

## Corrosion, Metallurgy, Failure Analysis and Prevention

### Registration Form

Photocopies of this form may be used for registrations.

You can also register online at [www.corrosionclinic.com](http://www.corrosionclinic.com)

Please register the following person(s) for the above course (please TYPE or PRINT clearly):

1. Dr/Mr/Ms \_\_\_\_\_

Designation \_\_\_\_\_

2. Dr/Mr/Ms \_\_\_\_\_

Designation \_\_\_\_\_

3. Dr/Mr/Ms \_\_\_\_\_

Designation \_\_\_\_\_

\*delete where inappropriate

Enclosed is a cheque / bank draft No. \_\_\_\_\_  
for S\$ \_\_\_\_\_ (payable to **WebCorr Corrosion Consulting Services**) being Registration Fee for the above person(s).

Name of Organization \_\_\_\_\_

Contact Person \_\_\_\_\_

Contact Dept \_\_\_\_\_

Telephone \_\_\_\_\_ Fax \_\_\_\_\_

Email \_\_\_\_\_

Crossed cheques should be made payable to **WebCorr Corrosion Consulting Services** and mailed together with the registration form to:

### WebCorr Corrosion Consulting Services

Toa Payoh Central., PO Box 225,  
Singapore 913108

Tel: (65) 64916456 Mobile: (65) 97110759

Fax: (65) 64916456

Email: [webcorr@corrosionclinic.com](mailto:webcorr@corrosionclinic.com)

<http://www.corrosionclinic.com>

## Course Details

**Date:** TBA

**Time:** 9:00 am to 5:00 pm

**Venue:** PUB WaterHub

**Course Fee:** \$1995 (GST not applicable)

**Closing Date:** 4 weeks before course date

**Discount:**

**Group:** (3 or more people): 10%

**Early-bird:** N% **if paid** "N" months

before the course

commencing date

### Withdrawal/Refund Policy:

Withdrawal or replacement should be conveyed to the organizer in writing (email or fax). An administration charge of 50% of the course fee will be levied if the withdrawal notice is received less than 7 working days before the course commencing date. No refund will be made for withdrawal notice received 3 working days and less.

### Certificates:

Certificate of attendance will be given to participants with at least 75% attendance of the course.

### Cancellation:

WebCorr reserves the right to cancel the course and fully refund the participants should unforeseen circumstances necessitate it.

# Corrosion, Metallurgy, Failure Analysis and Prevention

*Conducted by*

**Dr. Qiu Jianhai** *BEng PhD CEng MIM FICorr*

*NACE Certified Corrosion Specialist*

*Date*

**TBA**

*Venue*

**PUB WaterHub**

**80 Toh Guan Road East**

**Singapore 608575**

*Organized by:*



## Course Overview:

This corrosion short course aims to provide the participants with an understanding of why and how corrosion occurs, the metallurgical and environmental factors influencing corrosion, and practical methods of corrosion control and failure prevention. Participants will be able to grasp the basic concepts related to corrosion, metallurgy and failure analysis, and to apply the state of the art technology in their workplace. This 3-day course provides an excellent avenue for corrosion practitioners, failure analysis personnel, designers, technical managers, inspection and maintenance engineers, coatings and weld inspectors, quality control personnel and anyone who is interested in corrosion, metallurgy and materials failure analysis and its prevention.

## Course Contents

1. Basic Concepts in Corrosion
2. Metallurgy and Corrosion
  - 2.1 Introduction to Metallurgy
  - 2.2 Metals in the melting pot
  - 2.3 Defects in metals
  - 2.4 The iron-carbon phase diagram
  - 2.5 The microstructure of common metals/alloys
  - 2.6 Different Forms of Corrosion: Mechanisms, Recognition & Prevention
    - 2.6.1 Uniform corrosion
    - 2.6.2 Galvanic corrosion
    - 2.6.3 Dealloying and Graphitisation
    - 2.6.4 Crevice corrosion
    - 2.6.5 Pitting corrosion
    - 2.6.6 Intergranular corrosion and weld decay
    - 2.6.7 Exfoliation
    - 2.6.8 Filiform corrosion
    - 2.6.9 Microbiologically-influenced corrosion (MIC)
    - 2.6.10 Environment-sensitive cracking
    - 2.6.11 Hydrogen damages
    - 2.6.12 Corrosion fatigue
    - 2.6.13 Fretting
    - 2.6.14 Erosion corrosion, impingement attack and cavitation damage
    - 2.6.15 Stray current corrosion

3. Weldment Metallurgy and Corrosion
  - 3.1 Weldment metallurgy and weldment corrosion
  - 3.2 Precipitation of intermetallics (sigma, chi & Laves phases) in stainless steels
    - 3.2.1 Microstructural features in SS
    - 3.2.2 Precipitation of delta ferrite
    - 3.2.3 Alpha prime phase and 475°C embrittlement
    - 3.2.4 Precipitation of intermetallics: submicroscopic sigma, chi and Laves phases
    - 3.2.5 Chemical compositions of various intermetallics and phases
    - 3.2.6 Time-Temperature-Precipitation diagrams for sigma, chi and Laves phases and carbides
    - 3.2.7 Effect of chemical composition on sigma precipitation
    - 3.2.8 Effect of Nitrogen on sigma precipitation
    - 3.2.9 Effect of cold working on sigma precipitation
    - 3.2.10 Invisible (submicroscopic) sigma/chi phases and their effects on corrosion
    - 3.2.11 Time-temperature-precipitation curves for precipitation of carbides, sigma, chi and Laves
  - 3.3 Intergranular corrosion, weld decay and knifeline attack
    - 3.3.1 Sensitization of austenitic stainless steels
    - 3.3.2 Cr profile along the grain boundaries
    - 3.3.3 Effect of carbon, molybdenum and nitrogen
    - 3.3.4 Effect of cold working and applied stress
    - 3.3.5 Sensitization of Ferritic Stainless Steels
    - 3.3.6 Sensitization of Duplex Stainless Steels
    - 3.3.7 Effect sulfide inclusions in stainless steels
    - 3.3.8 Ferritic and duplex stainless steels
    - 3.3.9 Nickel-chromium alloys
    - 3.3.10 Aluminum alloys
    - 3.3.11 Weld decay and knifeline attack
  - 3.5 Weldment corrosion of various alloy systems
  - 3.6 CO<sub>2</sub> and H<sub>2</sub>S Corrosion of various steels and alloys
  - 3.7 Corrosion under insulation
  - 3.8 Corrosion in seawater systems
  - 3.9 Corrosion in atmosphere
4. Failure Analysis and Prevention
  - 4.1 General approach to failure analysis
  - 4.2 General methods of failure prevention
  - 4.3 Corrosion Resistant Coatings
  - 4.4 Cathodic & Anodic Protection

- 4.5 Corrosion Inhibitors
- 4.6 Corrosion Testing & Monitoring

## Who Should Attend

This course provides an excellent avenue for corrosion practitioners, designers, technical managers, maintenance engineers, inspection and quality control personnel, and those involved in failure analysis to update their appreciation of corrosion and the awareness of the emerging technologies for corrosion control and failure prevention.

## Course Lecturer

**Dr. Qiu Jianhai** *BEng PhD CEng MIM FICorr*

Dr Qiu obtained his BEng and PhD degrees both in the field of corrosion. He has 27 years of industry, university teaching, research and consulting experience in areas of corrosion and its prevention. He has been working closely with both local and overseas companies and has been an active consultant to governmental agencies, multinational companies and private organizations on corrosion and materials related issues such as corrosion design review, materials selection and life prediction, corrosion inspection and condition assessment, plant process optimization, corrosion training, corrosion testing and monitoring, trouble-shooting and corrosion failure analysis. Dr. Qiu is also experienced in providing expert witness and assistance in litigation and arbitration matters related to corrosion and materials. He has authored over 120 technical papers and reports. Dr. Qiu was an invited contributing author to the latest edition of the world renowned ASM Handbook Vol.13C Corrosion: Environments and Industries. His biographical profile was included in the 7th edition of Marquis Who's Who in Science and Engineering.

Dr. Qiu is a NACE certified Corrosion Specialist (USA), a Chartered Engineer registered with the Engineering Council (UK), a Fellow of the Institute of Corrosion (UK) and a professional member of the Institute of Materials, Minerals and Mining (UK). Dr. Qiu is the Singapore representative in the International Corrosion Council (ICC).