or standard.**

Charlie Chong/Fion Zhang

AWS D1.1/D1.1M:2010
An American National Standard

Structural Welding Code—Steel

American Welding Society®

Approved American National Standard
ANSI

second printing, October 2011

ASME B31.3-2004
(Revision of ASME B31.3-2002)

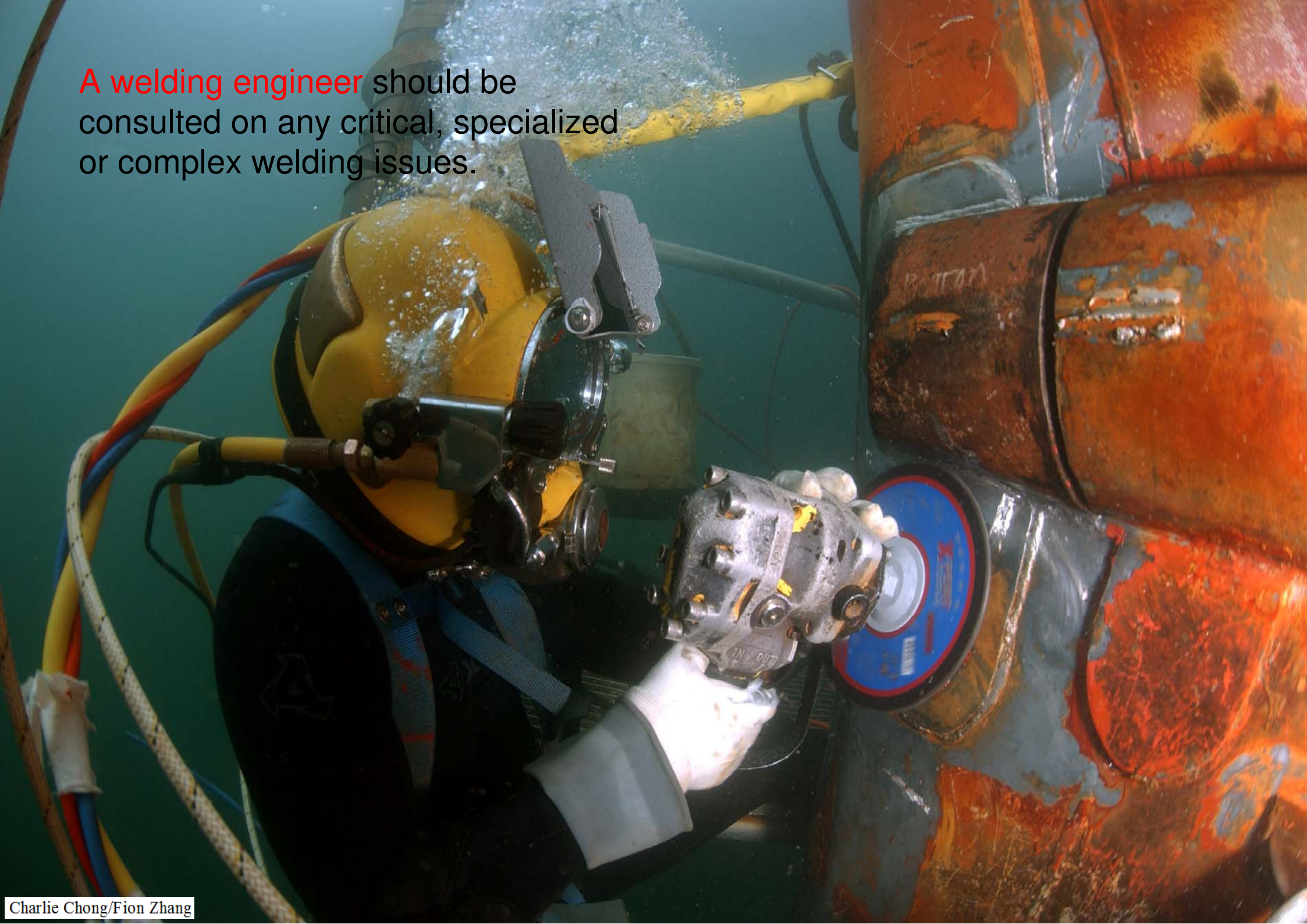
Process Piping

ASME Code for Pressure Piping, B31

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

The importance, difficulty, and problems that could be encountered during welding should be considered by all involved. A welding engineer should be consulted on any critical, specialized or complex welding issues.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consulted on any critical, specialized
or complex welding issues.
Charlie Chong/Fion Zhang


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or complex welding issues.
Charlie Chong/Fion Zhang

Charlie Chong/Fion Zhang

INTERNATIONAL INSTITUTE OF WELDING

Having met the Education and Training requirements of IIW Guideline 'International Welding Engineer' and by examination having satisfied the requirements of the Examination Board of the IIW Authorised National Body

First and surname: **Matthias Seifert**

Date of birth: 1968-06-08

is hereby awarded the diploma of

INTERNATIONAL WELDING ENGINEER

Date: 2002-05-03

Diploma No.: D-S-13353-1173-020503-0044

Dipl.-Ing. D. Wolff
The Examiner
(Stamp, name, signature)

Dr.-Ing. D. Paulnus
Welding Training Center
The Head
(Stamp, name, signature)

EWF Authorised National Body
DVS-PersZert®
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Under the Registration Number TGA-ZP-03-92-71

EUROPEAN FEDERATION FOR WELDING, JOINING AND CUTTING

Having met the education and training requirements of
EWF Guideline 'European Welding Engineer' and
by examination having satisfied the requirements of the
Governing Board of the EWF Authorised National Body

Name: **Günter Dobritzsch**

Date of birth: 11.7.1944

is hereby awarded the certificate of

EUROPEAN WELDING ENGINEER

Date: 30.10.1998 Diploma No.: D-S-06118-1173/A-981030-022888-01

Dipl.-Ing. Bendler
Chairman,
Board of Examiners

Dr.-Ing. Keitel
Head,
Training School

DVS® EWF Accredited National Body: Deutscher Verband für Schweißtechnik e.V.

SLV HALLE

Training School: **Schweißtechnische Lehr- und Versuchsanstalt Halle GmbH**

PARTICIPATING COUNTRIES

Austria · Belgium · Denmark · Finland · France · Germany · Italy · Luxembourg · Netherlands · Norway · Portugal · Spain · Sweden · Switzerland · United Kingdom

2 References

2.1 CODES AND STANDARDS

The following codes and standards are referenced in this recommended practice. All codes and standards are subject to periodic revision, and the most recent revision available should be used.

API

- API 510 Pressure Vessel Inspection Code: Maintenance, Inspection, Rating, Repair, and Alteration
- API 570 Piping Inspection Code: Inspection, Repair, Alteration, and Rerating of In-Service Piping Systems
- RP 578 Material Verification Program for New and Existing Alloy Piping Systems
- RP 582 Recommended Practice and Supplementary Welding Guidelines for the Chemical, Oil, and Gas Industries
- Std 650 Welded Steel Tanks for Oil Storage
- Std 653 Tank Inspection, Repair, Alteration, and Reconstruction
- Publ 2201 Procedures for Welding or Hot Tapping on Equipment in Service

ASME

- B31.3 Process Piping
- Boiler and Pressure Vessel Code
  - Section V, Nondestructive Examination;
  - Section VIII, Rules for Construction of Pressure Vessels,
  - Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators
    Practical Guide to ASME Section IX Welding Qualifications

ASNT

ASNT Central Certification Program

- CP-189 Standard for Qualification and Certification of Nondestructive Testing Personnel
- SNT-TC-1A Personnel Qualification and Certification in Nondestructive Testing

AWS

- A2.4 Standard Symbols for Welding, Brazing, and Nondestructive Examination
- A3.0 Standard Welding Terms and Definitions
- A5.XX Series of Filler Metal Specifications
- B1.10 Guide for the Nondestructive Inspection of Welds

CASTI

- CASTI Guidebook to ASME Section IX—Welding Qualifications

WRC

- Bulletin 342 Stainless Steel Weld Metal: Prediction of Ferrite Content

2.2 OTHER REFERENCES

The following codes and standards are not referenced directly in this recommended practice. Familiarity with these documents may be useful to the welding engineer or inspector as they provide additional information pertaining to this recommended practice. All codes and standards are subject to periodic revision, and the most recent revision available should be used.

API

- RP 572 Inspection of Pressure Vessels
- RP 574 Inspection Practices for Piping System Components
- Publ 2207 Preparing Tank Bottoms for Hot Work
- Publ 2217A Guidelines for Work in Inert Confined Spaces in the Petroleum Industry

ASME

- Boiler and Pressure Vessel Code, Section II, Materials
  - Part C, Specifications for Welding Rods, Electrodes, and Filler Metals
  - Part D, Properties
- B16.5 Pipe Flanges and Flanged Fittings
- B16.9 Factory-Made Wrought Steel Butt welding Fittings
- B16.34 Valves- Flanged, Threaded, and Welding End
- B31.1 Power Piping

AWS

- JWE Jefferson's Welding Encyclopedia
- CM-00 Certification Manual for Welding Inspectors

NB

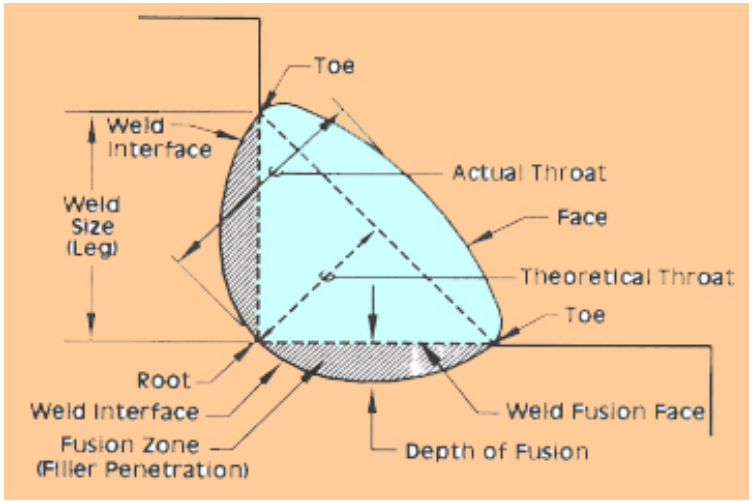
- NB-23 National Board Inspection Code

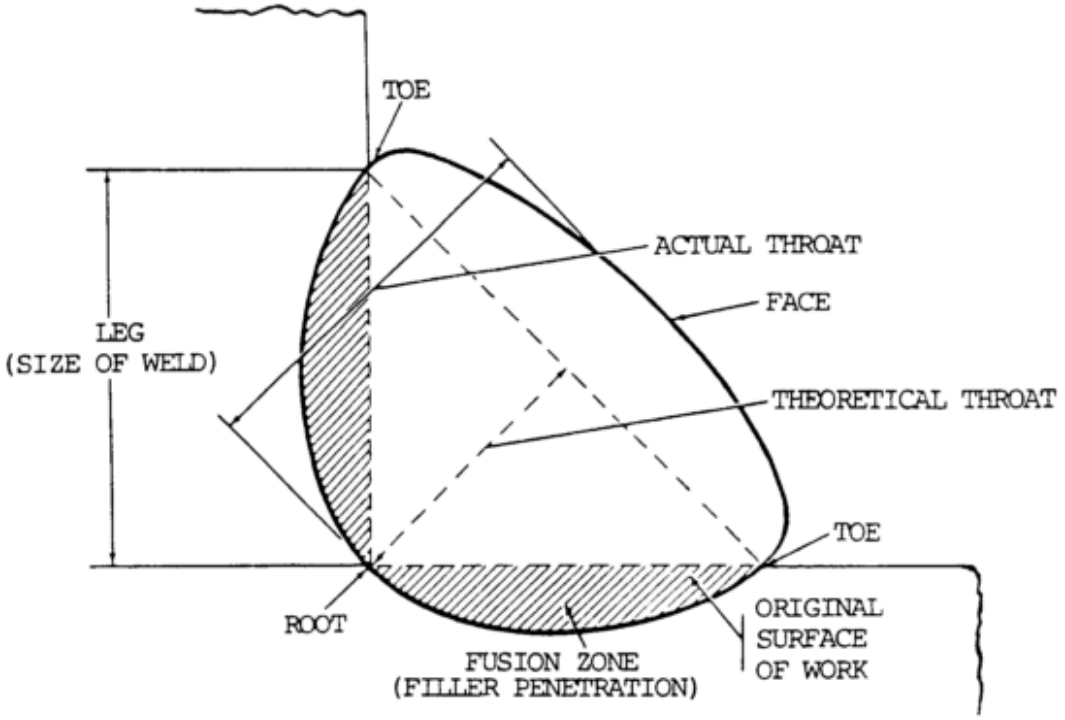
3 Definitions

Charlie Chong/Fion Zhang

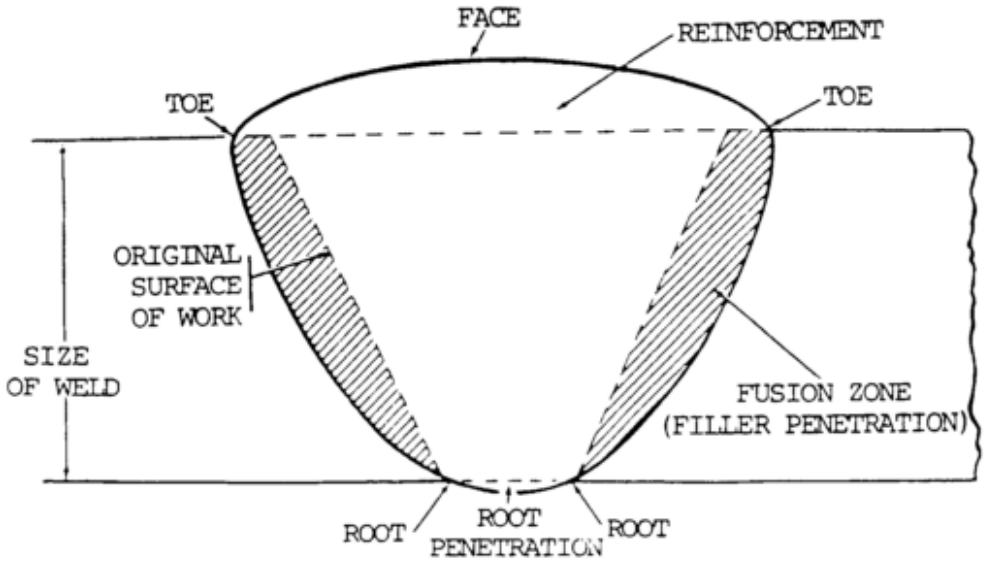
The following definitions apply for the purposes of this publication:

3.1 actual throat: The shortest distance between the weld root and the face of a fillet weld.





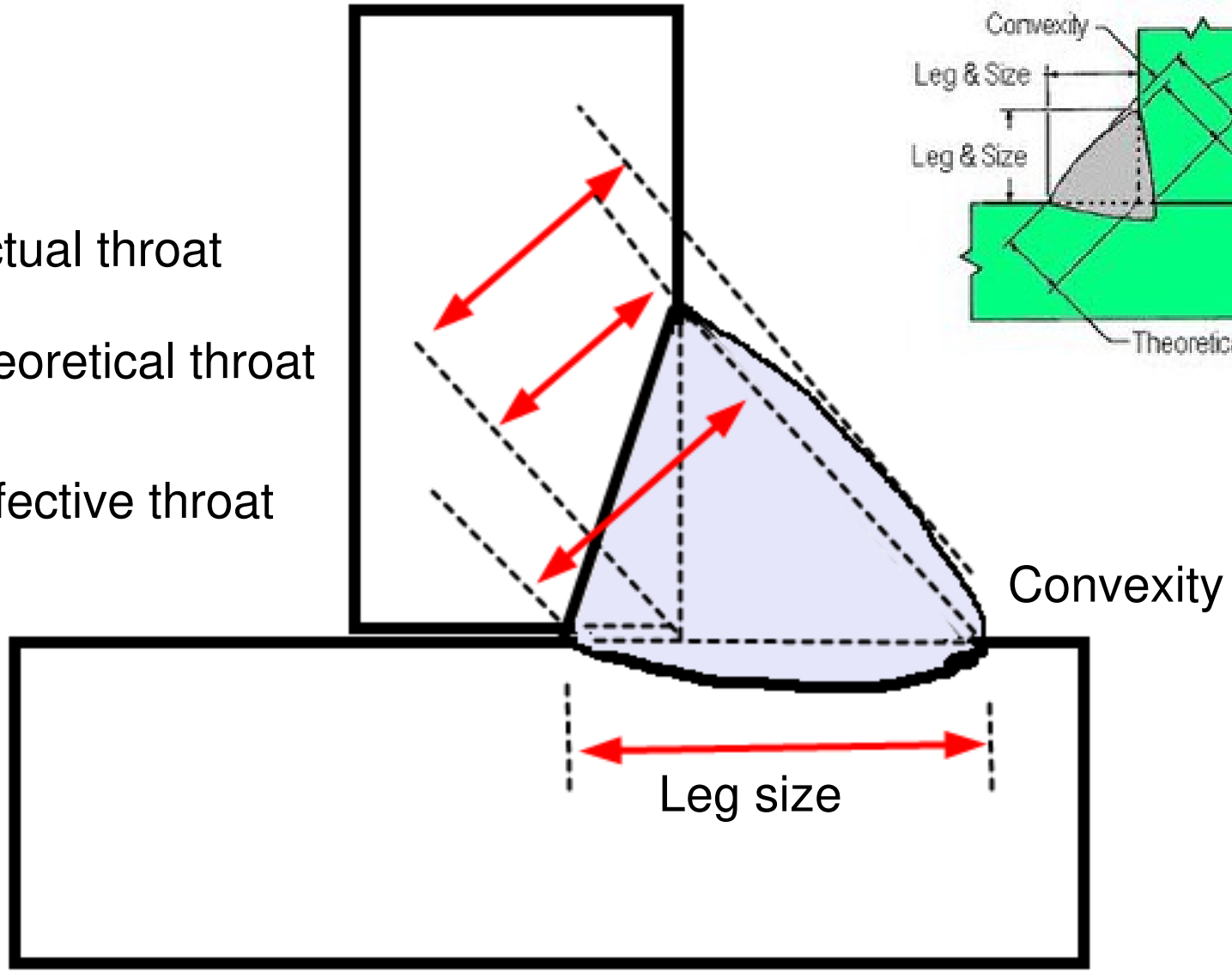
FILLET WELD



GROOVE WELD

Figure 6-13. Nomenclature of welds.

Fillet Weld


Actual throat
Theoretical throat
Effective throat
Convexity
Leg size

Convexity
Actual Throat
Leg & Size
Leg & Size
Effective Throat
Theoretical Throat

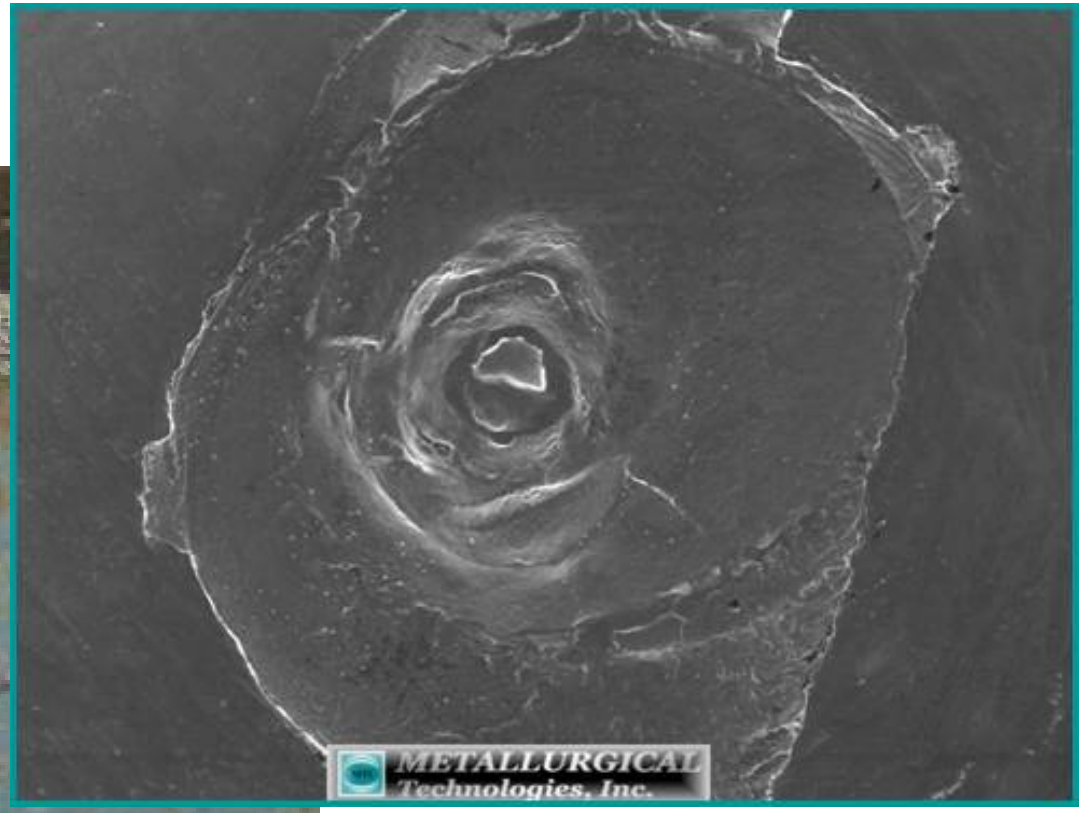
3.2 air carbon arc cutting (CAC-A): A carbon arc cutting process variation that removes molten metal with a jet of air.

3.3 arc blow: The deflection of an arc from its normal path because of magnetic forces.

3.4 arc length: The distance from the tip of the welding electrode to the adjacent surface of the weld pool.

3.5 arc strike: A discontinuity resulting from an arc, consisting of any localized remelted metal, heat-affected metal, or change in the surface profile of any metal object.

arc strike



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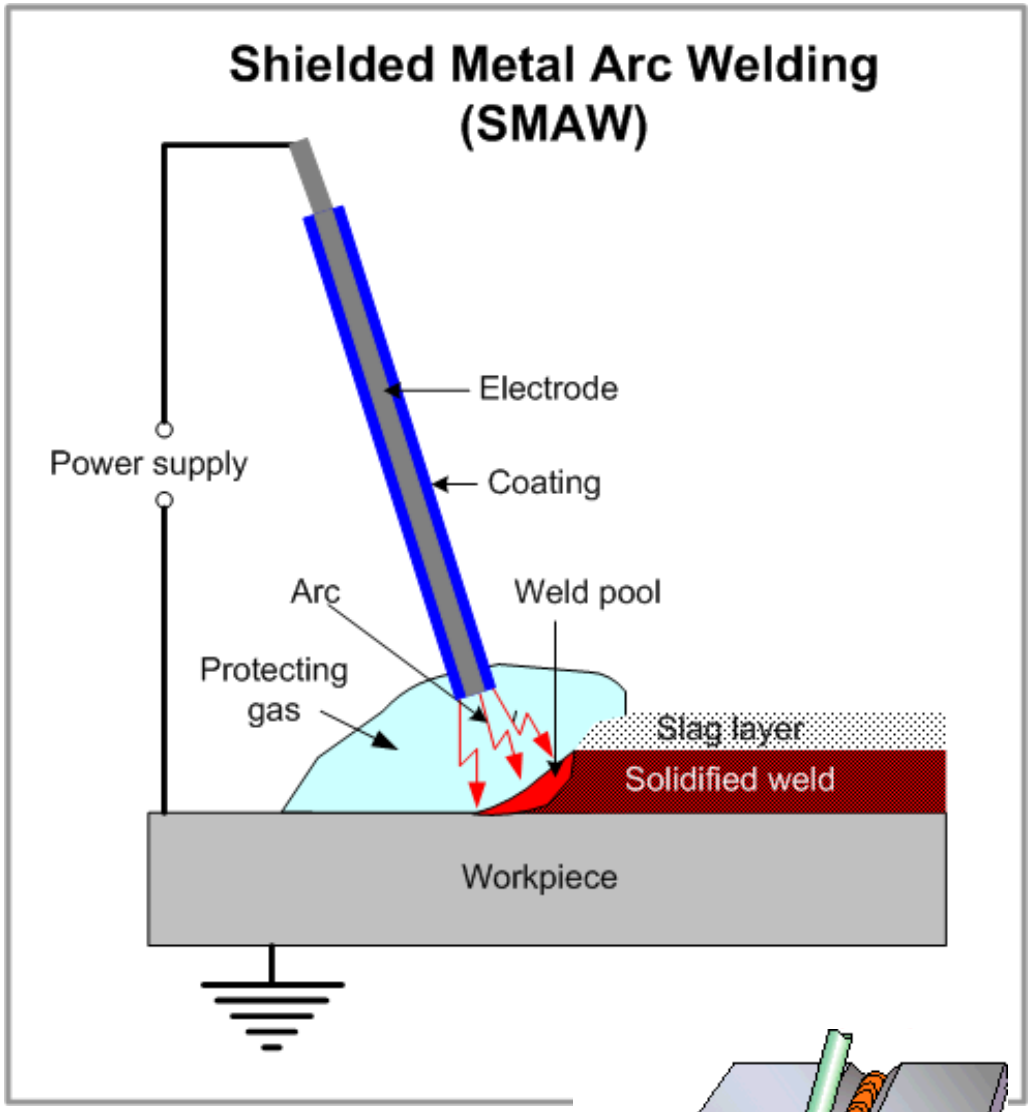
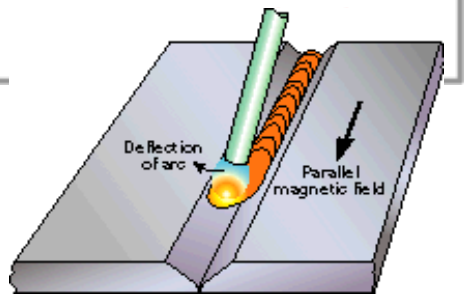
arc blow





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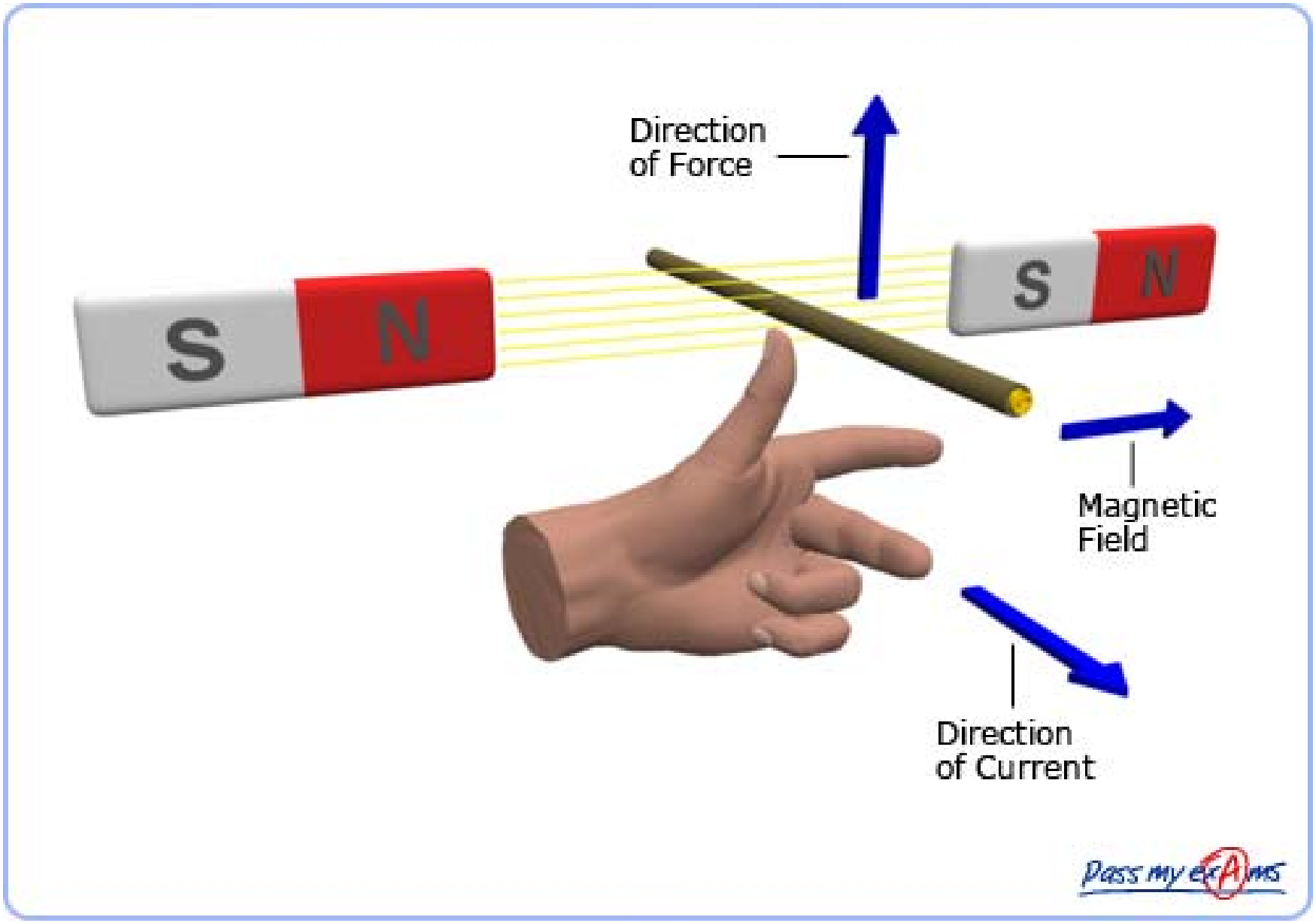
arc blow


Direction
of Force
S
N
S
N
Magnetic
Field
Direction
of Current
Pass my exAms

3.6 arc welding (AW): A group of welding processes that produces coalescence of work pieces by heating them with an arc. The processes are used with or without the application of pressure and with or without filler metal.

3.7 autogenous weld: A fusion weld made without filler metal.

3.8 back-gouging: The removal of weld metal and base metal from the weld root side of a welded joint to facilitate complete fusion and complete joint penetration upon subsequent welding from that side.

3.9 backing: A material or device placed against the backside of the joint, or at both sides of a weld in welding, to support and retain molten weld metal.

3.10 base metal: The metal or alloy that is welded or cut.

3.11 bevel angle: The angle between the bevel of a joint member and a plane perpendicular to the surface of the member.

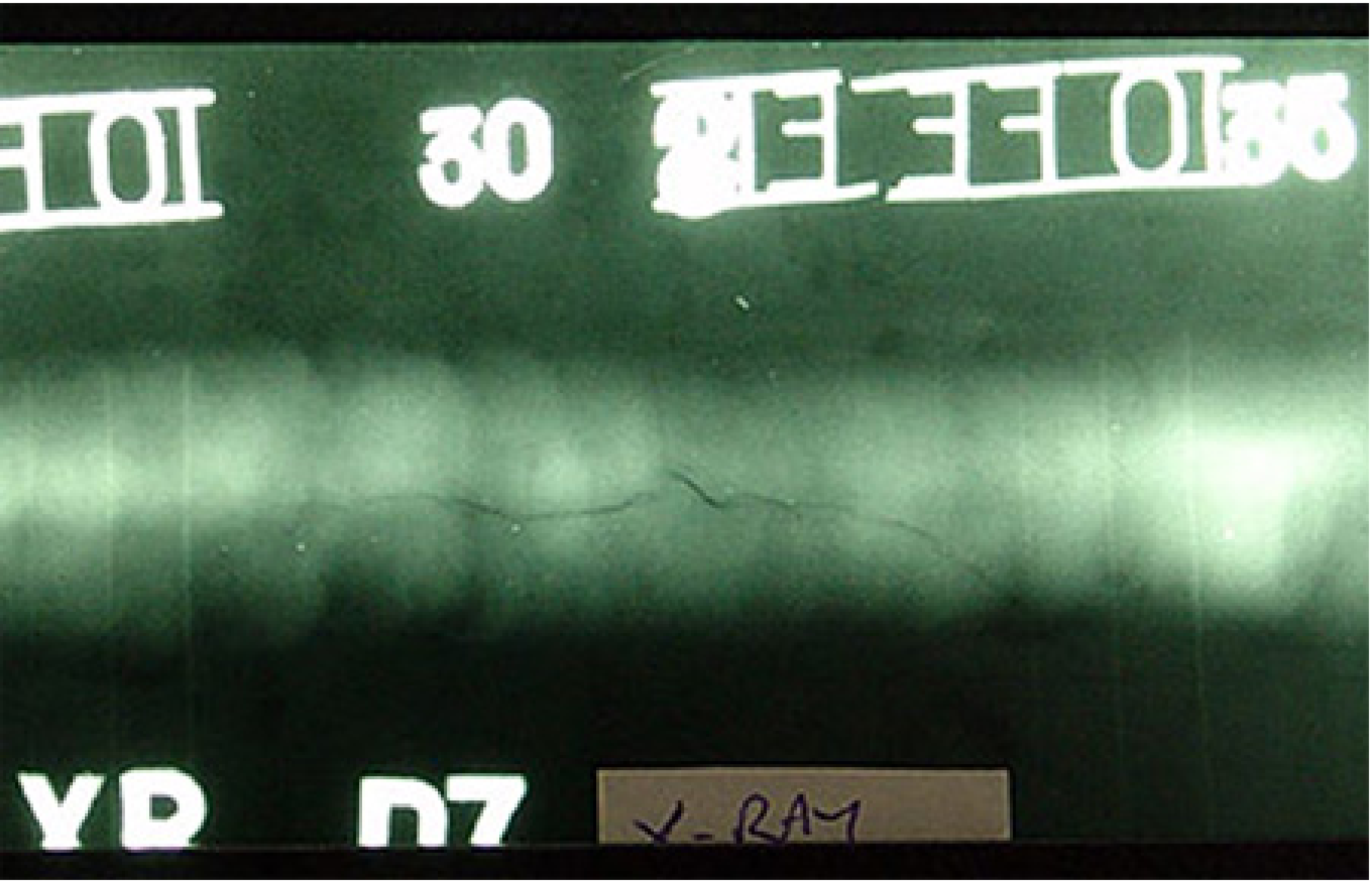
3.12 burn-through: A non-standard term for excessive visible root reinforcement in a joint welded from one side or a hole through the root bead. Also, a common term used to reflect the act of penetrating a thin component with the welding arc while hot tap welding or in-service welding.

3.13 constant current power supply: An arc welding power source with a volt-ampere relationship yielding a small welding current change from a large arc voltage change.

3.14 constant voltage power supply: An arc welding power source with a volt-ampere relationship yielding a large welding current change from a small voltage change.

3.15 crack: A fracture type discontinuity characterized by a sharp tip and high ratio of length and width to opening displacement.

Crack



3.16 defect: A discontinuity or discontinuities that by nature or accumulated effect (for example total crack length) render a part or product unable to meet minimum applicable acceptance standards or specifications. The term designates rejectability.

3.17 direct current electrode negative (DCEN): The arrangement of direct current arc welding leads in which the electrode is the negative pole and workpiece is the positive pole of the welding arc. Commonly known as straight polarity.

3.18 direct current electrode positive (DCEP): The arrangement of direct current arc welding leads in which the electrode is the positive pole and the workpiece is the negative pole of the welding arc. Commonly known as reverse polarity.

3.19 discontinuity: An interruption of the typical structure of a material, such as a lack of homogeneity in its mechanical, metallurgical, or physical characteristics. A discontinuity is not necessarily a defect.

3.20 distortion: The change in shape or dimensions, temporary or permanent, of a part as a result of heating or welding.

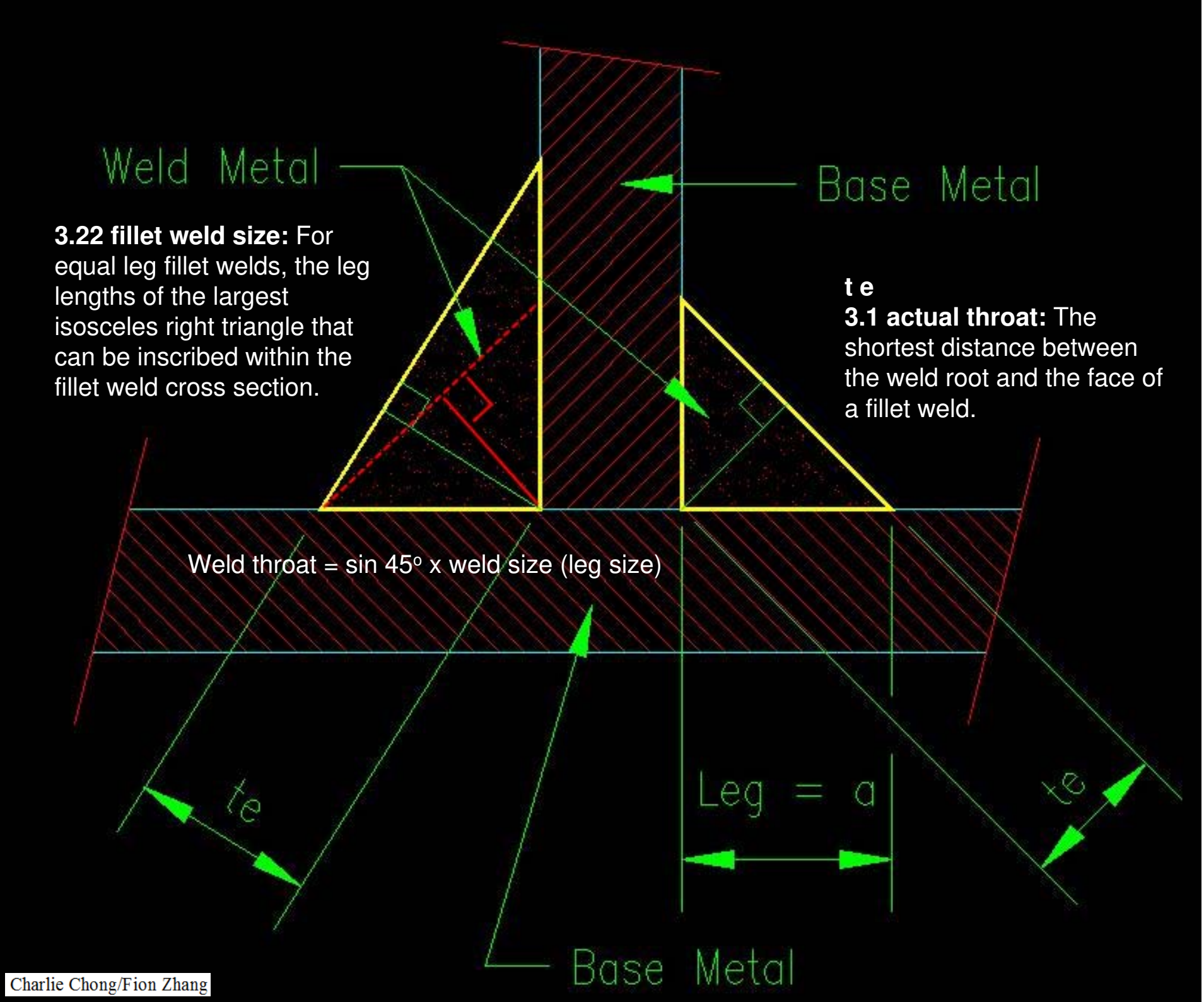
3.21 filler metal: The metal or alloy to be added in making a welded joint.

3.22 fillet weld size: For equal leg fillet welds, the leg lengths of the largest isosceles right triangle that can be inscribed within the fillet weld cross section.

3.23 fusion line: A non-standard term for weld interface.

3.24 groove angle: The total included angle of the groove between workpieces.

3.25 heat affected zone (HAZ): The portion of the base metal whose mechanical properties or microstructure have been altered by the heat of welding or thermal cutting.



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t e
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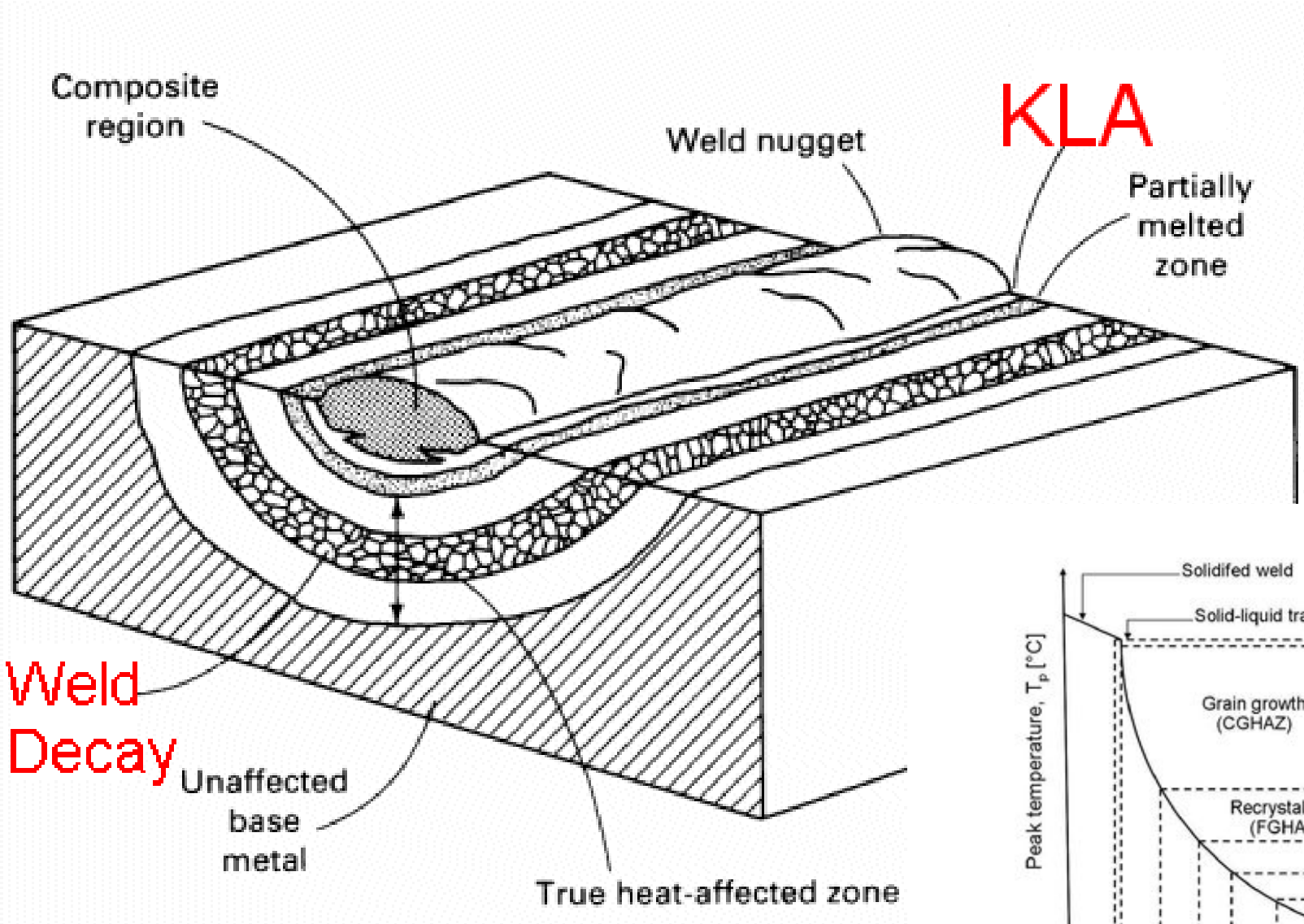
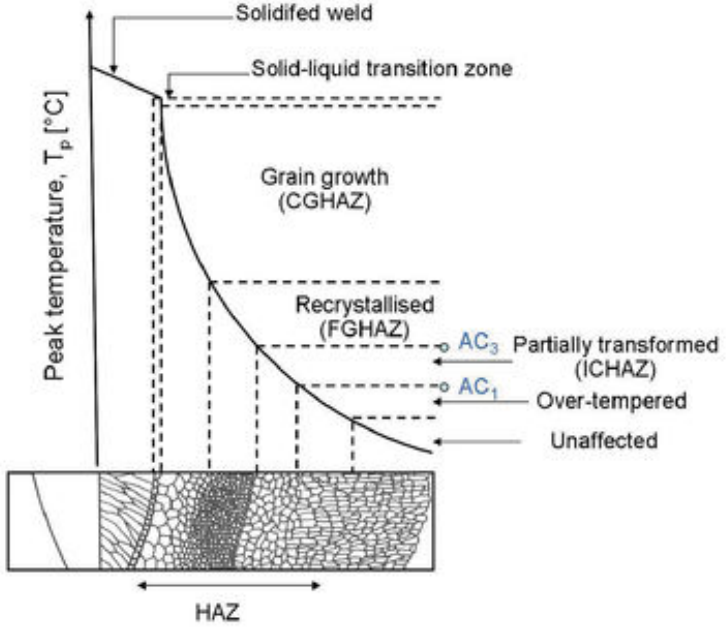
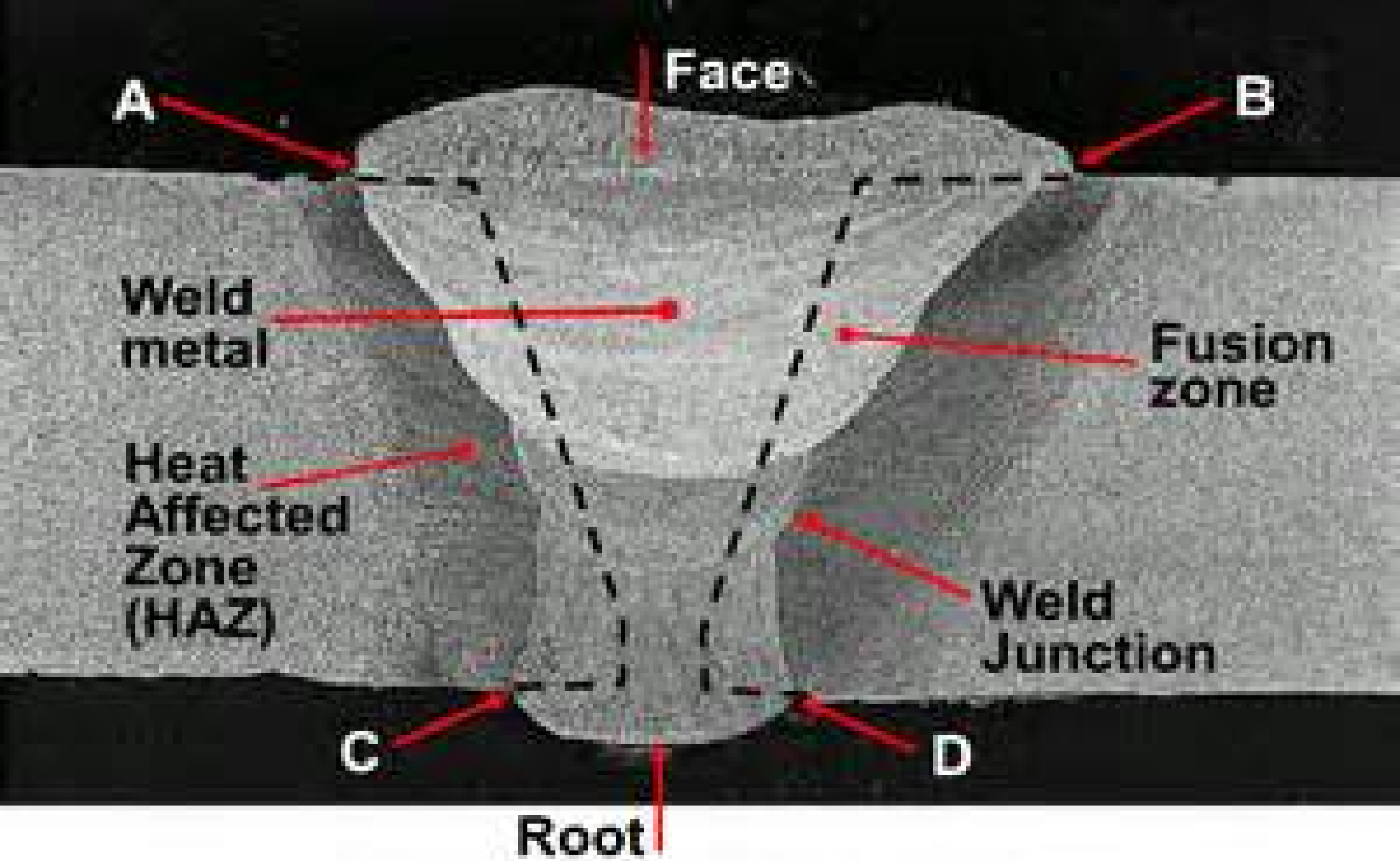
Charlie Chong/Fion Zhang

HAZ

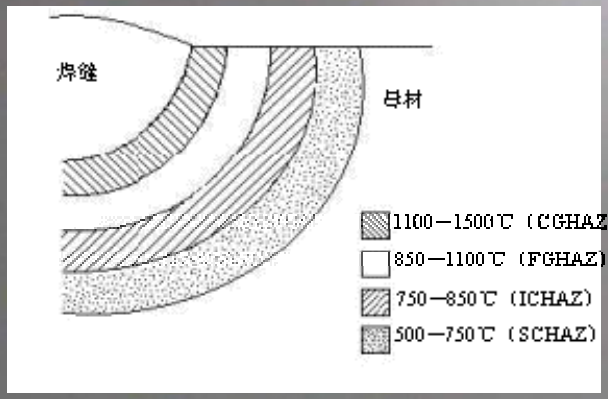

Composite region
Weld nugget
KLA
Partially melted zone
Weld Decay
Unaffected base metal
True heat-affected zone


Solidifed weld
Solid-liquid transition zone
Peak temperature, T_p [°C]
Grain growth (CGHAZ)
Recrystallised (FGHAZ)
AC_3
Partially transformed (ICHAZ)
AC_1
Over-tempered
Unaffected
HAZ

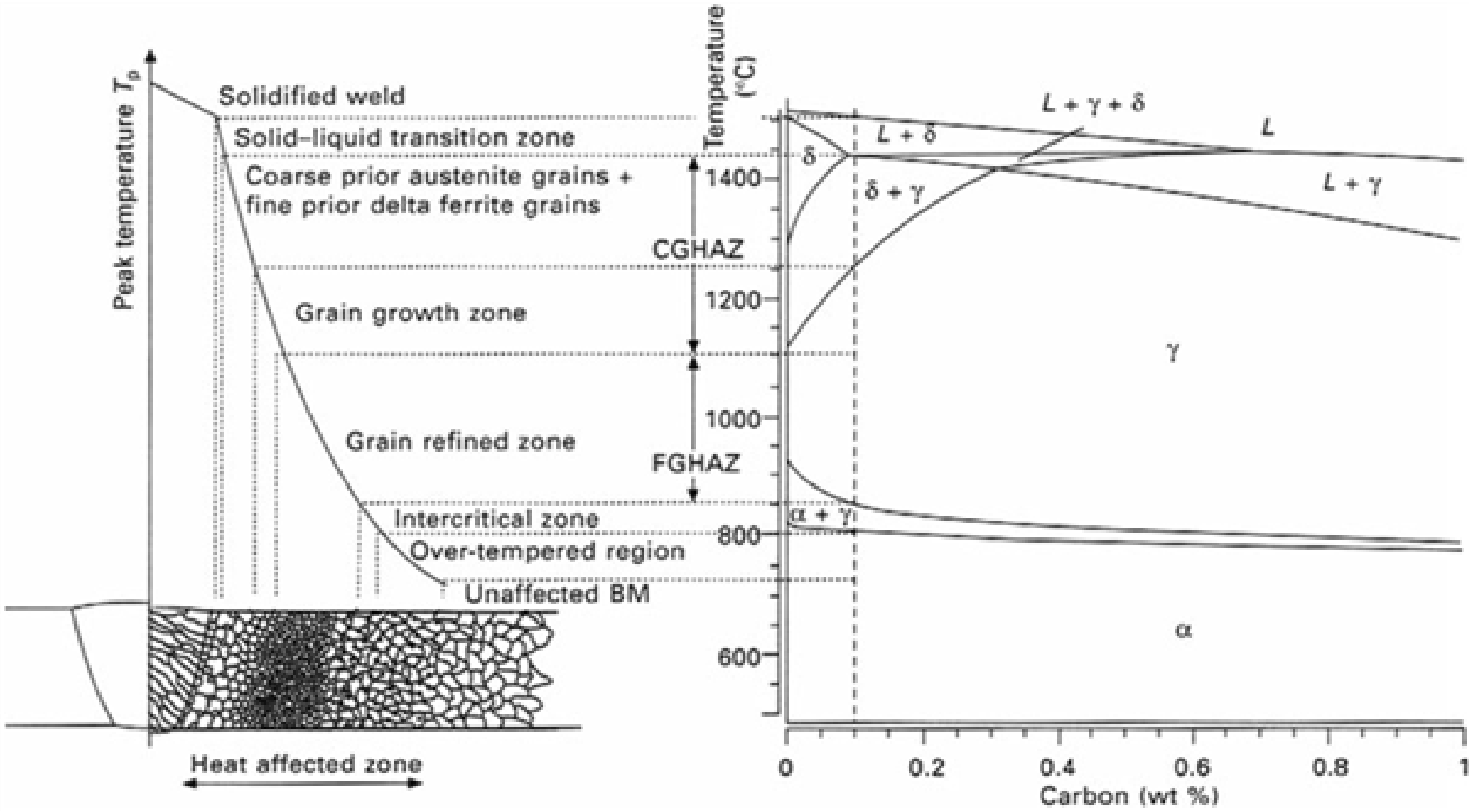


A, B, C & D = Weld Toes

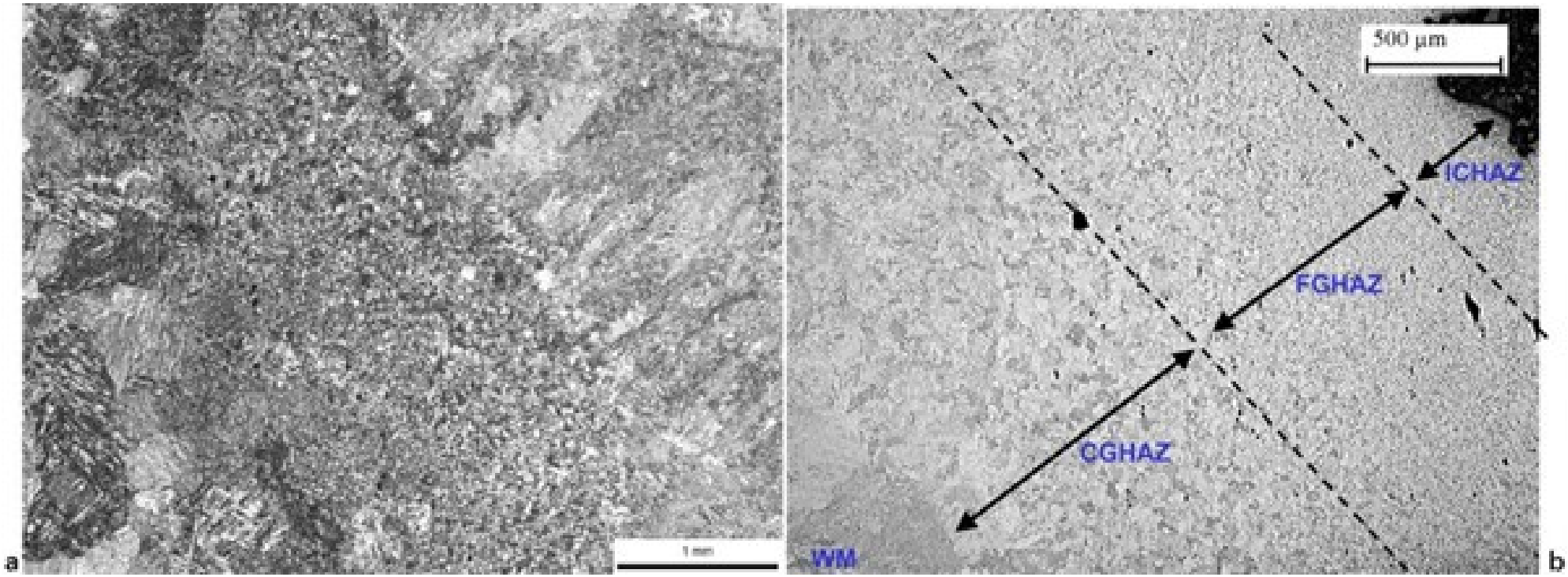
HAZ


焊缝
母材
1100—1500℃ (CGHAZ)
850—1100℃ (FGHAZ)
750—850℃ (ICHAZ)
500—750℃ (SCHAZ)

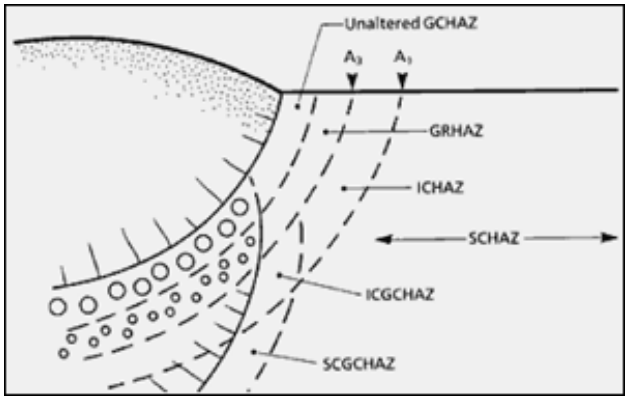
HAZoning


Peak temperature T_p
Solidified weld
Solid–liquid transition zone
Coarse prior austenite grains + fine prior delta ferrite grains
Grain growth zone
Grain refined zone
Intercritical zone
Over-tempered region
Unaffected BM
Heat affected zone
Temperature (°C)
CGHAZ
FGHAZ
1400
1200
1000
800
600
L + γ + δ
L + δ
L
δ
δ + γ
L + γ
γ
α + γ
α
0
0.2
0.4
0.6
0.8
1
Carbon (wt %)

HAZ



http://www.twi-global.com/technical-knowledge/published-papers/review-of-type-iv-cracking-of-weldments-in-9-12cr-creep-strength-enhanced-ferritic-steels/



3.26 heat input: the energy supplied by the welding arc to the workpiece. Heat input is calculated as follows:

$$\text{Heat Input Joules/inch} = \frac{\text{Ampere i x Voltage V x 60}}{\text{Travel speed in inch per minute } v}$$

where V = voltage, i = amperage, v =weld travel speed (in./min.)

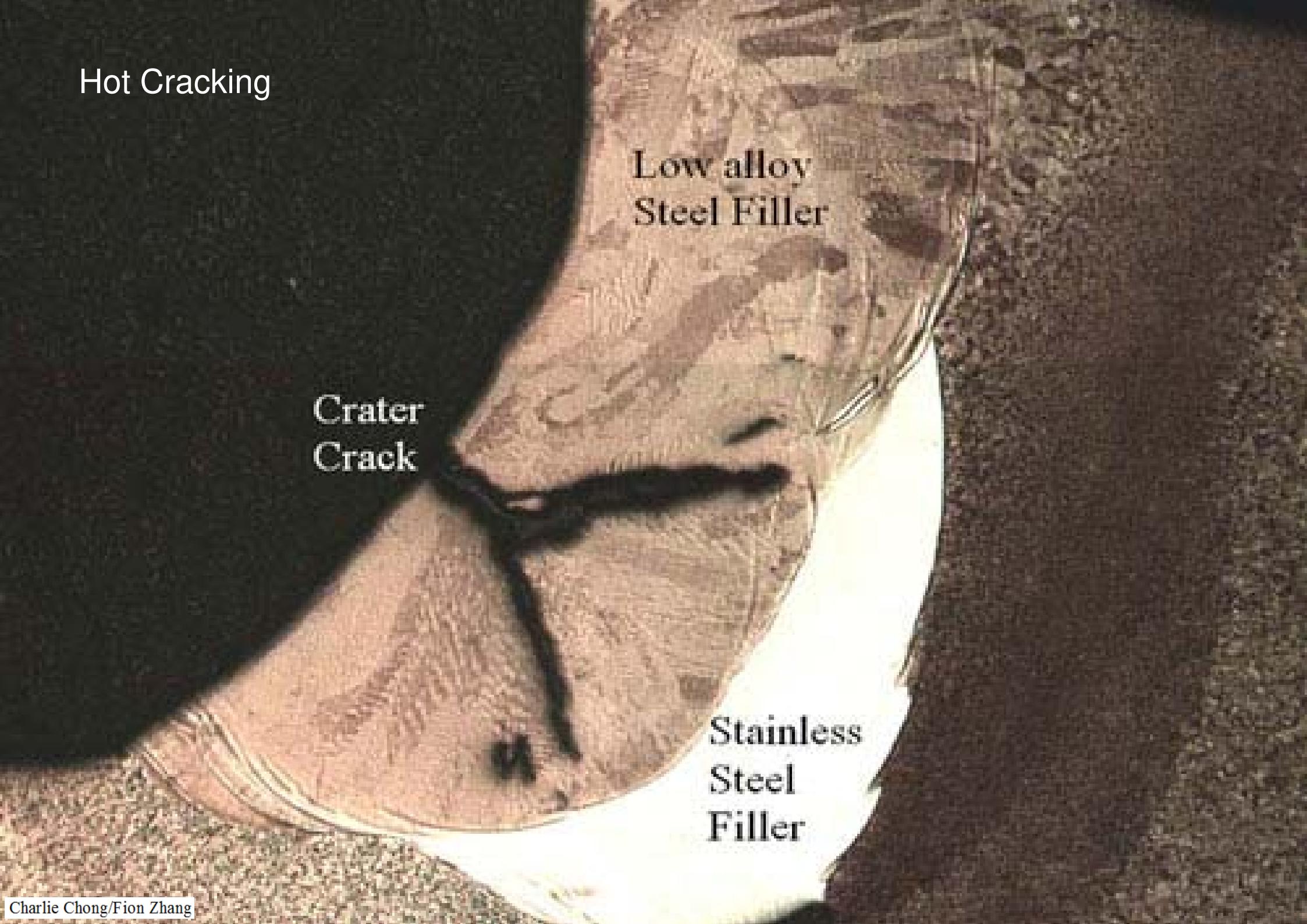
3.27 hot cracking: Cracking formed at temperatures near the completion of solidification

3.28 inclusion: Entrapped foreign solid material, such as slag, flux, tungsten, or oxide.

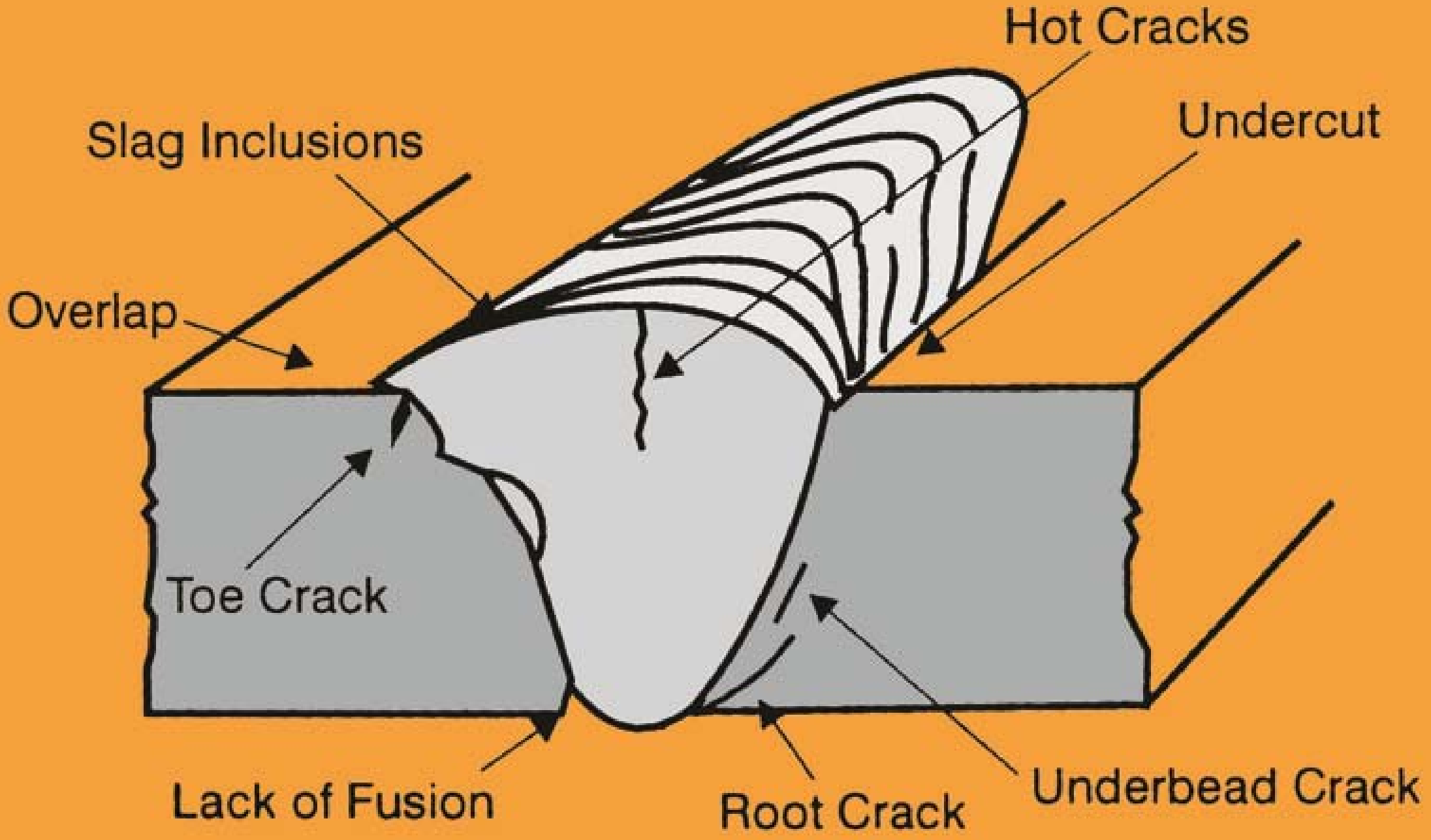
3.29 incomplete fusion: A weld discontinuity in which complete coalescence did not occur between weld metal and fusion faces or adjoining weld beads.

3.30 incomplete joint penetration: A joint root condition in a groove weld in which weld metal does not extend through the joint thickness.

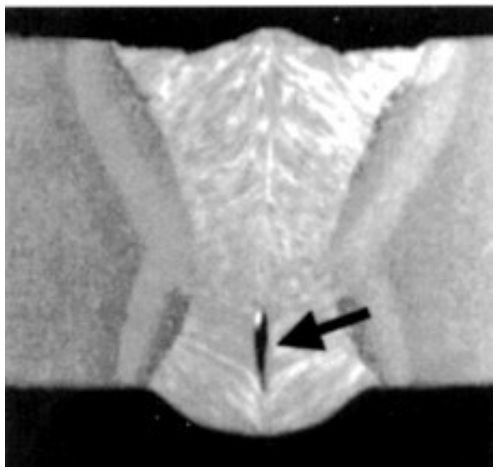
Hot Cracking



Hot cracking



Hot cracking



These cracks are known as hot cracks because they occur immediately after welds are completed and sometimes while the welds are in progress, when the weld metal tends to solidify from the corners of the base metal to which it is joined. There are 2 major reasons contributing to hot cracking;

- As the solidification proceeds, the low melting eutectics are concentrated in the center and remain liquid, which is then torn apart by the stress associated with the welding, resulting in a center line crack.
- Hot cracking occurs when the available supply of liquid weld metal is insufficient to fill the spaces between solidifying weld metal, which are opened by shrinkage strains.

http://www.corrosionpedia.com/definition/634/hot-cracking

Hot cracking

http://en.wikipedia.org/wiki/Cold_cracking#Cold_cracking

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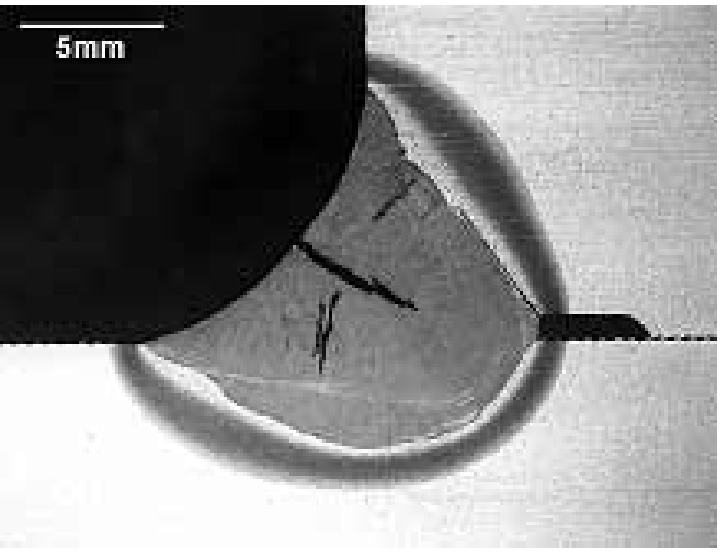
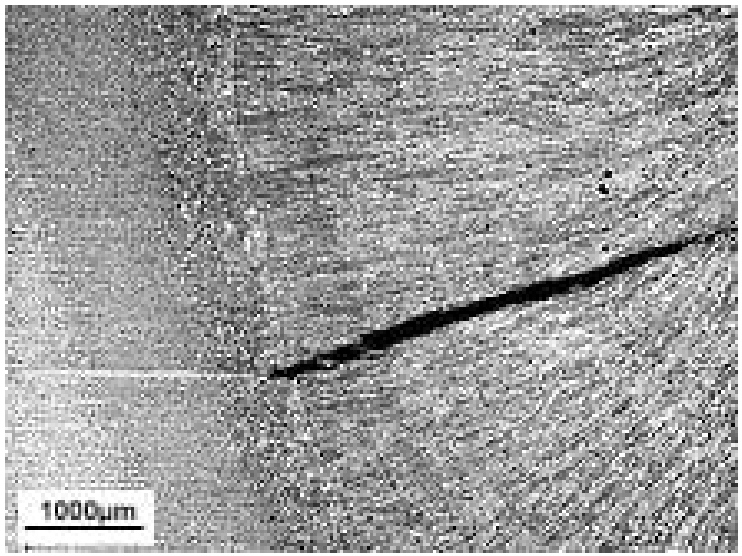
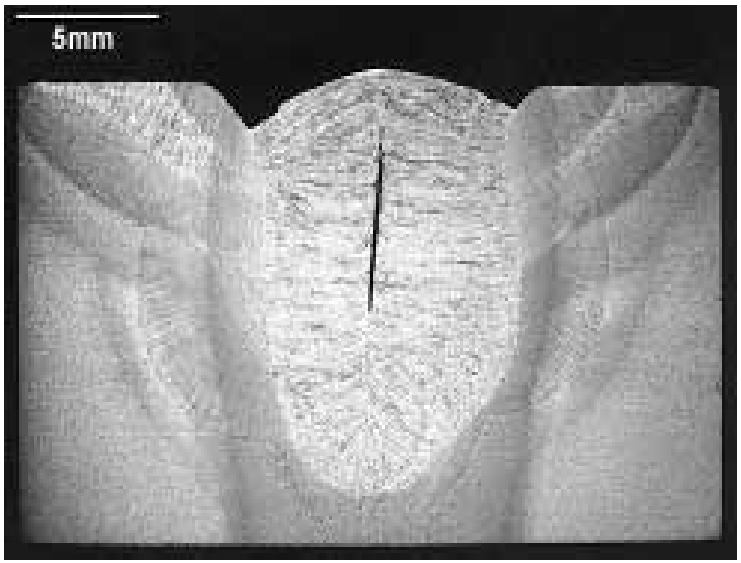






Both solidification cracking and hot cracking refer to the formation of shrinkage cracks during the solidification of weld metal, although hot cracking can also refer to liquation cracking. Solidification cracks can appear in several locations, and orientations, but most commonly are longitudinal centreline cracks (coincident with the intersection of grains growing from opposite sides of the weld), or 'flare' cracks, again longitudinal, but at an angle to the through-thickness direction (Fig.1). Where there is a central segregate band in the plate, cracking may extend from this position at the fusion boundary (Fig.2). The cracks in all locations can be buried (Fig.3) or surface-breaking.

http://www.twi-global.com/technical-knowledge/faqs/material-faqs/faq-what-is-hot-cracking-solidification-cracking/

3.31 inspector: An individual who is qualified and certified to perform inspections under the proper inspection code or who holds a valid and current National Board Commission.

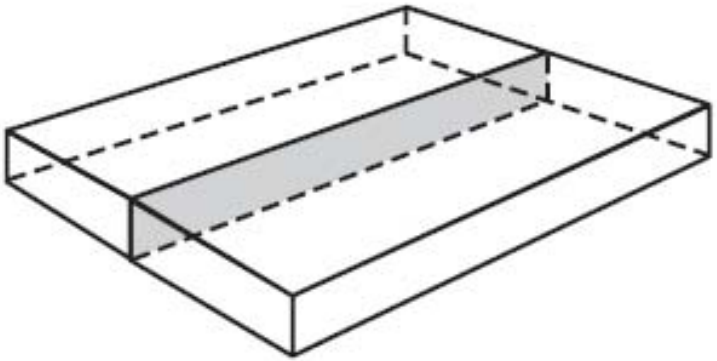
3.32 interpass temperature, welding: In multipass weld, the temperature of the weld area between weld passes.

3.33 IQI: Image quality indicator. “Penetrameter” is another common term for IQI.

3.34 joint penetration: The distance the weld metal extends from the weld face into a joint, exclusive of weld reinforcement.

3.35 joint type: A weld joint classification based on five basic joint configurations such as a butt joint, corner joint, edge joint, lap joint, and t-joint.

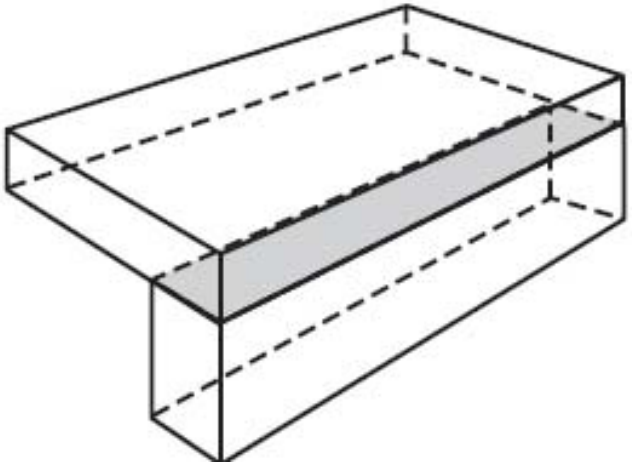
Figure A-1—Joint Types and Applicable Welds



(A) Butt Joint

Applicable Welds

Bevel-groove	U-groove
Flare-bevel-groove	V-groove
J-groove	Edge-flange
Square-groove	Braze

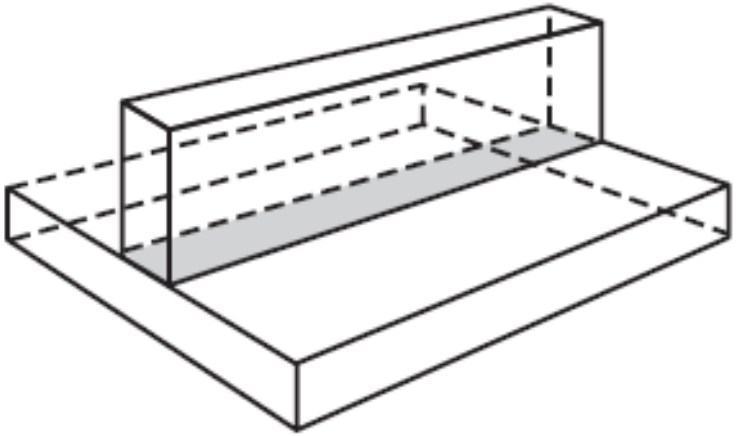


(B) Corner Joint

Applicable Welds

Fillet	V-groove
Bevel-groove	Plug
Flare-bevel-groove	Slot
Flare-V-groove	Spot
J-groove	Seam
Square-groove	Projection
U-groove	Braze

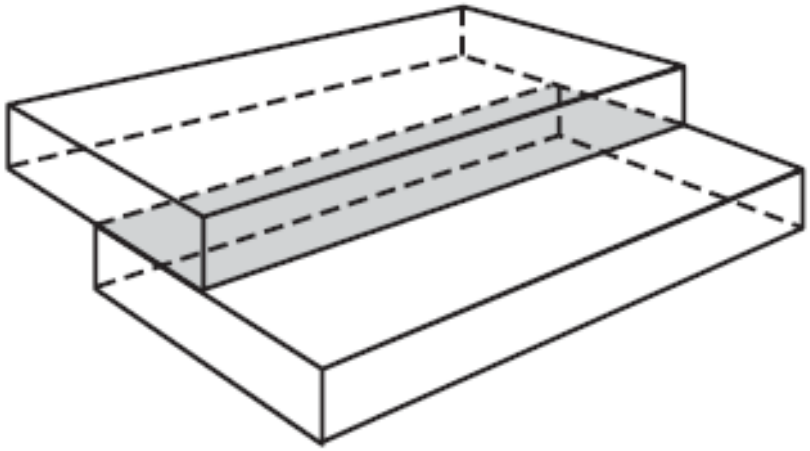
Figure A-1—Joint Types and Applicable Welds



(C) T-Joint

Applicable Welds

Fillet	Slot
Bevel-groove	Spot
Flare-bevel-groove	Seam
J-groove	Projection
Square-groove	Braze
Plug	

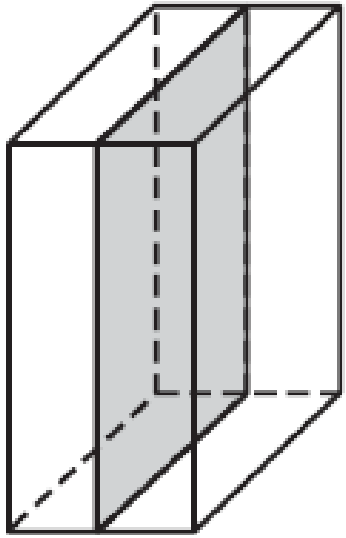


(D) Lap Joint

Applicable Welds

Fillet	Slot
Bevel-groove	Spot
Flare-bevel-groove	Seam
J-groove	Projection
Plug	Braze

Figure A-1—Joint Types and Applicable Welds



(E) Edge Joint

Applicable Welds

Bevel-groove	U-groove
Flare-bevel-groove	V-groove
Flare-V-groove	Edge
J-groove	Seam
Square-groove	

3.36 lack of fusion (LOF): A non-standard term indicating a weld discontinuity in which fusion did not occur between weld metal and fusion faces or adjoining weld beads.

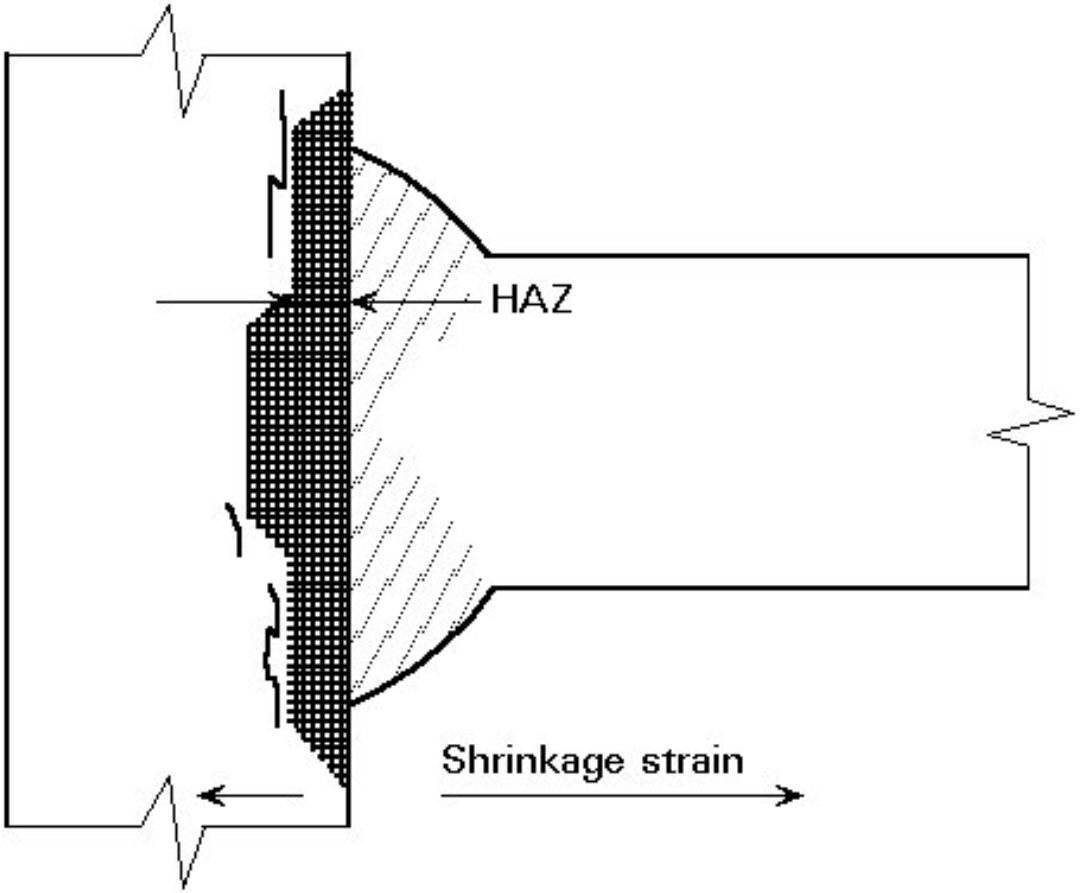
3.37 lamellar tear: A subsurface terrace and step-like crack in the base metal with a basic orientation parallel to the wrought surface caused by tensile stresses in the through thickness direction of the base metal weakened by the presence of small dispersed, planar shaped, nonmetallic inclusions parallel to the metal surface.

3.38 lamination: A type of discontinuity with separation or weakness generally aligned parallel to the worked surface of a metal.

3.39 linear discontinuity: A discontinuity with a length that is substantially greater than its width.

3.40 longitudinal crack: A crack with its major axis orientation approximately parallel to the weld axis.

lamellar tear



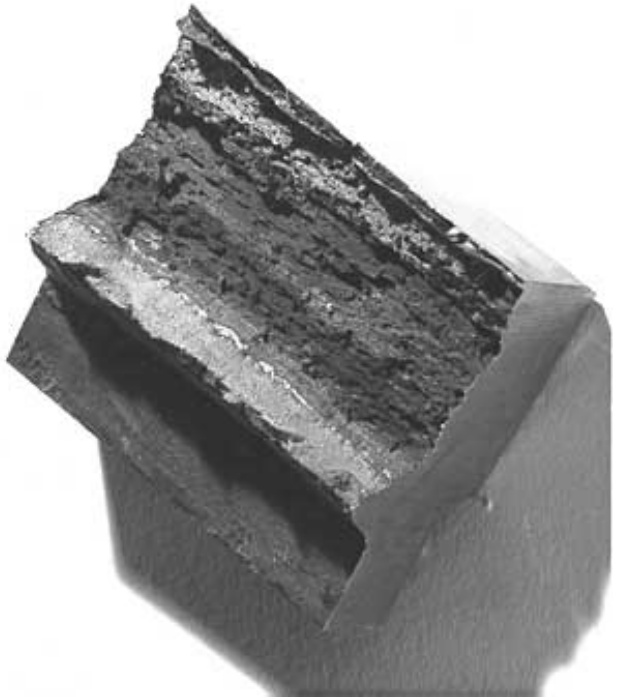
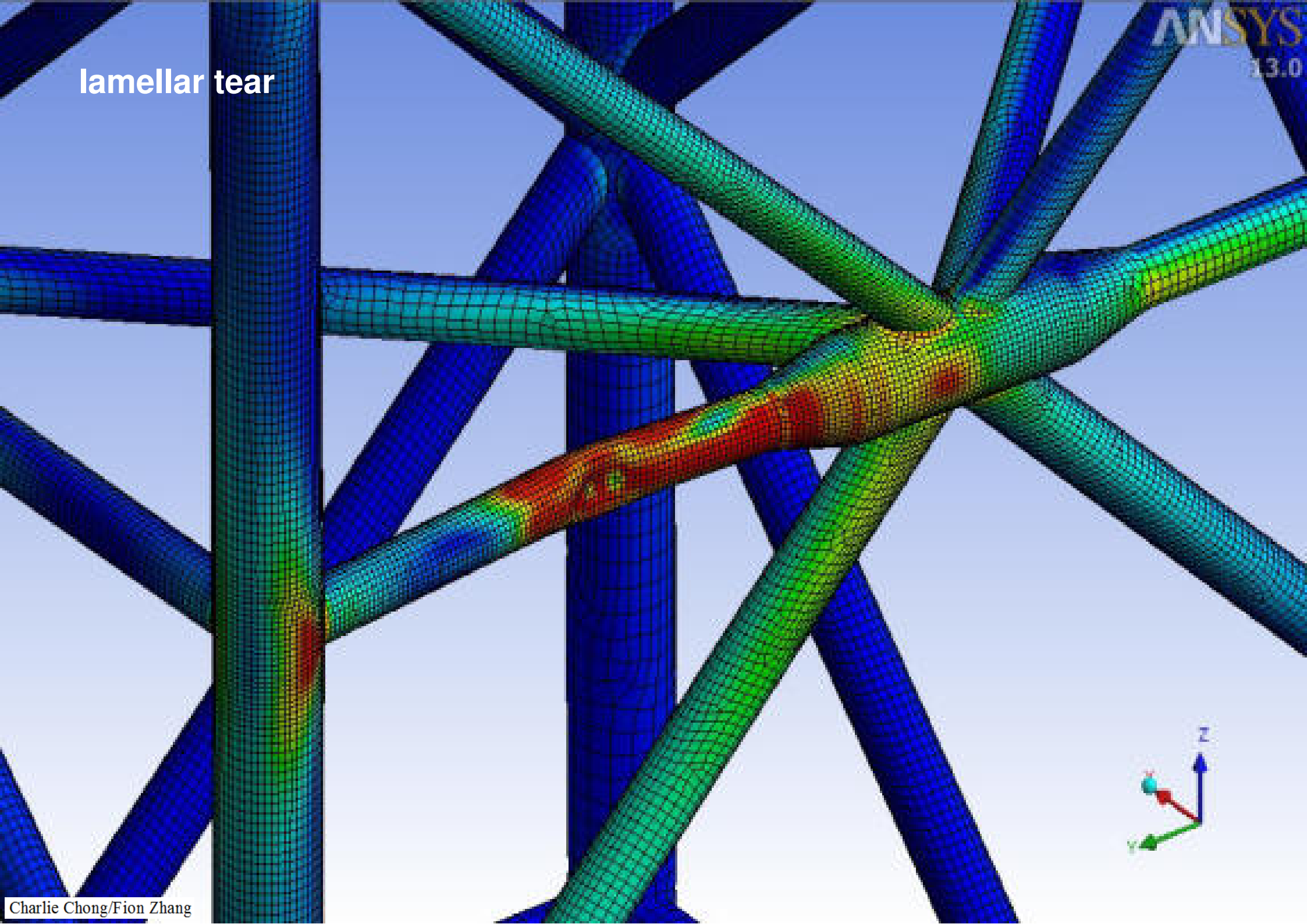


Figure 10 Lamellar tearing


lamellar tear
Z
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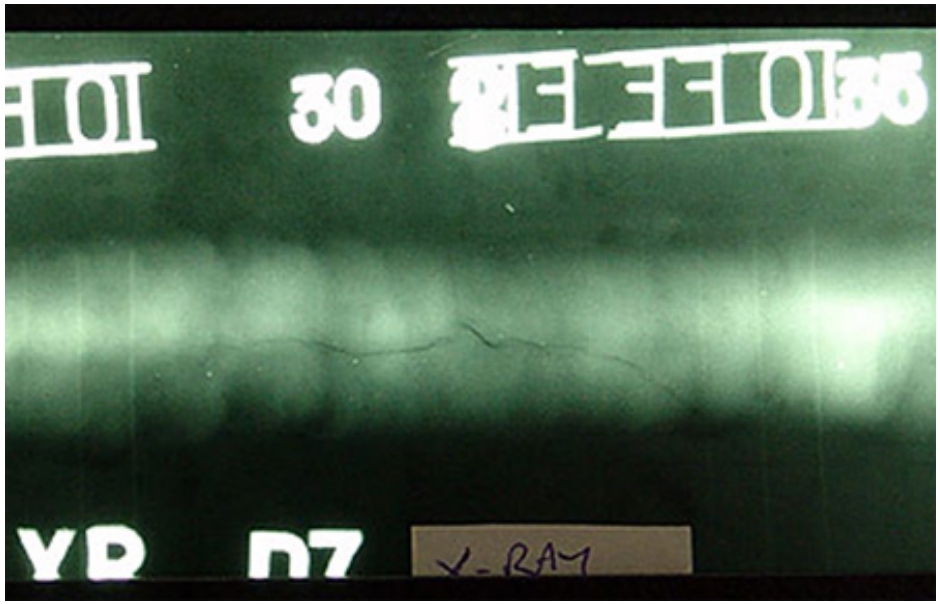
E3
E4
+10

longitudinal crack



3.41 nondestructive examination (NDE): The act of determining the suitability of some material or component for its intended purpose using techniques that do not affect its serviceability.

3.42 overlap: The protrusion of weld metal beyond the weld toe or weld root.

3.43 oxyacetylene cutting (OFC-A): An oxygen gas cutting process variation that uses acetylene as the fuel gas.

3.44 PMI (Positive Materials Identification): Any physical evaluation or test of a material (electrode, wire, flux, weld deposit, base metal, etc.), which has been or will be placed into service, to demonstrate it is consistent with the selected or specified alloy material designated by the owner/ user. These evaluations or tests may provide either qualitative or quantitative information that is sufficient to verify the nominal alloy composition.

PMI


PMI
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PMI

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PMI
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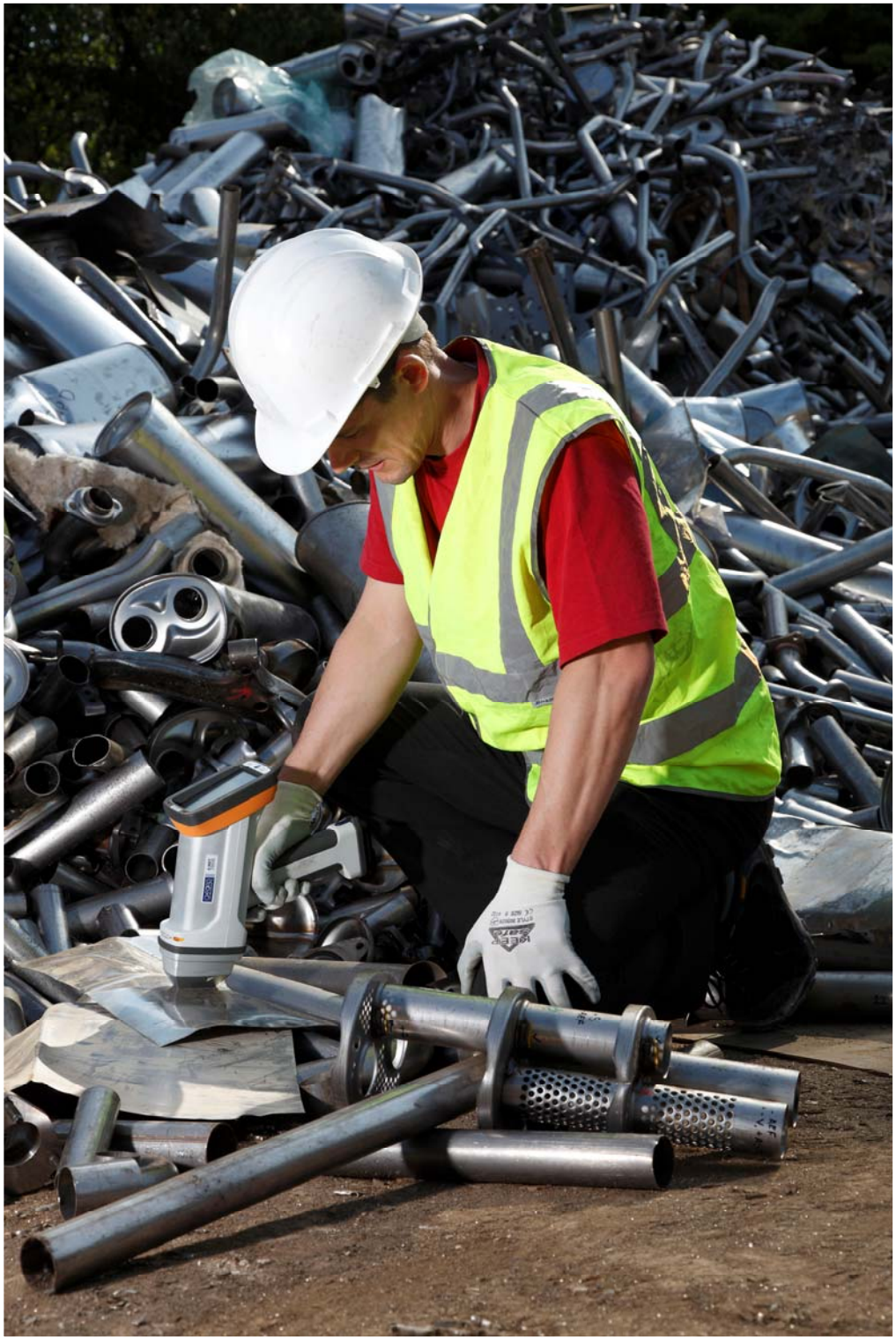
PMI



3.45 peening: The mechanical working of metals using impact blows.

3.46 penetrameter: Old terminology for IQI still in use today but not recognized by the codes and standards.

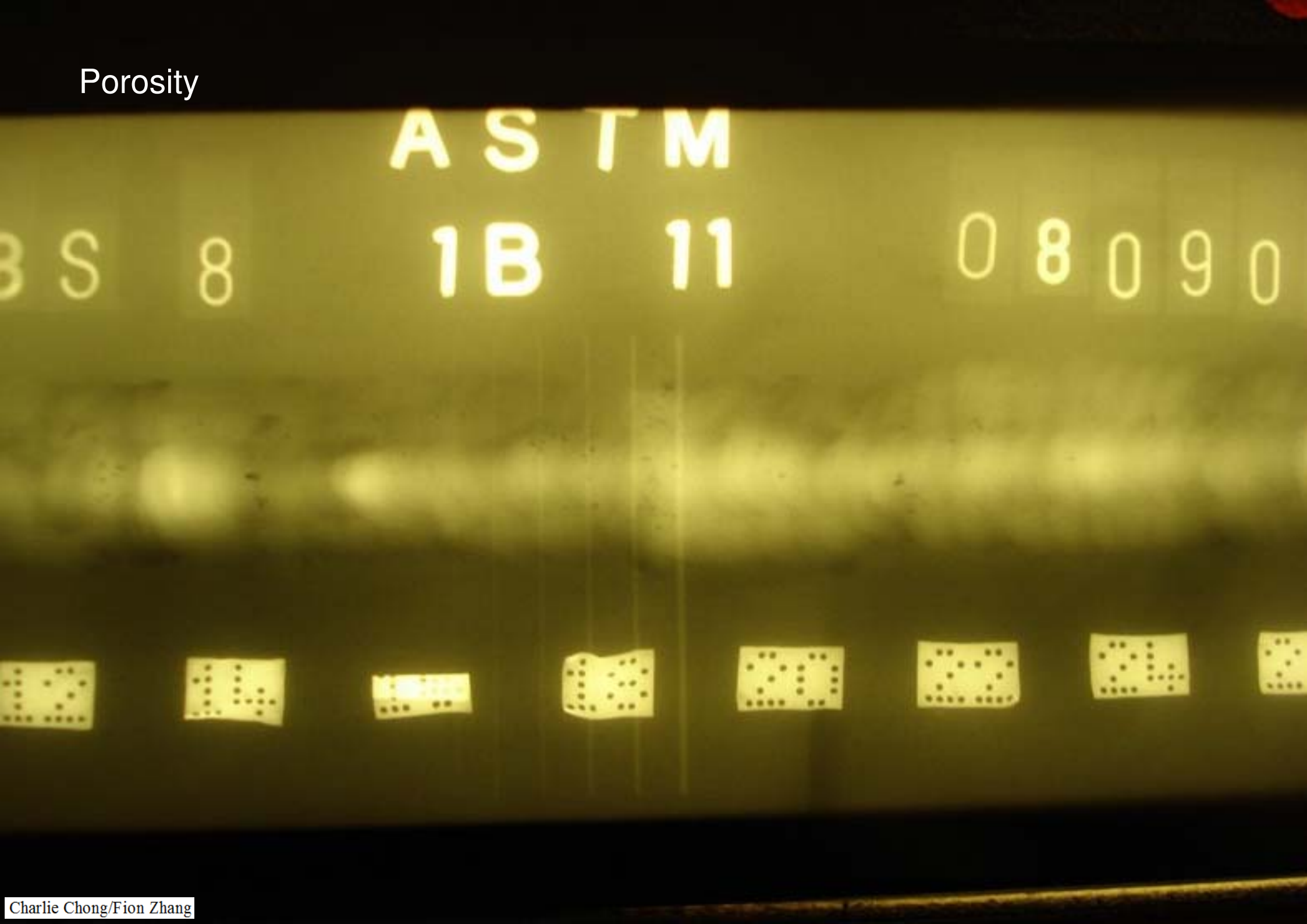
3.47 porosity: Cavity-type discontinuities formed by gas entrapment during solidification or in thermal spray deposit.

3.48 preheat: Metal temperature value achieved in a base metal or substrate prior to initiating the thermal operations.

3.49 recordable indication: Recording on a data sheet of an indication or condition that does not necessarily exceed the rejection criteria but in terms of code, contract or procedure will be documented.

3.50 reportable indication: Recording on a data sheet of an indication that exceeds the reject flaw size criteria and needs not only documentation, but also notification to the appropriate authority to be corrected. All reportable indications are recordable indications but not vice-versa.

Porosity



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3.51 root face: The portion of the groove face within the joint root.

3.52 root opening: A separation at the joint root between the workpieces.

3.53 shielding gas: Protective gas used to prevent or reduce atmospheric contamination.

3.54 slag: A nonmetallic product resulting from the mutual dissolution of flux and nonmetallic impurities in some welding and brazing processes.

3.55 slag inclusion: A discontinuity consisting of slag entrapped in the weld metal or at the weld interface.

3.56 spatter: The metal particles expelled during fusion welding that do not form a part of the weld.

3.57 tack weld: A weld made to hold the parts of a weldment in proper alignment until the final welds are made.

Slag Inclusions

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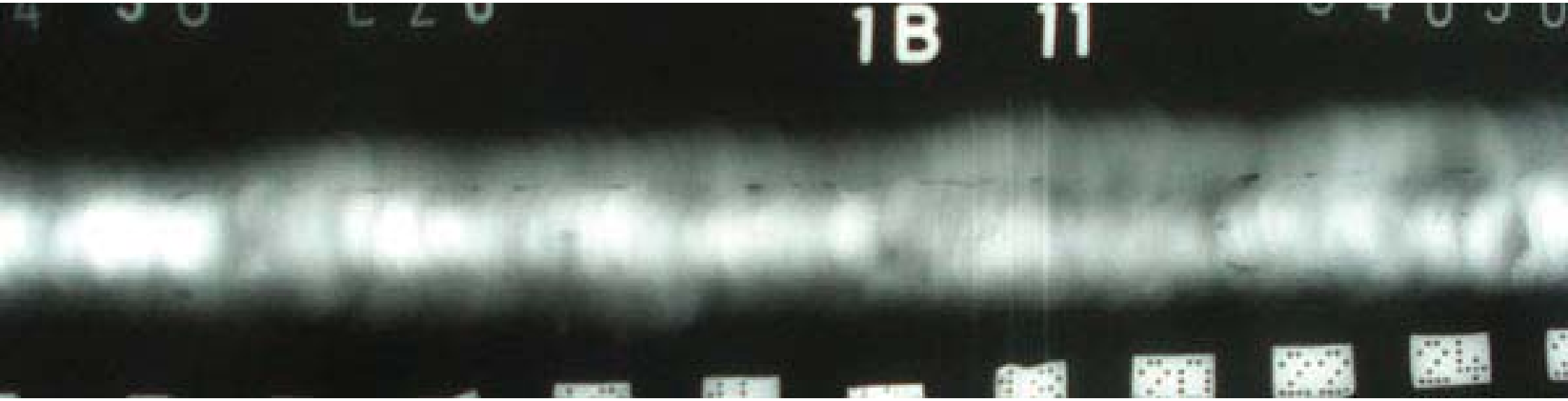
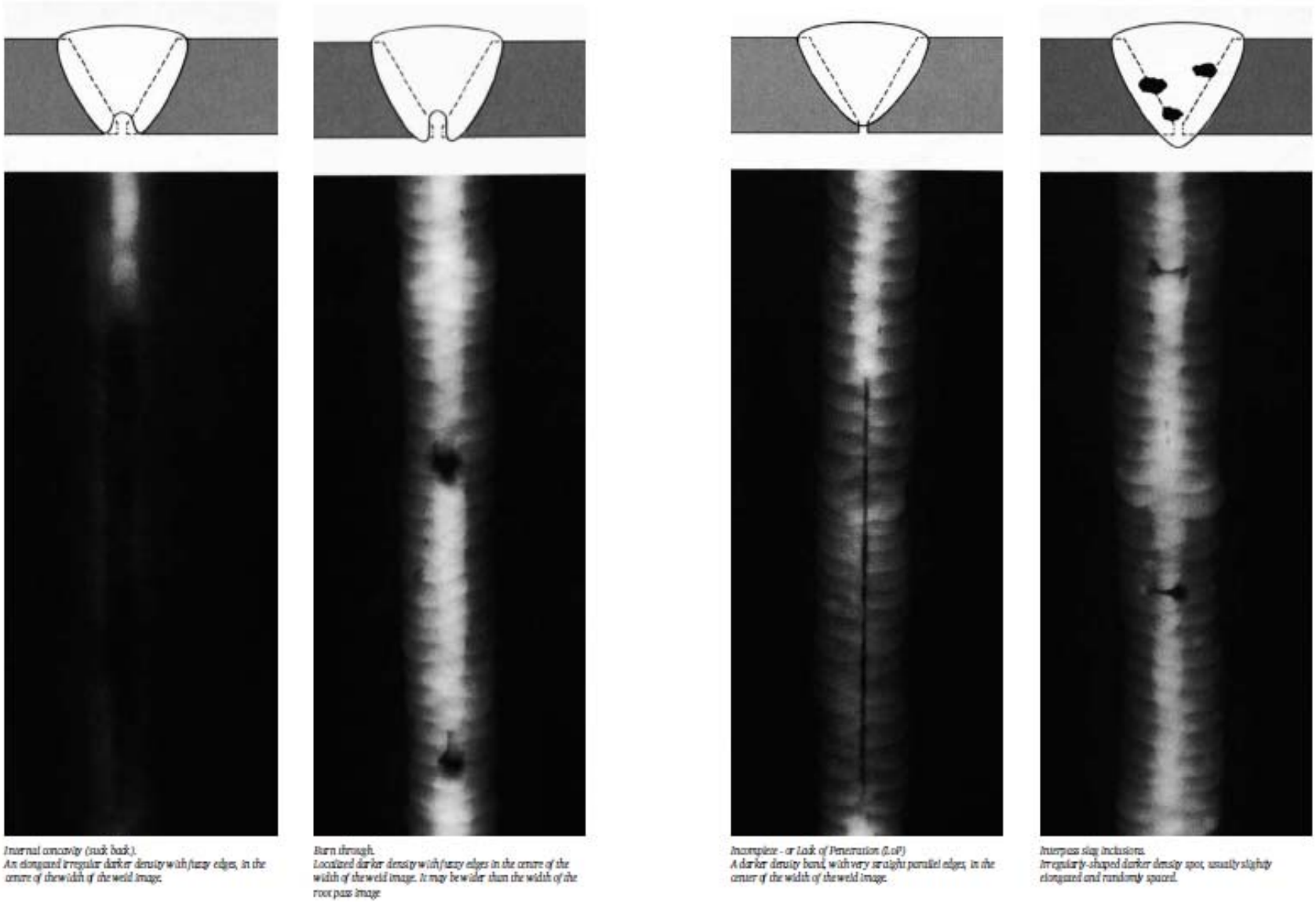
Slag Inclusion



Slag inclusions



Internal concavity (suck back).
An elongated irregular darker density with fuzzy edges, in the centre of the width of the weld image.

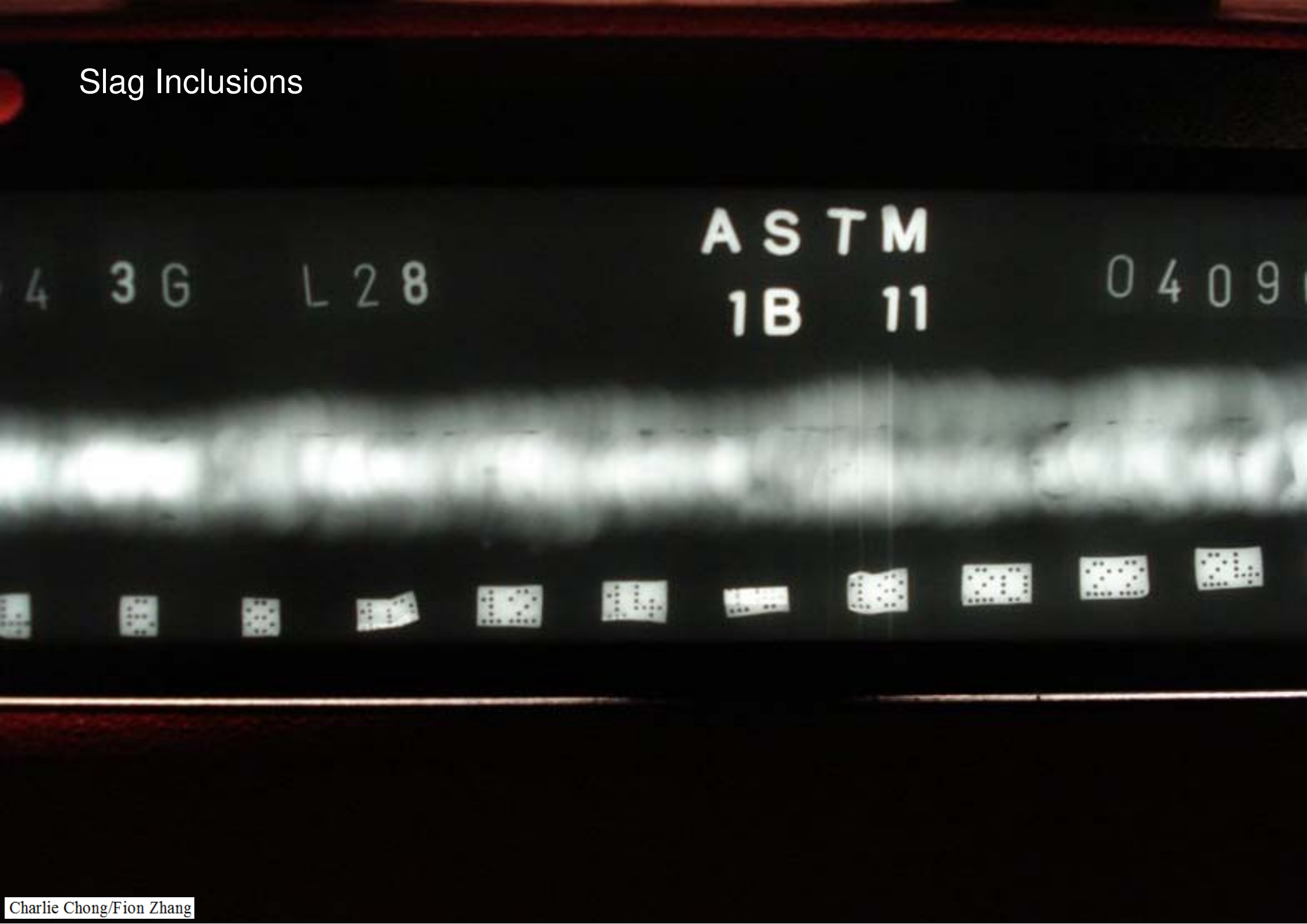
Burn through.
Localized darker density with fuzzy edges in the centre of the width of the weld image. It may be wider than the width of the root pass image.

Incomplete - or Lack of Penetration (LoP)
A darker density band, with very straight parallel edges, in the centre of the width of the weld image.

Interpass slag inclusions.
Irregularly-shaped darker density spot, usually slightly elongated and randomly spaced.

http://www.ge-mcs.com/download/x-ray/GEIT-30158EN_industrial-radiography-image-forming-techniques.pdf

Slag Inclusions



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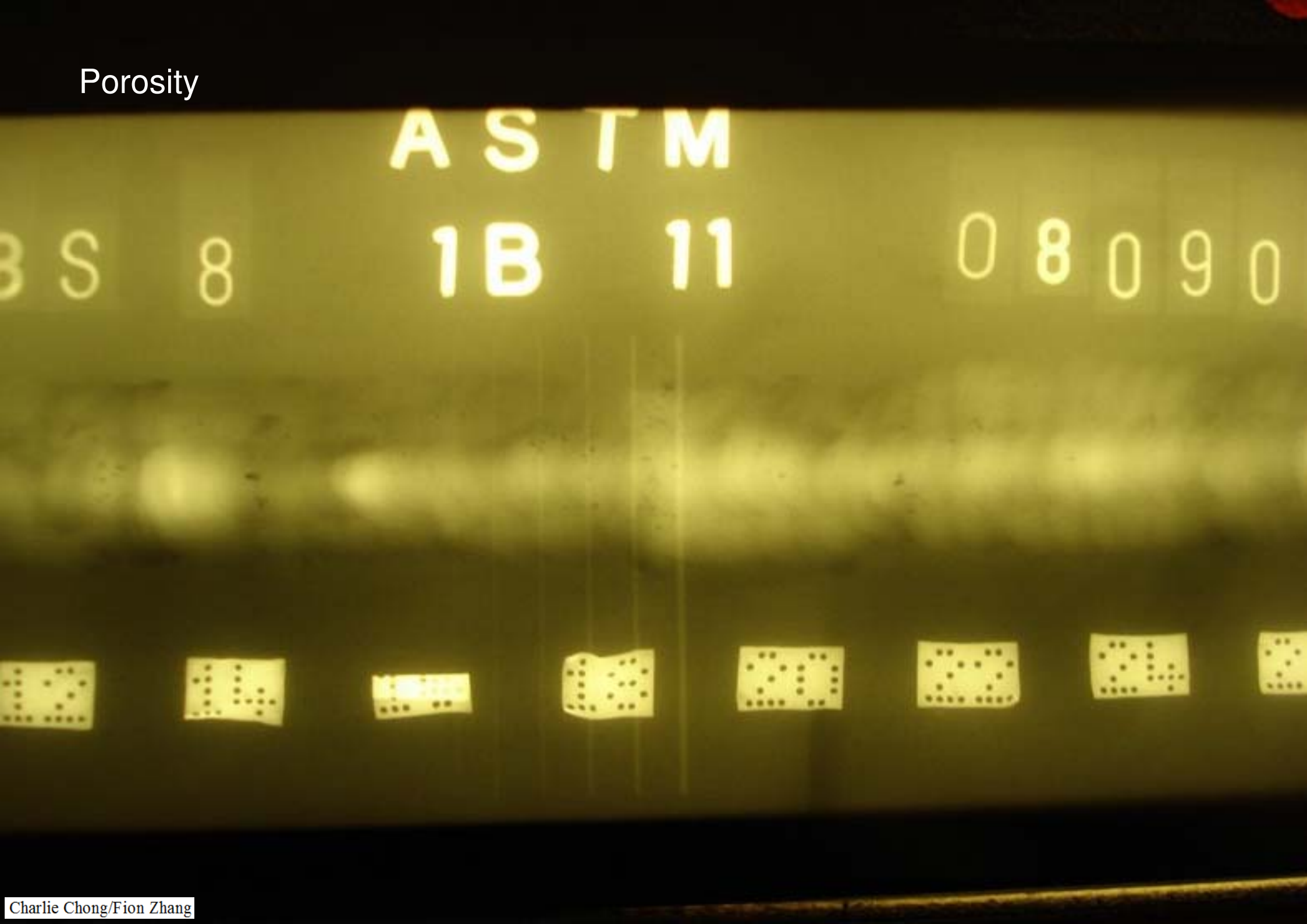
Porosity



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3.58 throat theoretical: The distance from the beginning of the joint root perpendicular to the hypotenuse of the largest right triangle that can be inscribed within the cross-section of a fillet weld. This dimension is based on the assumption that the root opening is equal to zero.

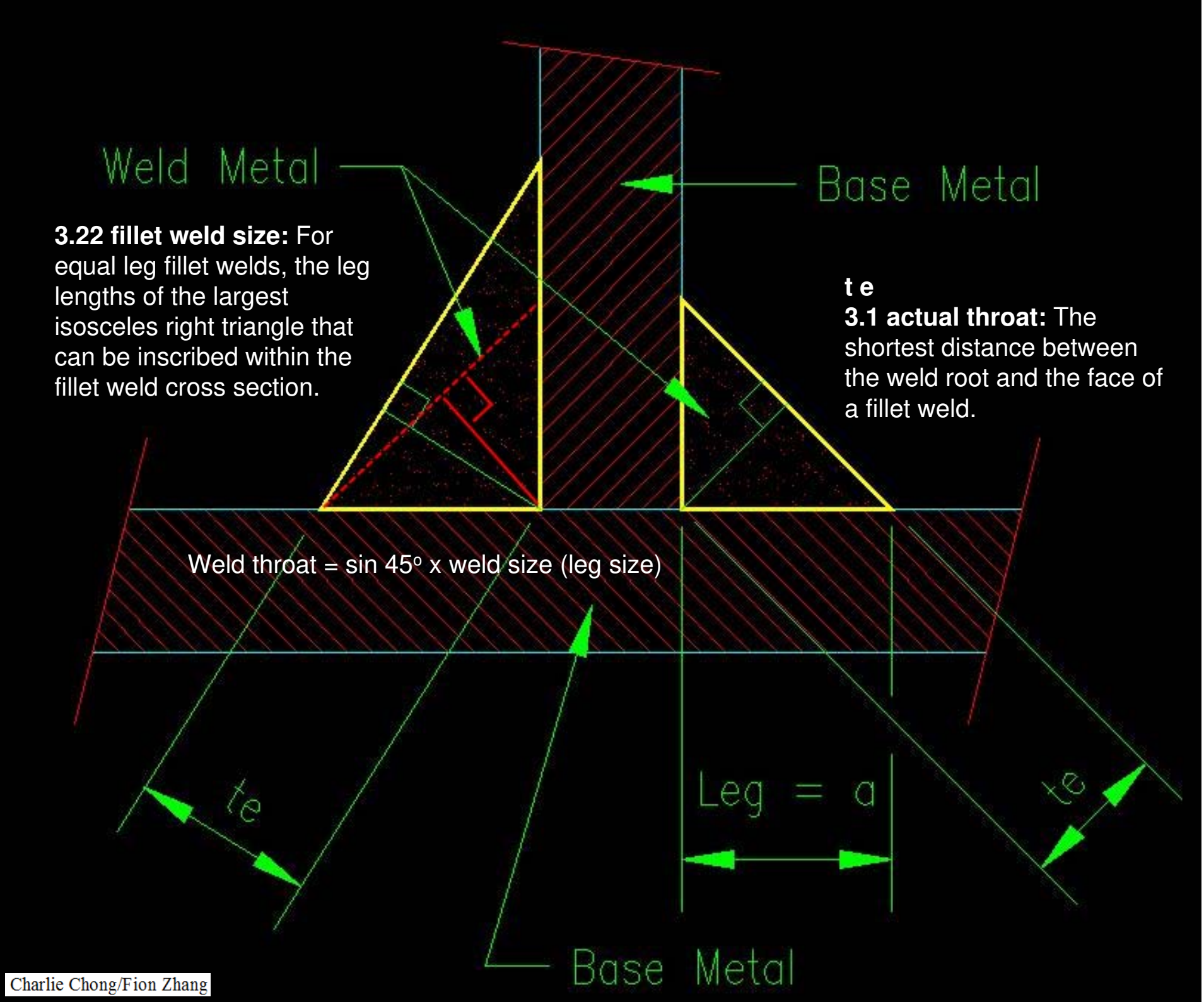
3.59 transverse crack: A crack with its major axis oriented approximately perpendicular to the weld axis.

3.60 travel angle: The angle less than 90 degrees between the electrode axis and a line perpendicular to the weld axis, in a plane determined by the electrode axis and the weld axis.

3.61 tungsten inclusion: A discontinuity consisting of tungsten entrapped in weld metal.

3.62 undercut: A groove melted into the base metal adjacent to the weld toe or weld root and left unfilled by weld metal.

3.63 underfill: A condition in which the weld joint is incompletely filled when compared to the intended design.



3.22 fillet weld size: For equal leg fillet welds, the leg lengths of the largest isosceles right triangle that can be inscribed within the fillet weld cross section.

t e
3.1 actual throat: The shortest distance between the weld root and the face of a fillet weld.

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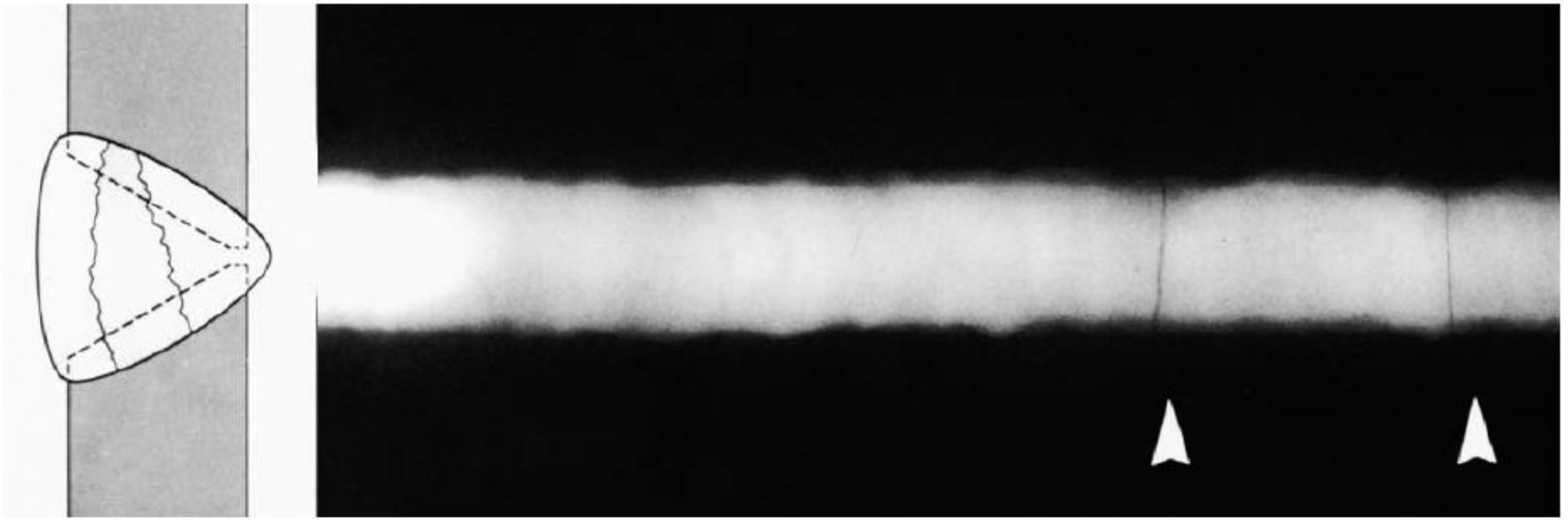
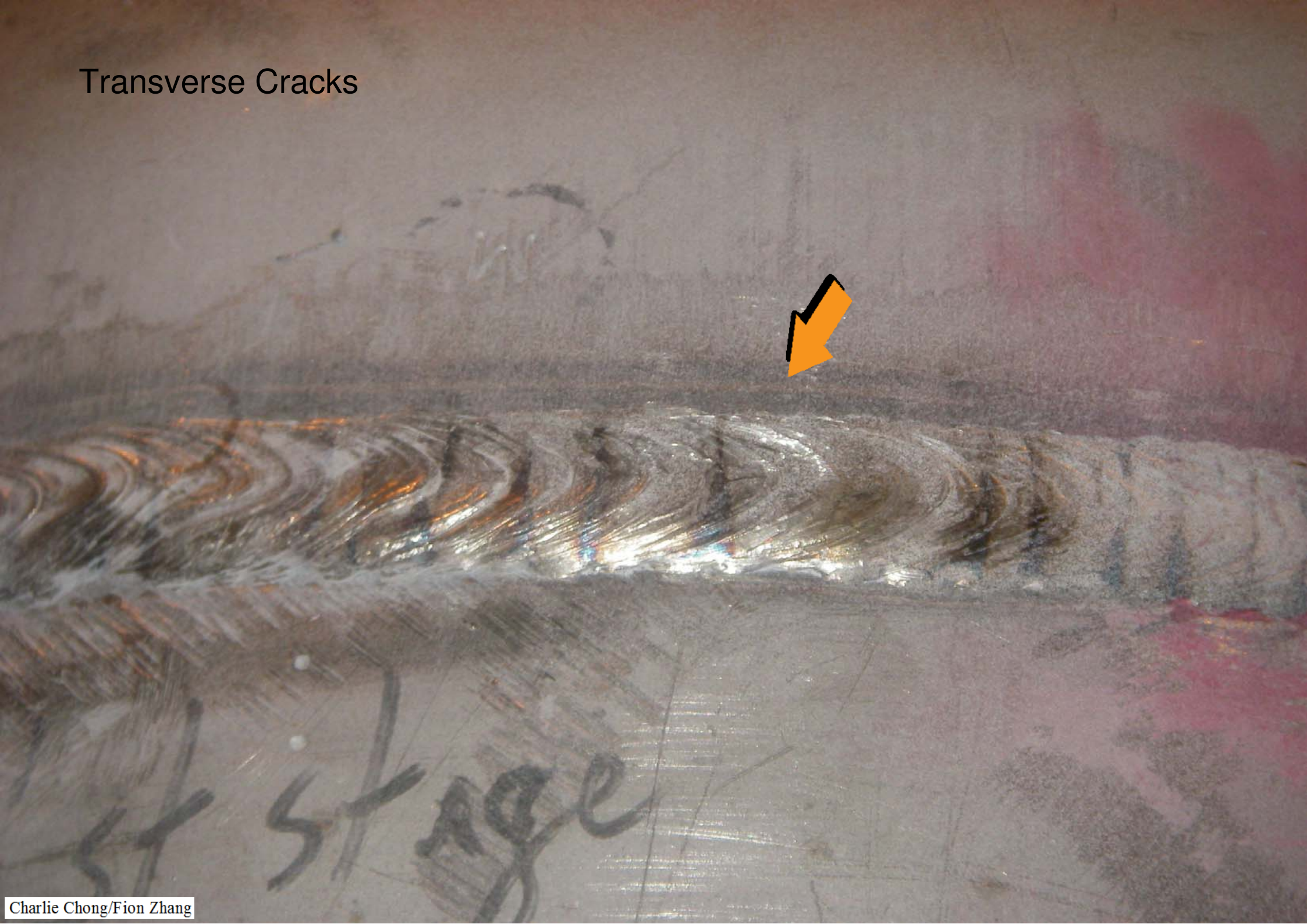
Transverse crack



Transverse crack
Feathery, twisting lines of darker density running across the width of the weld image.

Transverse Cracks



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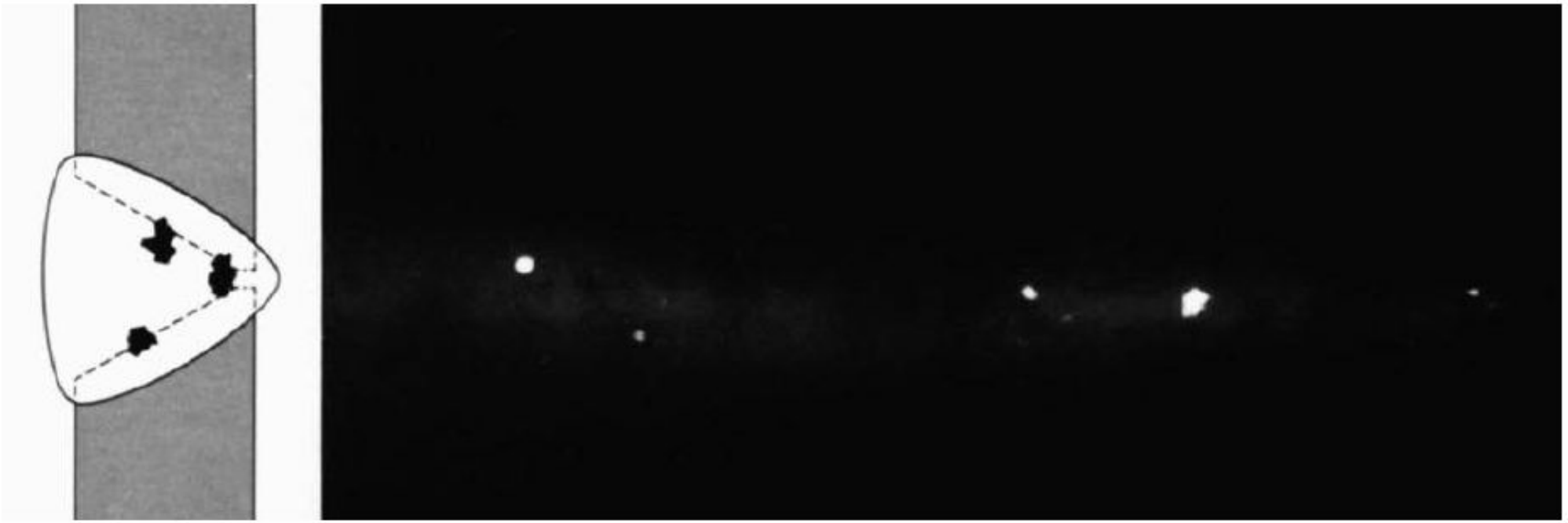
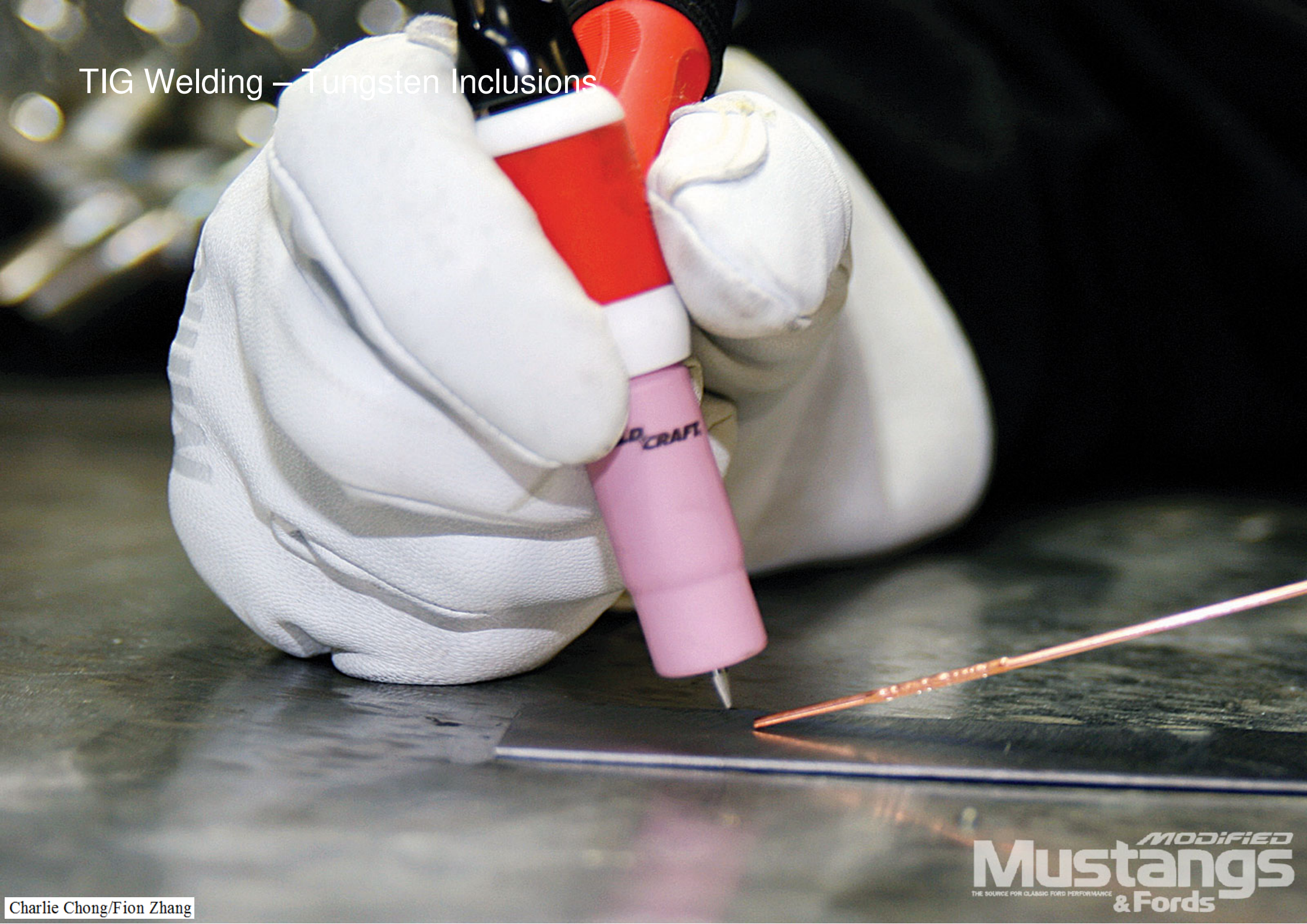
Tungsten Inclusions – TIG Welding



Tungsten inclusions.
Irregularly shaped lower density spots randomly located in the weld image.

TIG Welding – Tungsten Inclusions



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TIG Welding – Tungsten Inclusions

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TIG Welding – Tungsten Inclusions

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3.64 welder certification: Written verification that a welder has produced welds meeting a prescribed standard of welder performance.

3.65 welding: A joining process that produces coalescence of base metals by heating them to the welding temperature, with or without the application of pressure or by the application of pressure alone, and with or without the use of filler metal.

3.66 welding engineer: An individual who holds an engineering degree and is knowledgeable and experienced in the engineering disciplines associated with welding.

3.67 weldment: An assembly whose component parts are joined by welding.

3.68 weld joint: The junction of members or the edges of members which are to be joined or have been joined by welding.

3.69 weld reinforcement: Weld metal in excess of the quantity required to fill a joint.

3.70 weld toe: The junction of the weld face and the base metal.

4 Welding Inspection

4.1 GENERAL

Welding inspection is a critical part of an overall weld quality assurance program. Welding inspection includes much more than just the non-destructive examination of the completed weld. Many other issues are important, such as review of specifications, joint design, cleaning procedures, and welding procedures. Welder qualifications should be performed to better assure the weldment performs properly in service.

Welding inspection activities can be separated into three stages corresponding to the welding work process. Inspectors should perform specific tasks;

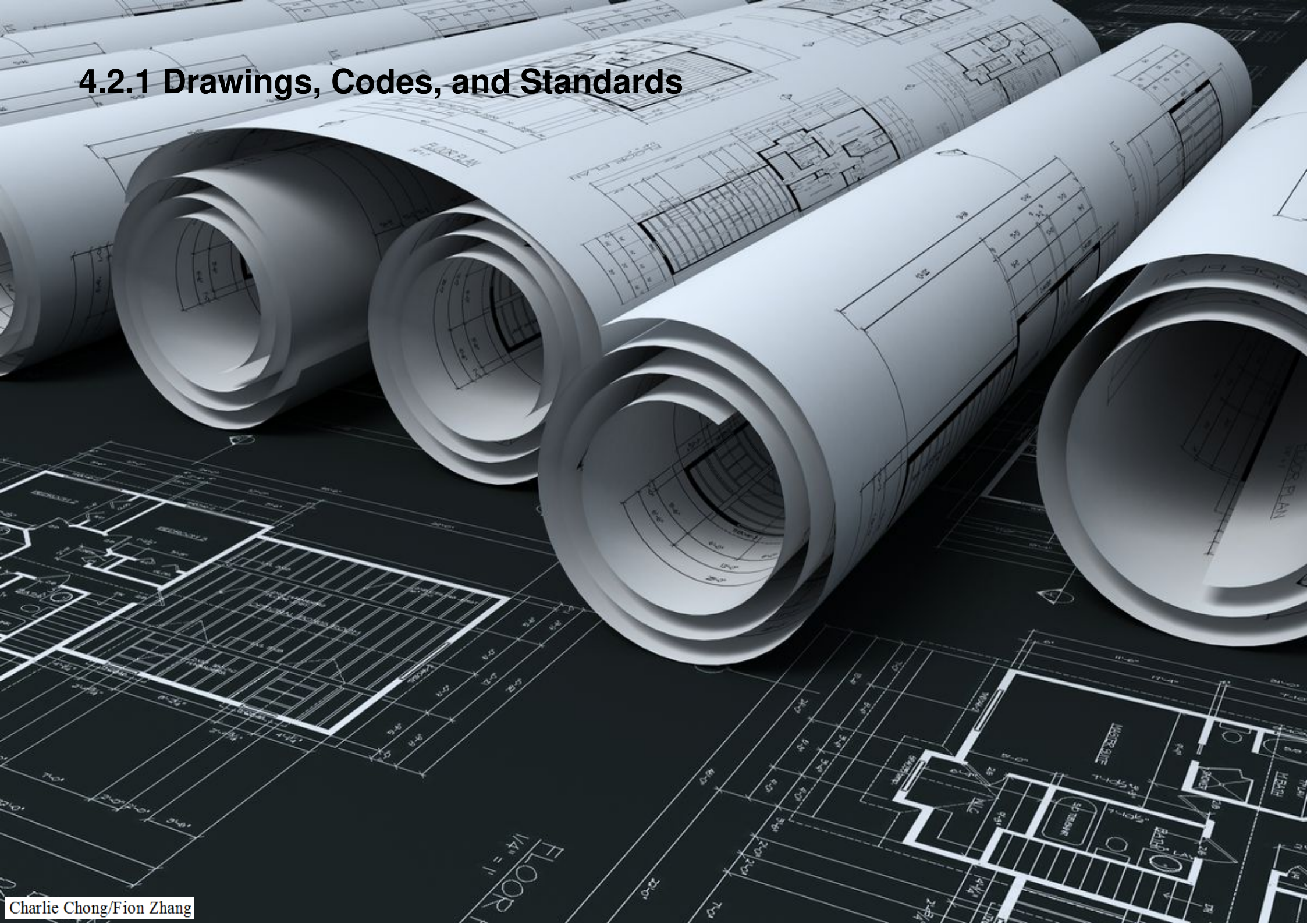
- prior to welding,
- during welding and
- upon completion of welding,

although it is usually not necessary to inspect every weld.

4.2 TASKS PRIOR TO WELDING

The importance of tasks in the planning and weld preparation stage should not be understated. Many welding problems can be avoided during this stage when it is easier to make changes and corrections, rather than after the welding is in progress or completed. Such tasks may include:

4.2.1 Drawings, Codes, and Standards



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4.2.1 Drawings, Codes, and Standards

Review drawings, standards, codes, and specifications to both understand the requirements for the weldment and identify any inconsistencies.

ASME B31.3-2004

(Revision of ASME B31.3-2002)

Process Piping

ASME Code for Pressure Piping, B31

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

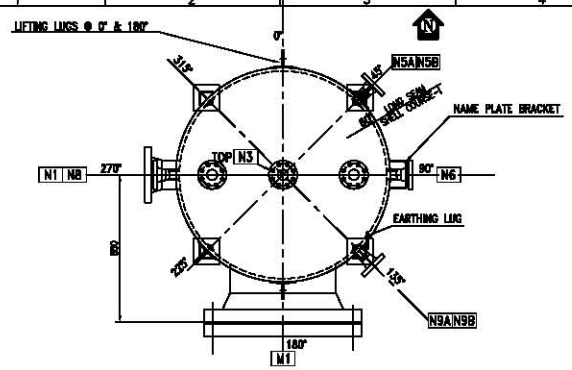
TECHNICAL SPECIFICATION

ACTIVE FIRE PROTECTION SYSTEMS AND EQUIPMENT FOR ONSHORE FACILITIES

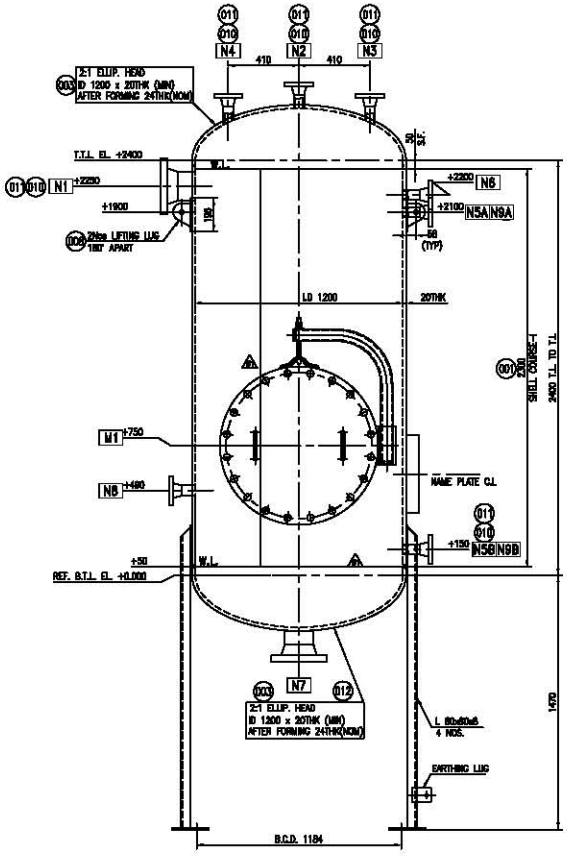
DEP 80.47.10.31-Gen.

December 1999

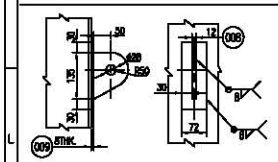
DESIGN AND ENGINEERING PRACTICE

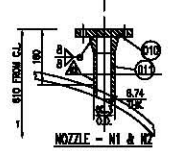


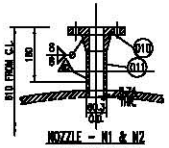
ORIENTATION PLAN

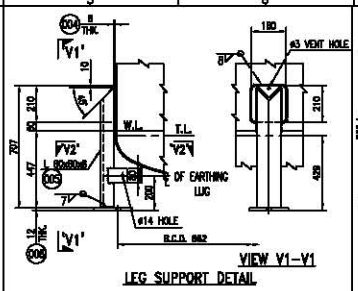


ELEVATION



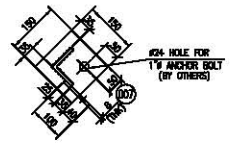




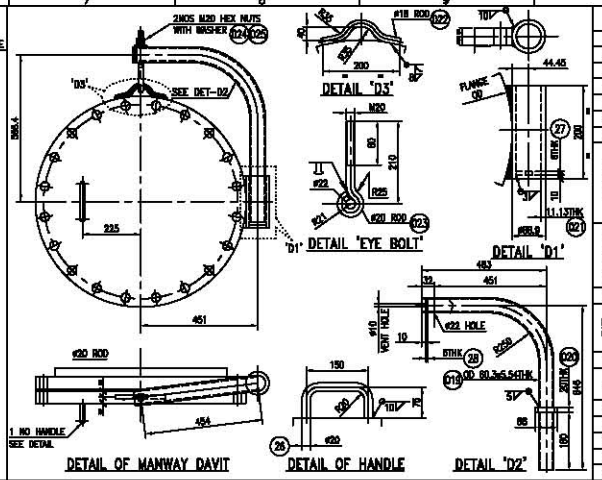


LEG SUPPORT DETAIL

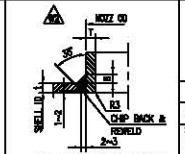
VIEW V1-V1



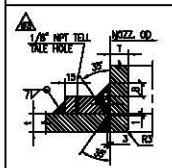
VIEW V2-V2



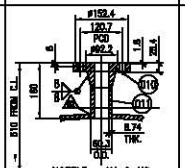
SHELL, D'END, PIPE FITTINGS CIRC. SEAM & LONG SEAM

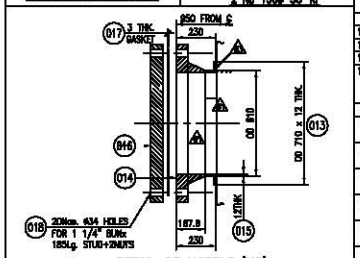


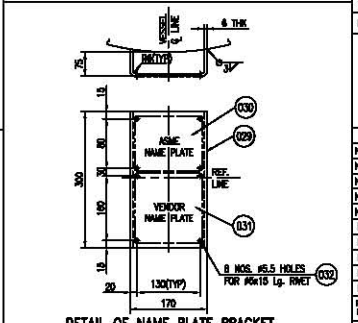
NOZZLE NECK WITH SHELL



NOZZLE JOINT WITH R. PAD







PAINTING SYSTEM (EXTERNAL)

VESSEL PART	TOTAL DFT	SURFACE PREPARATION	PRIMER COAT	INTERMEDIATE COAT	FINISH COAT
SHELL, DISHED END, SHELL NOZZLES, LEG SUPPORTS	250µm	GRIT BLAST TO SA 2.5	DFT: 50 MICRON THIN FILM EPOXY PRIMER No. OF COATS: 1	DFT: 75 MICRON EPOXY No. OF COATS: 1	DFT: 125 MICRON (93+3 COATS) EPOXY No. OF COATS: 2

GENERAL NOTES

13. BEFORE SHIPPING THE VESSEL MUST BE INTERNALLY CLEANED, DRAINED & DRIED.
12. ALL SHELL DIMENSIONS ARE FROM REF. T.L. MARKED +0.00
11. FLANGES SEALING SURFACE FINISHING : 125-250 AARH FINISH AS PER ASME/ANSI B 16.5
10. BESIDES THE INSTALLED MATERIALS AT SHOP SHALL BE SUPPLIED THE FOLLOWINGS SPARE PARTS:
    -1SQR. GASKETS FOR MANHOLE, EARTH FLANGE & EACH BLIND FLANGE.
    -STUD BOLTS AND NUTS: NOS WITH A MINIMUM OF 2 PIECES FOR EACH CONNECTION TYPE.
9. ALL UNSLOTTED WELDS MUST HAVE SIDES EQUAL TO THE LOWER THICKNESS OF THE PLATES TO WELD.
8. PADS TO BE AIR TESTED AT 1 bar(g). AFTER THE PRESSURE MUST BE REDUCED TO 0.5 bar (g) AND ALL WELDS MUST BE TESTED FOR LEAKS WITH SOAP SOLUTION.
7. MANHOLE TO BE SUPPLIED COMPLETE WITH COVER, STUD-BOLT, GASKET & DAVIT. WELD SEAMS IN MANWAY NECK SHALL BE GROUND FLUSH WITH BORE.
6. ALL INTERNAL AND EXTERNAL PARTS WELDED TO THE SHELL SHALL BE OF THE SAME MATERIAL WHICH CONSTITUTES THE SECTION OF THE SHELL WHERE THE PARTS WILL BE WELDED.
5. FLANGES ACCORDING TO STD. ASME B16.5, PIPE CARBON STEEL ACCO. TO ASME B36.10 SEAMLESS, PIPE FITTINGS ACCO. TO ASME B16.9
4. ALL THICKNESSES SHOWN IN THIS DRAWING ARE INTENDED AS MINIMUM VALUES AFTER FORMING FOR DISH HEADS. DISH HEADS BLANK WELD SHALL BE 100% RADIOGRAPHED BEFORE FORMING.
3. UNLESS OTHERWISE INDICATED NOZZLE PROJECTIONS ARE MEASURED FROM EQUIPMENT CENTERLINE OR FROM TANGENT LINES TO CONTACT FLANGE FACINGS.
2. UNLESS OTHERWISE INDICATED, ALL FLANGE CONNECTIONS BOLT HOLES MUST BE STAGGERED TO MAIN AXIS OF THE EQUIPMENT
1. UNLESS OTHERWISE NOTED ALL DIMENSIONS ARE IN MILLIMETERS.

LIST OF CONNECTIONS

POSITION NOTATION	QTY.	NOM. SIZE	SCHEDULE / THICKNESS	PRESS. CLASS	SERVICE	FLANGE TYPE	TEMPLATE NO. DIA. x THK.	PROJ. FROM CENTER LINE	NOTES
N5A/B	2	2"	-/12	300#	LEVEL TRANSMITTAL(LALL)	WN-RF	710 x 12	860	11
N6	1	2"	-/12	300#	PURGE OR UTILITY CONNECTION	WN-RF	710 x 12	860	11
N7	1	6"	-/12	300#	CONDENSITE POT OUTLET	WN-RF	710 x 12	860	11
N8	1	2"	-/12	300#	PVC INLET	WN-RF	710 x 12	860	11
N5A/B	2	2"	-/12	300#	LEVEL TRANSMITTAL/LEVEL GAUGE	WN-RF	710 x 12	860	11
N4	1	2"	NPT(F)	300#	PRESSURE INDICATOR	WN-RF	–	–	–
N3	1	2"	160/8.74	300#	VENT	WN-RF	–	610	11
N2	1	2"	160/8.74	300#	EQUALIZING LINE CONNECTION	WN-RF	–	–	11
N1	1	6"	160/8.74	300#	CONDENSATE POT FEED	WN-RF	–	610	11
M1	1	24"	160/8.74	300#	MANHOLE	WN-RF	–	750	11

DESIGN DATA

				NOTES
DESIGN CODE			ASME SEC. VIII DIV.1 2001 ED. ADD. 2002	
EQUIPMENT NUMBER			–	
ASME STAMP			YES – 'U'	
NATIONAL BOARD NUMBER			N.A.	
INSPECTION AUTHORITY			BI & MRE/LAMPRELL	
MANUFACTURER SERIAL No.			FRF 003 & 004	
PRESSURE: DESIGN	INT/EXT	barg (psig)	12 (174)	
PRESSURE: OPERATING		barg (psig)	–	
PRESSURE: HYDROTEST		barg (psig)	15.6 (226)	
PRESSURE: MAWP		barg (psig)	12 (174) @ 60°C (140°F)	
PRESSURE: CONTROLLED BY			AS PER UG 98, FOOT NOTE 35	
TEMPERATURE: DESIGN		°C (°F)	80 (140)	
TEMPERATURE: OPERATING (NOR. / MAX.)		°C	50/5	
TEMPERATURE: ACTUAL HYDRAULIC TEST		°F	NOT LESS THAN 82 °F	
TEMPERATURE: MDMT		°C (°F)	–29° (–20°) AS PER UG–20(f)	
CORROSION ALLOWANCE		mm	1.6	
FLUID: NAME			CONDENSATE STEAM	
FLUID: DENSITY		kg/m³	1	
FLUID: CAPACITY		m³	1.63	
RADIOGRAPHY			SPOT–RT3	
JOINT EFFICIENCY	SHELL		0.85 AS PER UW 11(b)	
	HEADS		0.85 AS PER UW 11(b)	
INSULATION		TYPE/THK	–	
FIREPROOFING		TYPE/THK	–	
WIND LOAD CALCULATION AS PER			AS PER ASCE–7, ED 98 ,160 kmph	
EARTHQUAKE LOADING AS PER			UBC–94, ZONE–1	
INSTALLATION			VERTICAL	
DYE PEN. TEST			YES	
PWHT			NIL–AS PER UCS–56	
IMPACT TESTING			NIL–EXCEMPTED AS PER PARA UG–20 (f)	
INSPECTION OPENING			AS PER UG–46 f(3)–24"NB–1No.	

WEIGHTS IN Kgs.

FABRICATED	OPENINGS	HYDROTEST				
1000	1000	2830				

MATERIAL CERTIFICATION:
BS EN10204 TYPE 3.1.B – FOR PRESSURE PARTS
BS EN10204 TYPE 2.2 – FOR BOLTS

BILL OF MATERIAL (FOR ONE NO. ONLY)

POS.	QTY.	DESCRIPTION	DIMENSIONS	MATERIAL	NOTES
032	8	RIVET FOR N/P FIXING	ø5x15 Lg. RIVET	BS 364	–
031	1	VENDOR NAME PLATE	3THK x 150 x 180	BS 364	–
030	1	ASME NAME PLATE	3THK x 100 x 150	BS 3064	–
029	1	NAME PL. BRACKET	6THK x 315 x 300	SA 516 GR. 70	–
028	1	END PLATE	OD 48 x 6 THK	SA 36	–
027	1	END PLATE	OD 88 x 6 THK	SA 36	–
026	1	HANDLE	ø20 x 274 Lg.	SA 36	–
025	2	WASHER	40 O.D. x 22 I.D. x 3 THK	C.S.	–
024	1	NUT	M20	SA 194 GR. 2H	–
023	1	EYE BOLT	ø20 (SEE DETAIL)	SA 36	–
022	1	ROD	910 x 240 Lg.	SA 36	–
021	1	PIPE	3"NB SCH–160(11.13)=2000Lg.	SA 106 GR. B	–
020	1	SUPT. PLATE	OD 88 x ID 65 x 20THK	SA 36	–
019	1	DRAFT PIPE	2"NB SCH-80(5.54TH)x1022Lg.	SA 106 GR. B	–
018	20+2	STUD+NUT FOR N6	1 1/4" SUH x 185 Lg.	SA 193–B7/194–2H	–
017	1+1	GASKET FOR N6	FOR 24"NB x 150# – 3THK	CNAF (ASME/ANSI B16.21)	–
016	1	BLIND FLANGE FOR N6	24"NB x 150# RF	SA 105	–
015	1	FNSL PIPE FOR N6	12 THK. x 305 x 1479 Lg.	SA 516 GR. 70	–
014	1	FLANGE FOR N6	24"NB x 150# SO–RF	SA 105	–
013	1	R.F. PAD FOR N6	OD 710 x 12 THK	SA 516 GR. 60	–
012	1	RAL COUPLING WITH PLUG FOR M6	1"NPT (F) x 6000#	SA 105	–
011	4	NOZZLE PIPE FOR N1,N2,N3,N4	2"NB SCH.160(8.74TH)x153 Lg.	SA 106 GR. B	–
010	4	FLANGE FOR N1,N2,N3,N4	2"NB x 300# WN–RF	SA 105	–
009	2	PAD FOR LIFTING LUG	6 THK. 72 x 195 Lg.	SA 516 GR. 70	–
008	2	LIFTING LUG	12 THK. 100 x 136 Lg.	SA 516 GR. 70	–
007	1	EARTHING LUG	6 THK. 80 x 100	SA 516 GR. 70	–
006	4	SHIMS PLATE	12 THK. 150 x 150	SA 36	–
005	4	SUPPORT LEG	L 80 x 80 x 8 – 897 Lg.	SA 36	–
004	4	PAD FOR SUPPORT LEG	6 THK. 180 x 210	SA 516 GR. 70	–
003	2	DISH (2:1 ELLIP.)	20 THK. (M.A.F.) = 1200 I.D.	SA 516 GR. 70	8mm (NOM)
001	1	SHELL COURSE–I PLATE	20 THK x 2300 x 3833 Lg.	SA 516 GR. 70	–

REV	DESCRIPTION	DATE	DRAWN	CHECKED	APPROVED
0	ISSUED FOR APPROVAL	19/03/2003	Kannanaan	Murthy	

CODED FABRICATOR:
FERROFAB L.L.C
P.O. BOX: 14726
DUBAI, U.A.E

TEL: +971–4–3477780
FAX: +971–4–3477065

CONTRACTOR :
LAMPRELL
SHARJAH, U.A.E

ITEM –

SERVICE :
AIR RECEIVER–II
QTY. – 2 Nos.

JOB NO. –

DRAWING NUMBER FF–LAM–A1–0120

REV. 0

SCALE 1:15

SHEET 1 OF 2

FILE NAME : – FF–LAM–A0–0063_SH1.DWG

4.2.1 Drawings, Codes, and Standards

Review drawings, standards, codes, and specifications to both understand the requirements for the weldment and identify any inconsistencies.

4.2.1.1 Quality control items to assess:

a. Welding symbols and weld sizes clearly specified (See Appendix A).
b. Weld joint designs and dimensions clearly specified (see Appendix A).
c. Weld maps identify the welding procedure specification (WPS) to be used for specific weld joints.
d. Dimensions detailed and potential for distortion addressed.
e. Welding consumables specified (see 7.3, 7.4, 7.6, and Appendix D).
f. Proper handling of consumables, if any, identified (see 7.7).
g. Base material requirements specified (such as the use of impact tested materials where notch ductility is a requirement in low temperature service).
h. Mechanical properties and required testing identified (see 10.4)
i. Weather protection and wind break requirements defined.

i. Preheat requirements and acceptable preheat methods defined (see 10.5).
j. Post-weld heat treatment (PWHT) requirements and acceptable PWHT method defined (see 10.6).
k. Inspection hold-points and NDE requirements defined (see Section 9).
l. Additional requirements, such as production weld coupons, clearly specified.
m. Pressure testing requirements, if any, clearly specified (see 9.11).

4.2.1.2 Potential inspector actions:

a. Identify and clarify missing details and information.
b. Identify and clarify missing weld sizes, dimensions, tests, and any additional requirements.
c. Identify and clarify inconsistencies with standards, codes and specification requirements.
d. Highlight potential weld problems not addressed in the design.

4.2.2 Weldment Requirements

Review requirements for the weldment with the personnel involved with executing the work such as the design engineer, welding engineer, welding organization and inspection organization.

4.2.2.1 Quality control items to assess:

a. Competency of welding organization to perform welding activities in accordance with codes, standards, and specifications.
b. Competency of inspection organization to perform specified inspection tasks.
c. Roles and responsibilities of engineers, welding organization, and welding inspectors defined and appropriate for the work.
d. Independence of the inspection organization from the production organization is clear and demonstrated.

4.2.2.2 Potential inspector action: highlight deficiencies and concerns with the organizations to appropriate personnel.

4.2.3 Procedures and Qualification Records

Review the WPS(s) and welder performance qualification record(s) (WPQ) to assure they are acceptable for the work.

4.2.3.1 Quality control items to assess:

a. WPS(s) are properly qualified and meet applicable codes, standards and specifications for the work (see 6.4).
b. Procedure qualification records (PQR) are properly performed and support the WPS(s) (see 6.4).
c. Welder performance qualifications (WPQ) meet requirements for the WPS (see 8.3).

4.2.3.2 Potential inspector actions:

a. Obtain acceptable WPS(s) and PQR(s) for the work.
b. Qualify WPS(s) where required and witness qualification effort.
c. Qualify or re-qualify welders where required and witness a percentage of the welder qualifications.

ASME IX: ARTICLE II WELDING PROCEDURE QUALIFICATIONS

Charlie Chong/Fion Zhang

E.I.E.
MESTRE (VE)

WELDING PROCEDURE SPECIFICATION
SPECIFICA PROCEDIMENTO DI SALDATURA

WPS N° 2M00

CLIENT: CLIENTE

PROJECT: PROGETTO

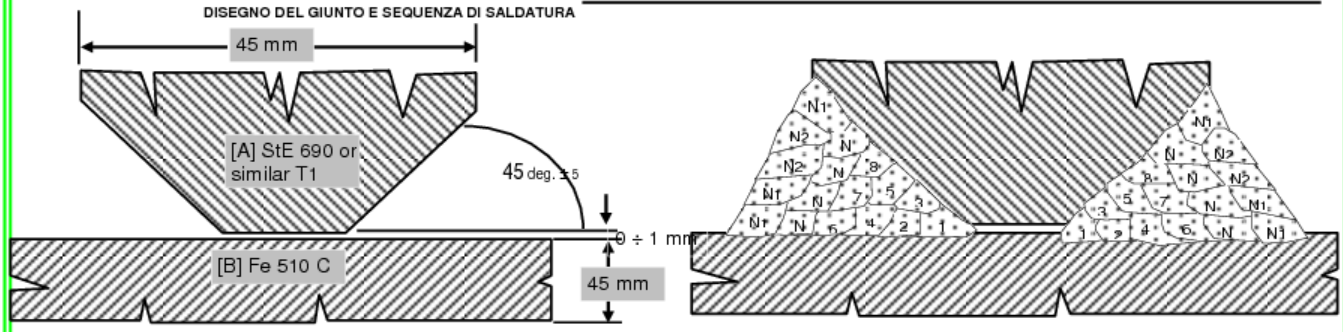
Supporting **PQR n°** N° PROCEDIMENTO DI SALDATURA (WPAR)

[XX] * ASME Code Sec.IX par.QW-200.1 [ ] OTHER RACCOLTA "S"

WELDING PROCESS:1) **SMAW** 2) 3)
PROCEDIMENTO DI SALDATURA

WELDING TYPES: 1) **MANUAL** (manua.aut.semiaut.) 2) 3)
TIPO DI SALDATURA

(QW-402)*JOINT DESIGN&WELDING SEQUENCES **SEE DETAIL**
DISEGNO DEL GIUNTO E SEQUENZA DI SALDATURA



BACKING: **YES** SUPPORT

BACKING MATERIAL: **BASE** MATERIALE DEL SUPPORTO

Test for PQR type TEST UTILIZZATI

(QW-403)* BASE METALS: [A] P-No **N.A. (StE 690)** Gr-No **N.A.** To [B] P-No **SAME 1** Gr-No **2**
METALLO DI BASE A e B

[A] SPECIFICATION, TYPE, GRADE: **StE 690 (T1) or similar (ex.: ASTM A 517 Gr.B P-No11B Gr.4 o A 514 Gr.B UNS No K11**
SPECIFICA TIPO E GRADO (Mater: [A])

[B] To SPECIFICAT., TYPE, GRADE: **Fe 510 C**
CON SPECIFICA TIPO E GRADO (Mater: [B])

VALIDITY RANGE (mm) Thickness: **40÷50** Outside Diam: **N.A**
CAMPO DI VALIDITA' IN mm SPESSORI DIAMETRO ESTERNO

(QW-404)* FILLER METAL CLASSIFICATION: F-No: **4** A-No: **1**
CLASSIFICAZIONE DEL MATERIALE D'APPORTO

SFA-AWS 1) **A5.5 - E 9018-M** 2) 3)

Type - Trade Name - Size **FILARC 98 - OR SIMILAR ELECTRODE WITH LOW HYDROGEN CONTENT, SLIGHTELY ALLOYED**
TIPO - FABBRICANTE - DIAMETRO

CONDITION AGAIN INTO FURNACE AT 350÷370°C FOR 1 HOUR, TRANSFER INTO THE PORTABLE FURNACE DURING USE

(QW-405)* WELDING POSITION:
POSIZIONE DI SALDATURA

Position of Groove
POSIZIONE DEL GIUNTO

Position of Fillet **PLANE-FRONTAL PLANE**
POSIZIONE DELL'ANGOLO

Welding Progression **N.A.**
PROGRESSIONE DI SALDATURA

(QW-406)* PREHEAT CONDITION:
CONDIZIONI DI PRERISCALDO

Preheat Temper. minimun/max. °C **150**
TEMPERATURA MINIMA DI PRERISCALDO

Interpass Temper.minim./ max.°C **100÷200**
TEMPERATURA MASS./MIN. TRA LE PASSATE

Preheat Maintenance T/°C-min. **NO**
TEMPERATURA E TEMPO DI POST-RISCALDO

(QW-407)* -PWHT- POST WELD HEAT TREATMENT:
TRATTAMENTO TERMICO DOPO SALDATURA

Temper: Range °C **520** Time **1h/25mm**
CAMPO DI REGIME TEMPO

Heat Rate °C/h **200°/h** Cool Rate °C/h **150-300°/h**
GRADIENTE DI RISCAL. GRADIENTE DI RAFF.

Other:
ALTRO

(QW-408)* GAS	Type TIPO	Composition % COMPOSIZIONE	Flow Rate-l/1' PORTATA l/1'
Shield Gas GAS DI PROTEZIONE	\\	\\	\\
Gas Backing GAS AL ROVESCIO	\\\	\\	\\

(QW-409)*ELECTRICAL CHARATER.(see table below)
CARATTERISTICHE ELETTRICHE (VEDI TABELLA SOTTO)

(QW-410)* TECHNIQUE:
TECNICA DEL PROCESSO DI SALDATURA

String or Weave Bead **MODERATE OSCILLATION**
CORDONI DI SALD. TESSUTI O TIRATI

Orifice or Gas Cup Size ****
DIMEN. CAPPUCCIO DELLA TORCIA

Tungsten E. Type & Size ****
E. TUNGSTENO TIPO E GRANDEZZA

Contact Tube to Work Distance ****
DISTANZA UGELLO PORTAFILO PEZZO

Initial and Interpass Cleaning ****BRUSHING & GRINDING**
PULIZIA INIZIALE E TRA LE PASSATE

Method Back Gouging **N.A.**
METODO DI PULIZIA AL ROVESCIO

Multiple or Single Pass **MULTIPLE**
MULTIPLE O SINGOLE PASSATE

W. Lay PASSATE	Process PROCEDIMENTO	Filler Metal AWS - CLASS	(MAT. D'APPORTO) DIA §	TYPE & POLARITY	Current (CORRENTE) AMPER - Range	VOLT. RANGE	OTHER ALTRO	Min e Max KJ/cm
1÷3	SMAW	E 9018-M	4	DC-EP	150-160	25-26	65mm = KJ/cm 36	21,4-53,4
4÷N	SMAW	E 9018-M	5	DC-EP	200-220	27-29	70 mm = KJ/cm 47	
N1	SMAW	E 9018-M	4	DC-EP	150-160	25-26	65mm = KJ/cm 36	
N2	SMAW	E 9018-M	4	DC-EP	150-160	25-26	65mm = KJ/cm 36	

ISSUE	DATE	DESCRIPTION (Reason)	MANUFACTURER
0	16-02-97	NOT FOR CONSTRUCTION	

4.2.4 NDE Information

Confirm the NDE examiner(s), NDE procedure(s) and NDE equipment of the inspection organization are acceptable for the work.

4.2.4.1 Quality control items to assess:

a. NDE examiners are properly certified for the NDE technique (see 4.6)
b. NDE procedures are current and accurate.
c. Calibration of NDE equipment is current.

4.2.4.2 Potential inspector actions:

a. Identify and correct deficiencies in certifications and procedures.
b. Obtain calibrated equipment.

Charlie Chong/Fion Zhang

ASNT Central Certification Program

Be it known that

Clyde L Finklea

has met the established and published Requirements for Certification by ASNT as

ACCP Level II

in the following Nondestructive Testing Methods:

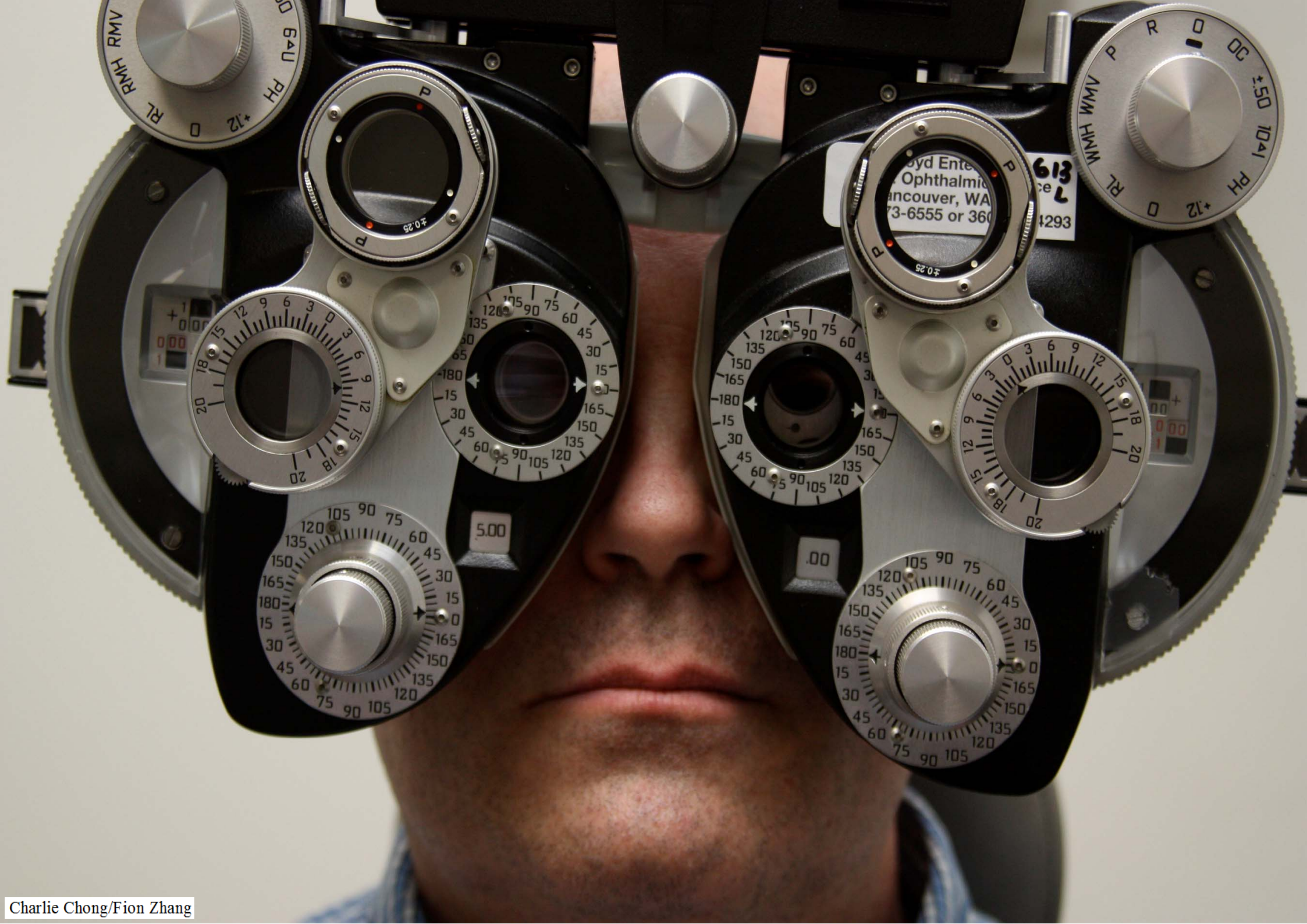
Method	Sector	Technique	Issue Date	Expiration Date
Magnetic Particle Testing	GI	Y	03/04	03/09
Liquid Penetrant Testing	GI	S;W	03/04	03/09
Ultrasonic Testing	GI	W	03/04	03/09
Visual and Optical Testing	GI	D	03/04	03/09

141337

Certificate Number

ASNT President

Certification Management Council Chair



Charlie Chong/Fion Zhang

4.2.5 Welding Equipment and Instruments

Confirm welding equipment and instruments are calibrated and operate.

4.2.5.1 Quality control items to assess:

a. Welding machine calibration is current
b. Instruments such as ammeters, voltmeters, contact pyrometers, have current calibrations.
c. Storage ovens for welding consumables operate with automatic heat control and visible temperature indication.

4.2.5.2 Potential inspector actions:

a. Recalibrate equipment and instruments.
b. Replace defective equipment and instruments.

4.2.6 Heat Treatment and Pressure Testing

Confirm heat treatment and pressure testing procedures and associated equipment are acceptable.

4.2.6.1 Quality control items to assess:

a. Heat treatment procedure is available and appropriate (see 10.6).

b. Pressure testing procedures are available and detail test requirements (see 9.11).

c. PWHT equipment calibration is current.

d. Pressure testing equipment and gauges calibrated and meet appropriate test requirements.

4.2.6.2 Potential inspector actions:

a. Identify and correct deficiencies in procedures

b. Obtain calibrated equipment

4.2.6 Heat Treatment and Pressure Testing

Confirm heat treatment and pressure testing procedures and associated equipment are acceptable.

4.2.6.1 Quality control items to assess:

a. Heat treatment procedure is available and appropriate (see 10.6).
b. Pressure testing procedures are available and detail test requirements (see 9.11).
c. PWHT equipment calibration is current.
d. Pressure testing equipment and gauges calibrated and meet appropriate test requirements.

4.2.6.2 Potential inspector actions:

a. Identify and correct deficiencies in procedures
b. Obtain calibrated equipment

4.2.7 Materials

Ensure all filler metals, base materials, and backing ring materials are properly marked and identified and if required, perform PMI to verify the material composition.

4.2.7.1 Quality control items to assess:

a. Material test certifications are available and items properly marked (including back-up ring if used; see 10.8).
b. Electrode marking, bare wire flag tags, identification on spools of wire, etc. as-specified (see 9.2).
c. Filler material markings are traceable to a filler material certification.
d. Base metal markings are traceable to a material certification.
e. Recording of filler and base metal traceability information is performed.
f. Base metal stampings are low stress and not detrimental to the component.
g. Paint striping color code is correct for the material of construction.
h. PMI records supplement the material traceability and confirm the material of construction (see 9.2).

4.2.7.2 Potential inspector actions:

a. Reject non-traceable or improperly marked materials.
b. Reject inappropriate materials.

4.2.8 Weld Preparation

Confirm weld preparation, joint fit-up, and dimensions are acceptable and correct.

4.2.8.1 Quality control items to assess:

a. Weld preparation surfaces are free of contaminants and base metal defects such as laminations and cracks.
b. Preheat, if required, applied for thermal cutting
c. Hydrogen bake-out heat treatment, if required, performed to procedure.
d. Weld joint is free from oxide and sulfide scales, hydrocarbon residue, and any excessive build-up of weld-through primers.
e. Weld joint type, bevel angle, root face and root opening are correct.
f. Alignment and mismatch is correct and acceptable.
g. Dimensions of base materials, filler metal, and weld joint are correct.
h. Piping socket welds have proper gap.

4.2.8.2 Potential inspector action: reject material or correct deficiencies.

4.2.9 Preheat

Confirm the preheat equipment and temperature.

4.2.9.1 Quality control items to assess:

a. Preheat equipment and technique are acceptable.
b. Preheat coverage and temperature are correct (see 10.5).
c. Reheat, if required, applied to thermal cutting operations.
d. Preheat, if required, applied to remove moisture.

4.2.9.2 Potential inspector action: identify and correct deficiencies in the preheat operations.

4.2.10 Welding Consumables

Confirm electrode, filler wire, fluxes, and inert gases are as specified and acceptable.

4.2.10.1 Quality control items to assess:

a. Filler metal type and size are correct per procedure.
b. Filler metals are being properly handled and stored (see 7.7).
c. Filler metals are clean and free of contaminants.
d. Coating on coated electrodes is neither damaged nor wet.
e. Flux is appropriate for the welding process and being properly handled.
f. Inert gases, if required are appropriate for shielding and purging.
g. Gas composition is correct and meets any purity requirements.
h. Shielding gas and purging manifold systems are periodically bled to prevent back filling with air.

4.2.10.2 Potential inspector actions:

a. Reject inappropriate materials.
b. Identify and correct deficiencies.

4.3 TASKS DURING WELDING OPERATIONS

Welding inspection during welding operations should include audit parameters to verify the welding is performed to the procedures. Such tasks may include the following:

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4.3.1 Quality Assurance

Establish a quality assurance and quality control umbrella with the welding organization.

4.3.1.1 Quality control items to assess:

a. Welder is responsible for quality craftsmanship of weldments
b. Welder meets qualification requirements
c. Welder understands welding procedure and requirements for the work.
d. Special training and mock-up weldments performed if required.
e. Welder understands the inspection hold-points.

4.3.1.2 Potential inspector actions:

a. Review welder performance with welding organization.
b. See Appendix B.

4.3.2 Welding Parameters and Techniques

Confirm welding parameters and techniques are supported by the WPS and WPQ.

4.3.2.1 Quality control items to assess:

a. Essential variables are being met during welding.

1. Filler material, fluxes, and inert gas composition/flow rate.
2. Purge technique, flow rate, O2 analysis, etc.
3. Rod warmers energized or where rod warmers are not employed, the welder complies with maximum exposure times out of the electrode oven.
4. Preheating during tack welding and tack welds removed (if required).
5. Welding technique, weld progression, bead overlap, etc.
6. Equipment settings such as amps, volts, and wire feed.
7. Preheat and interpass temperatures.
8. Travel speed (key element in heat input).
9. Heat input (where appropriate).

b. Mock-up weldment, if required, meets requirements with welder and welding engineer.
c. Welder displays confidence and adheres to good welding practices.

4.3.2.2 Potential inspector actions:

a. Review mock-up weldment problems with welding engineer.
b. Review welder quality with welding organization.
c. See Appendix B.

4.3.3 Weldment Examination

Complete physical checks, visual examination, and in-process NDE

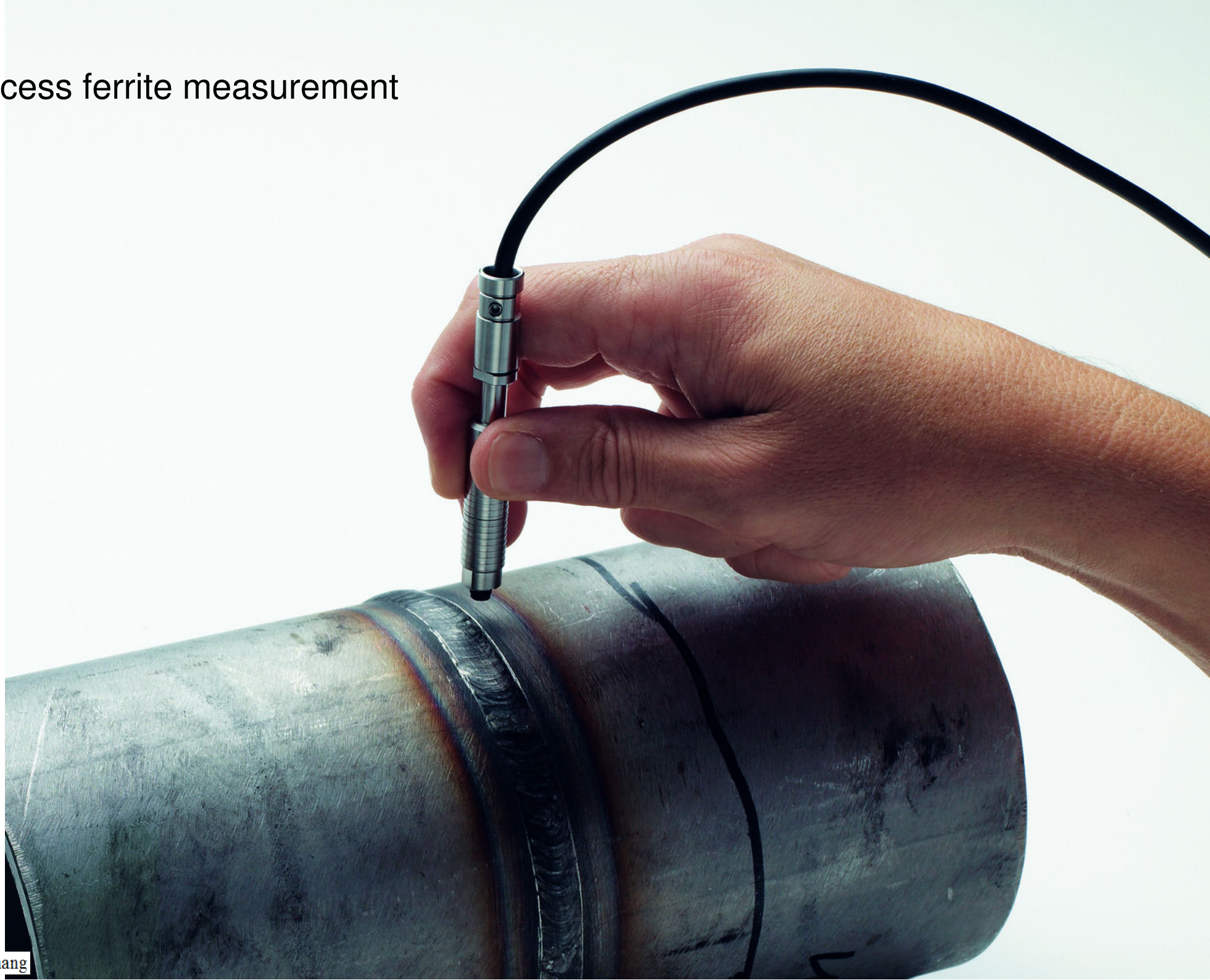
4.3.3.1 Quality control items to assess:

a. Tack welds to be incorporated in the weld are of acceptable quality.
b. Weld root has adequate penetration and quality.
c. Cleaning between weld passes and of any back-gouged surfaces is acceptable.
d. Additional NDE performed between weld passes and on back-gouged surfaces shows acceptable results.
e. In-process rework and defect removal is accomplished.
f. In-process ferrite measurement, if required, is performed and recorded.
g. Final weld reinforcement and fillet weld size meets work specifications and drawings.

4.3.3.2 Potential inspector action: reject unacceptable workmanship.

In-process ferrite measurement

In-process ferrite measurement



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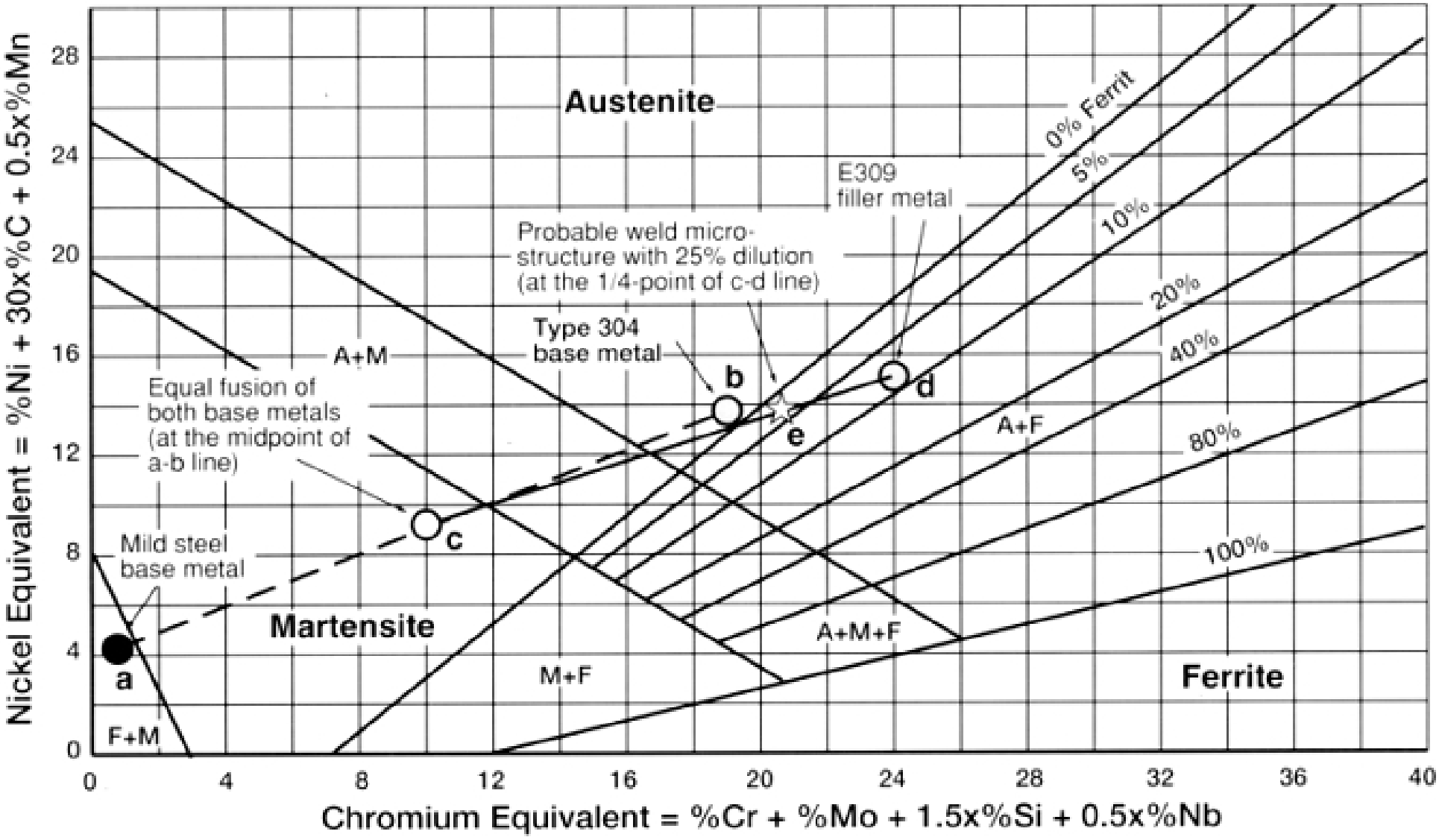
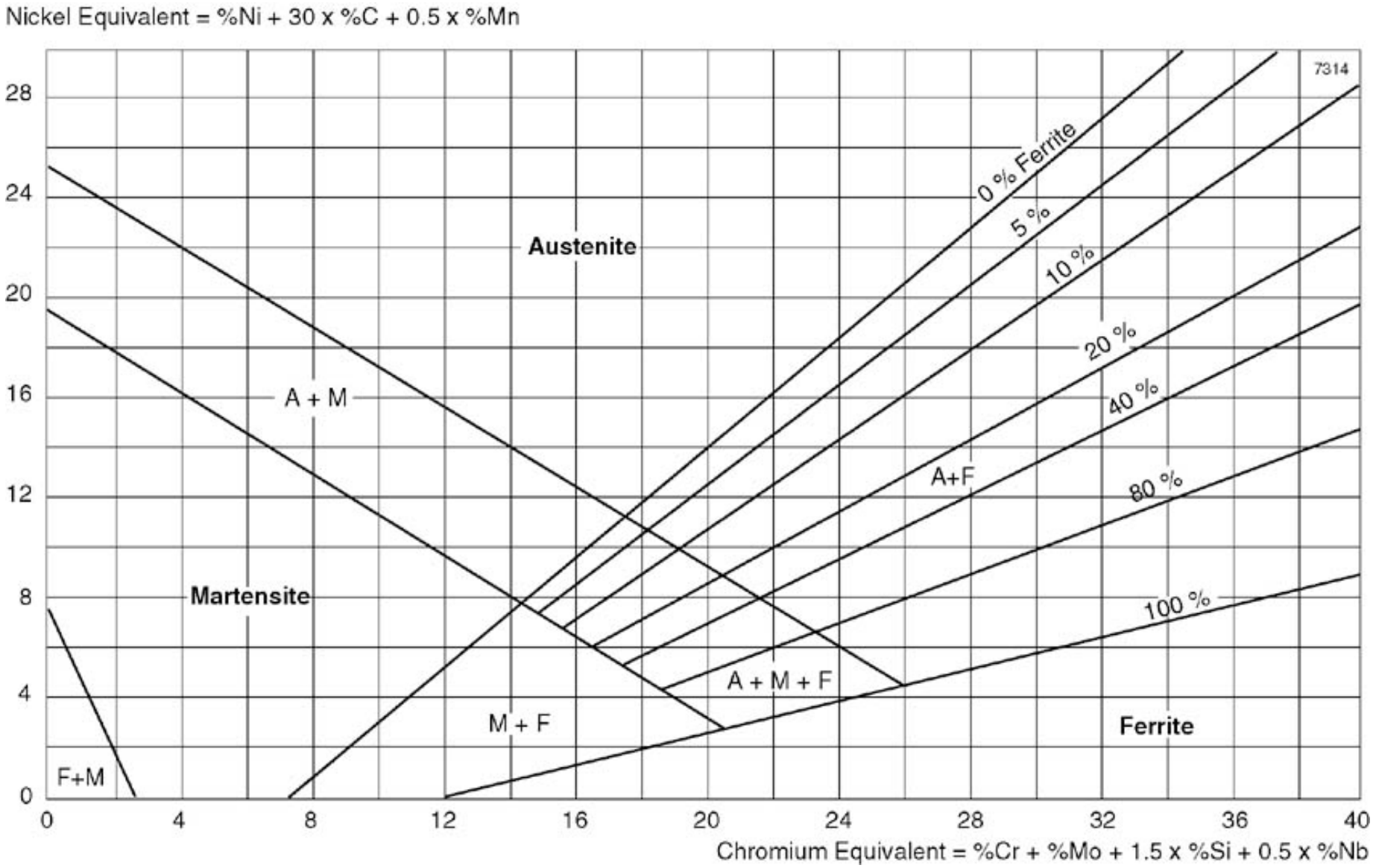
In-process ferrite measurement



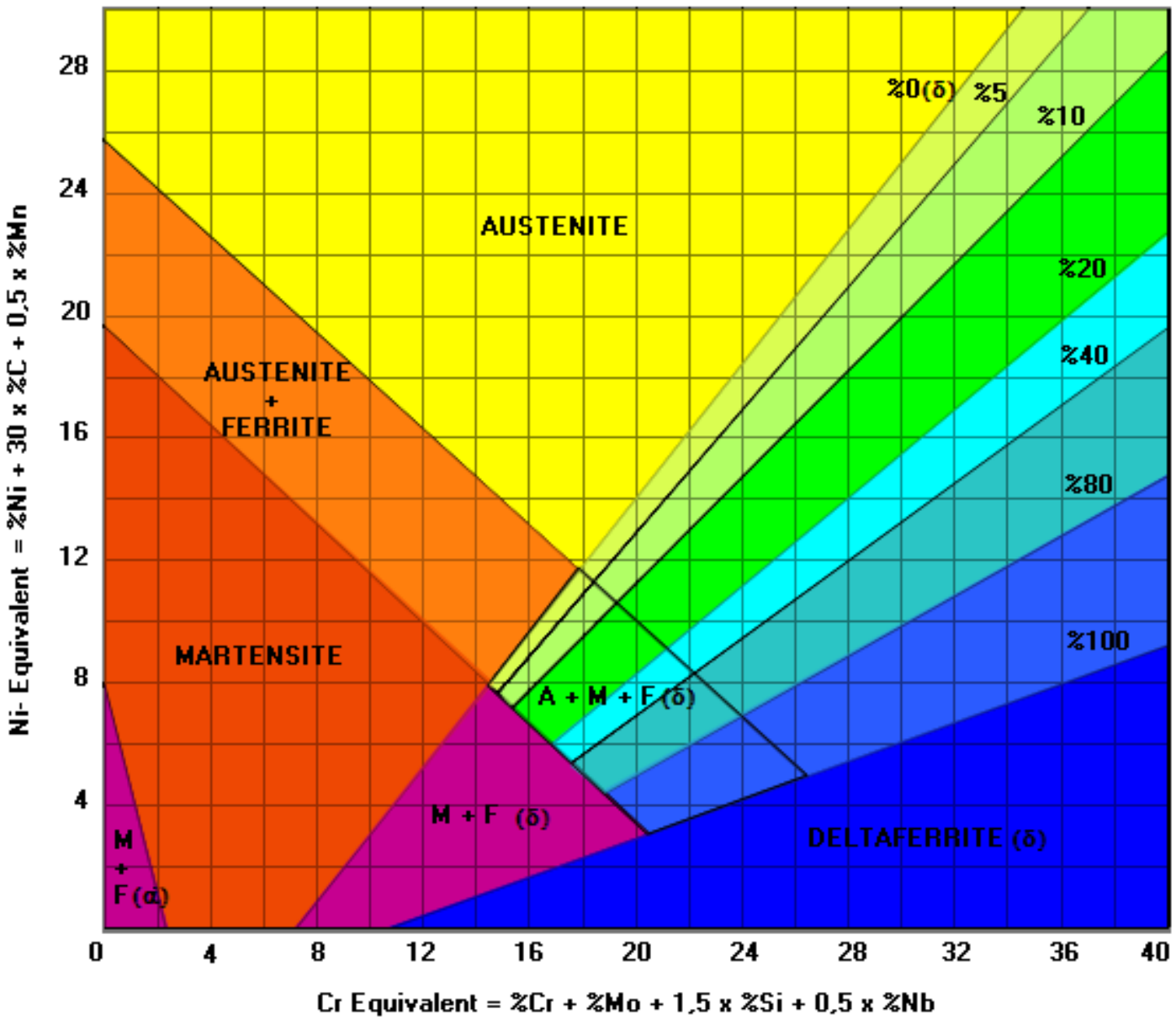
Why Dissimilar-Metal Welding is Needed, and How to Select Proper Filler Metals

http://www.kobelco-welding.jp/education-center/abc/ABC_1999-02.html

Schaeffler diagram



Schaeffler diagram



4.4 TASKS UPON COMPLETION OF WELDING

Final tasks upon completion of the weldment and work should include those that assure final weld quality before placing the weldment in service.

4.4.1 Appearance and Finish

Verify post-weld acceptance, appearance and finishing of the welded joints.

4.4.1.1 Quality control items to assess:

a. Size, length and location of all welds conform to the drawings/ specifications/Code.
b. No welds added without approval.
c. Dimensional and visual checks of the weld don't identify welding discontinuities, excessive distortion and poor workmanship.
d. Temporary attachments and attachment welds removed and blended with base metal.
e. Discontinuities reviewed against acceptance criteria for defect classification.
f. PMI of the weld, if required, and examiner's findings indicate they comply with the specification.
g. Welder stamping/marking of welds confirmed.
h. Perform field hardness check (see 9.10).

4.4.1.2 Potential inspector actions: rework existing welds, remove welds and make weld repairs as required.

Field hardness check

Field hardness check

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4.4.2 NDE Review

Verify NDE is performed at selected locations and review examiner's findings.

4.4.2.1 Quality control items to assess:

a. Specified locations examined.
b. Specified frequency of examination.
c. NDE performed after final PWHT.
d. Work of each welder included in random examination techniques.
e. RT film quality, IQI placement, IQI visibility, etc. complies with standards.
f. Inspector is in agreement with examiners interpretations and findings.
g. Documentation for all NDE correctly executed (see 9.11).

4.4.2.2 Potential inspector actions:

a. Require additional NDE to address deficiencies in findings.
b. Checking for delayed cracking of thick section, highly constrained and high strength material joining.
c. Repeat missing or unacceptable examinations.
d. Correct discrepancies in examination records.

4.4.3 Post-weld Heat Treatment

Verify post-weld heat treatment is performed to the procedure and produces acceptable results.

4.4.3.1 Quality control items to assess:

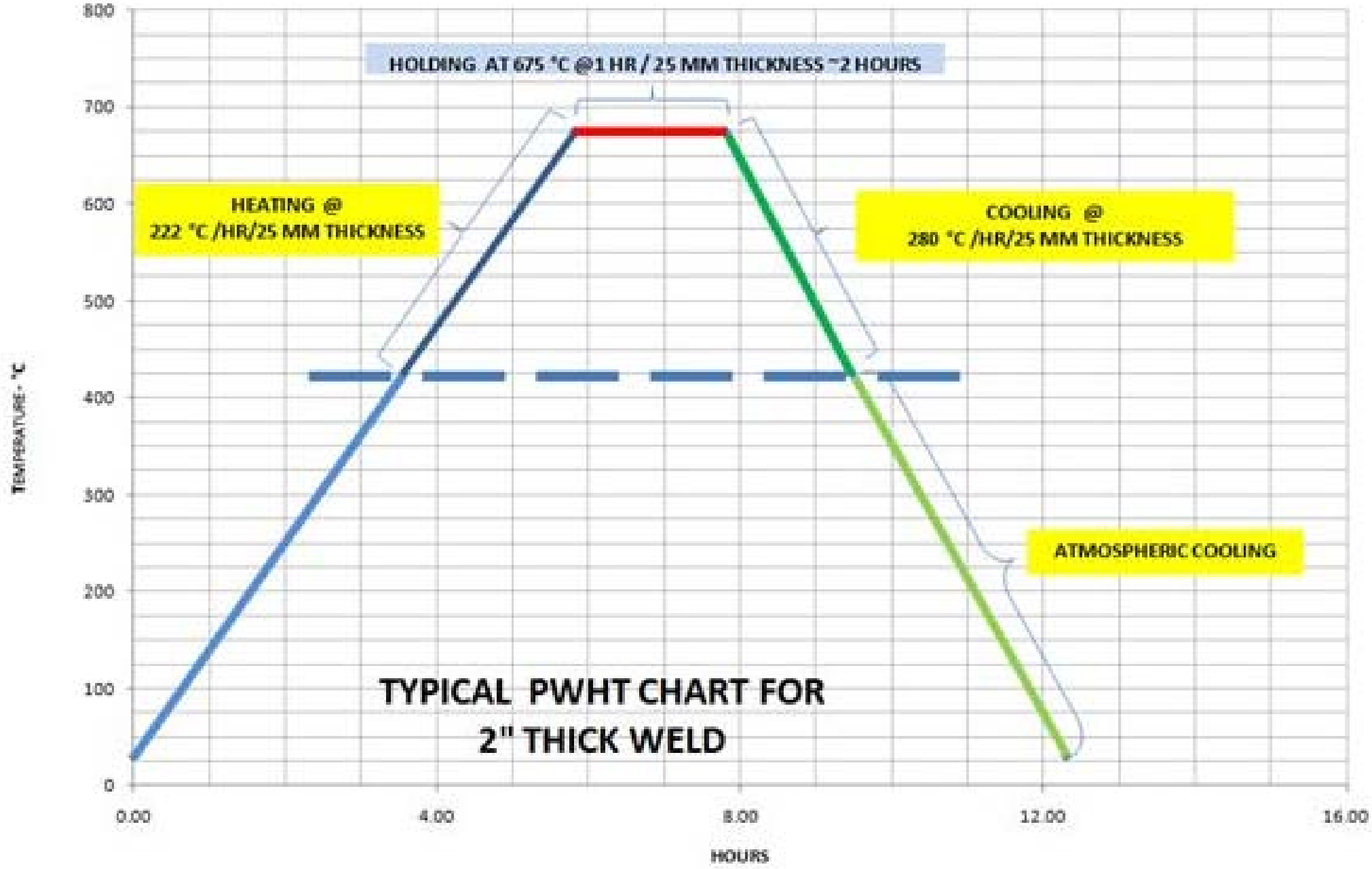
a. Paint marking and other detrimental contamination removed.
b. Temporary attachments removed.
c. Machined surfaces protected from oxidation.
d. Equipment internals, such as valve internals, removed to prevent damage.
e. Equipment supported to prevent distortion.
f. Thermocouples fastened properly.
g. Thermocouples adequately monitor the different temperature zones and thickest/thinnest parts in the fabrication.

h. Temperature monitoring system calibrated.
i. Local heating bandwidth is adequate.
j. Insulation applied to the component where required for local heating.
k. Temperature and hold time is correct.
l. Heating rate and cooling rate is correct.
m. Distortion is acceptable after completion of the thermal cycle.
n. Hardness indicates an acceptable heat treatment (see 10.7).

4.4.3.2 Potential inspector actions:

a. Calibrate temperature-monitoring equipment.
b. Correct deficiencies before heat treatment.
c. Repeat the heat treatment cycle.

PWHT Procedure



4.4.4 Pressure Testing

Verify pressure test is performed to the procedure.

4.4.4.1 Quality control items to assess:

a. Pressure meets test specification.
b. Test duration is as-specified.
c. Metal temperature of component meets minimum and maximum requirements.
d. Pressure drop or decay is acceptable per procedure.
e. Visual examination does not reveal defects.

4.4.4.2 Potential inspector actions:

a. Either correct deficiencies prior to or during pressure test as appropriate.
b. Repeat test as necessary.
c. Develop repair plan if defects are identified.

Metal temperature of component meets minimum and maximum requirements.

4.4.5 Documentation Audit

Perform a final audit of the inspection dossier to identify inaccuracies and incomplete information.

4.4.5.1 Quality control items to assess:

a. All verifications in the quality plan were properly executed.
b. Inspection reports are complete, accepted and signed by responsible parties.
c. Inspection reports, NDE examiners interpretations and findings are accurate (see 9.11).

4.4.5.2 Potential inspector actions:

a. Require additional inspection verifications to address deficiencies in findings.
b. Repeat missing or unacceptable examinations.
c. Correct discrepancies in examination records.

4.5 NON-CONFORMANCES AND DEFECTS

At any time during the welding inspection, if defects or non-conformances to the specification are identified, they should be brought to the attention of those responsible for the work or corrected before welding proceeds further. Defects should be completely removed and re-inspected following the same tasks outlined in this section until the weld is found to be acceptable. Corrective action for a non-conformance will depend upon the nature of the non-conformance and its impact on the properties of the weldment. Corrective action may include reworking the weld. See 9.1 for common types of discontinuities or flaws that can lead to defects or non-conformances.

4.6 NDE EXAMINER CERTIFICATION

The referencing codes or standards may require the examiner be qualified in accordance with a specific code and certified as meeting the requirements. ASME Section V, Article 1, when specified by the referencing code, requires NDE personnel be qualified with one of the following:

a. ASNT SNT-TC-1A
b. ANSI/ASNT CP-189

These references give the employer guidelines (SNT-TC-1A) or standards (CP-189) for the certification of NDE inspection personnel. They also require the employer to develop and establish a written practice or procedure that details the employer's requirements for certification of inspection personnel. It typically includes the training, and experience prerequisites prior to certification, and recertification requirements. If the referencing code does not list a specific standard to be qualified against, qualification may involve demonstration of competency by the personnel performing the examination or other requirements specified by the owner-user.

4.7 SAFETY PRECAUTIONS

Inspectors should be aware of the hazards associated with welding and take appropriate steps to prevent injury while performing inspection tasks. As a minimum, the site's safety rules and regulations should be reviewed as applicable to welding operations. Hazards that the inspector would more commonly encounter in the presence of welding include arc radiation, air contamination, airborne debris, and heat. The arc is a source of visible, ultraviolet and infrared light. As such, eye protection using proper filters and proper clothing to cover the skin should be used. Proper ventilation is necessary to remove air-borne particulates, which include vaporized metals. In areas of inadequate ventilation, filtered breathing protection may be required. The use of gas-shielded processes in confined spaces can create an oxygen deficient environment. Ventilation practice in these instances should be carefully reviewed. Welding can produce sparks and other airborne debris that can burn the eyes. Appropriate precautions are necessary.

Sevan Driller II

http://www.cosco-shipyard.com/englishNew/detail.asp?classid=8&id=563

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