Haward Technology Middle East

COURSE OVERVIEW FE0470
Metallurgical Failure Analysis & Prevention

Course Title
Metallurgical Failure Analysis & Prevention

Course Date/Venu
Session 1: April 27-May 01, 2025/Crowne Meeting Room, Crowne Plaza Al Khobar, KSA
Session 2: July 20-24, 2025/Boardroom 1, Elite Byblos Hotel Al Barsha, Sheikh Zayed Road, Dubai, UAE

3.0 CEUs (30 PDHs) AWARD

Course Reference
FE0470

Course Duration/Credits
Five days/3.0 CEUs/30 PDHs

Course Description

This practical and highly-interactive course includes real-life case studies and exercises where participants will be engaged in a series of interactive small groups and class workshops.

Metallurgical Failure Analysis is one of the most useful techniques for ensuring the safety and reliability of products and plant facilities/components. The main benefits are the prevention of failure in a similar equipment, and improvement in useful service life through design or material modifications. Failure Analysis of metallic components has been the preoccupation of the metallurgical community for years. Process plants usually have an excellent staff of “static equipment” inspectors, whose services prove invaluable during machinery component failure analysis. The strengths of the metallurgical inspectors lie in solving service failures based on the standard metallurgical failure modes and their causes.

To increase the odds of completing a conclusive Metallurgical failure analysis while at the same time saving time and money, investigations should be carried out using a systemic approach. It is important to note however, that it is often impossible to foresee results that might require the investigator to go back and repeat a test. A simple way reduces the occurrence of this is to go into a case well informed on how similar systems have failed. An excellent source of for this type of information is indeed this course as we include herein 39 case studies that will be discussed during the last 3 days of the course. This course is therefore an invaluable source to the beginner and the expert.

This course discusses the various types of failure mechanisms and the process of conducting a metallurgical failure analysis. It contains a general outline of the various mechanisms that are responsible for failures, and describes the procedures and laboratory techniques used in metallurgical failure analysis. Finding the root cause of failures through such investigations can provide valuable feedback to the design and manufacturing groups. In addition to the material properties, component failures are very much affected by the service environment. Engineers should be aware of the potential failure mechanisms so that proper precautions can be taken during the design stage of a system.

The course explores a systematic approach to successful metallurgical failure analysis and troubleshooting programs, including the determination of goals, use of checklists and setting up a failure analysis team. By reference to 39 case studies, it will be shown that such a systematic program can lead to significant failure reductions in many types of equipment and structures.

Equipment failure events will be reviewed and participants are encouraged to bring to the seminar relevant assembly drawings or such components as failed bearings, gears, mechanical seals and similar machine elements for failure analysis and discussion.

Course Objectives

Upon the successful completion of this course, each participant will be able to:-

- Apply systematic techniques in metallurgical failure analysis including proven tools on how to prevent such failure
- Discuss how parts fail, why they fail in a given mode, and how to prevent failures
- Use the available failure statistics in a conscientiously applied comprehensive program of specifying, purchasing, installing, commissioning and operating equipment and structures
- Enumerate the various factors that need to be considered in material selection, design and the service environment
- Recognize the basic features and characteristics of different failure mechanisms
- Carryout the latest methodology and procedures in laboratory testing that can help determine the cause of the failures
- Gain thorough experience in metallurgical failure analysis through studying and analysing 39 case histories in different industries

Exclusive Smart Training Kit - H-STK®

*Participants of this course will receive the exclusive "Haward Smart Training Kit" (**H-STK®**). The **H-STK®** consists of a comprehensive set of technical content which includes **electronic version** of the course materials conveniently saved in a **Tablet PC**.*

Who Should Attend

This course provides a suitable understanding and deeper appreciation of metallurgical failure analysis and prevention for maintenance, reliability, integrity, inspection, QA/QC, materials, corrosion, project, safety, chemical and process managers, engineers, superintendents, supervisors, officers, planners and foremen. Further, the course is applicable for design, manufacturing and product development managers and engineers.

Course Certificate(s)

Internationally recognized certificates will be issued to all participants of the course who completed a minimum of 80% of the total tuition hours.

Certificate Accreditations

Certificates are accredited by the following international accreditation organizations:-

- BAC British Accreditation Council (BAC)

  Haward Technology is accredited by the **British Accreditation Council** for **Independent Further and Higher Education** as an **International Centre**. BAC is the British accrediting body responsible for setting standards within independent further and higher education sector in the UK and overseas. As a BAC-accredited international centre, Haward Technology meets all of the international higher education criteria and standards set by BAC.

- ACCREDITED IACET PROVIDER The International Accreditors for Continuing Education and Training (IACET - USA)

  Haward Technology is an Authorized Training Provider by the International Accreditors for Continuing Education and Training (IACET), 2201 Cooperative Way, Suite 600, Herndon, VA 20171, USA. In obtaining this authority, Haward Technology has demonstrated that it complies with the **ANSI/IACET 2018-1 Standard** which is widely recognized as the standard of good practice internationally. As a result of our Authorized Provider membership status, Haward Technology is authorized to offer IACET CEUs for its programs that qualify under the **ANSI/IACET 2018-1 Standard**.

  Haward Technology's courses meet the professional certification and continuing education requirements for participants seeking **Continuing Education Units** (CEUs) in accordance with the rules & regulations of the International Accreditors for Continuing Education & Training (IACET). IACET is an international authority that evaluates programs according to strict, research-based criteria and guidelines. The CEU is an internationally accepted uniform unit of measurement in qualified courses of continuing education.

  Haward Technology Middle East will award **3.0 CEUs** (Continuing Education Units) or **30 PDHs** (Professional Development Hours) for participants who completed the total tuition hours of this program. One CEU is equivalent to ten Professional Development Hours (PDHs) or ten contact hours of the participation in and completion of Haward Technology programs. A permanent record of a participant's involvement and awarding of CEU will be maintained by Haward Technology. Haward Technology will provide a copy of the participant's CEU and PDH Transcript of Records upon request.

Accommodation

Accommodation is not included in the course fees. However, any accommodation required can be arranged at the time of booking.

Course Instructor(s)

This course will be conducted by the following instructor(s). However, we have the right to change the course instructor(s) prior to the course date and inform participants accordingly:

Mr. Tim Siakos, MSc, BSc, is a **Senior Metallurgical Engineer** with over **25 years** of extensive experience within the **Oil & Gas**, **Petrochemical**, **Refinery** and **Mining** industry. His wide expertise lies extensively in the areas of **Metallurgical Failure Analysis & Prevention**, **Corrosion & Metallurgy**, **Damage & Material** Evaluation, **Stress Analysis & Fracture Mechanics**, **Weld Cracking**, **Material & Corrosion** Engineering, **Material** Selection & Properties, **Corrosion** & Prevention of Failures, **Corrosion** Risk Assessment, **Corrosion** Monitoring Prevention & Control, Advanced Integrity Management for Corrosion & Inspection, **Corrosion** Management, **Corrosion** & Control System, **Corrosion** Technology & Inspection, **Welding** Fundamentals, **Welding** Engineering, Fabrication & Inspection, Practical **Welding** Technology, **Welding** Inspection Technology, **Welding & Fabrication**, **Welding & Machining**, **Welding** Technology and **Welding** Defects Analysis. Further, he is also well-versed in **Electric Furnace**, **Ladle Furnace Treatment**, Open Cast Lignite Mining, Bentonite Mining, Fe-Ni Metallurgy, **NEBOSH-IGC**, Risk Management, CPR & AED, SAP/ERP, Business Planning & Budgeting, Contract Management, Benchmarking, Key Performance Indicator (KPI) and Project Management. He is currently the **Mine Design & Planning Sector Head** of Public Power Company (**PPC**) wherein he is deeply involved in mine planning, mine exploitation, slope design and production design.

During his career life, Mr. Siakos gained his practical and field experience through his various significant positions and dedication as the **Mine Manager**, **Mines Production Subsector Head**, **Mines & Performance Sector Head**, **Health & Safety Training Head**, **Chief Production Engineer**, **Metallurgist**, **Engineer** and **Trainer/Lecturer** for various companies and institutions such as the Technological Institute of Peraius, National Technical University of Athens, Bentonite Industry, Mycobar SA and Larko SA.

Mr. Siakos has a **Master** degree in **Energy Management Systems** and a **Bachelor** degree in **Mining & Metallurgical Engineering** from the **Athens National Technical University**. Further, he is a **Certified Instructor/Trainer**, a **Certified OHSAS 18001:2007 Lead Auditor** and a **Certified ISO 14001:2015 Lead Auditor**. He has further delivered numerous trainings, courses, seminars, workshops and conferences globally.

Training Methodology

All our Courses are including **Hands-on Practical Sessions** using equipment, State-of-the-Art Simulators, Drawings, Case Studies, Videos and Exercises. The courses include the following training methodologies as a percentage of the total tuition hours:-

30% Lectures
20% Practical Workshops & Work Presentations
30% Hands-on Practical Exercises & Case Studies
20% Simulators (Hardware & Software) & Videos

In an unlikely event, the course instructor may modify the above training methodology before or during the course for technical reasons

Course Fee

US$ 5,500 per Delegate + **VAT**. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

Course Program

The following program is planned for this course. However, the course instructor(s) may modify this program before or during the course for technical reasons with no prior notice to participants. Nevertheless, the course objectives will always be met:

Day 1

0730 – 0800	*Registration & Coffee*
0800 – 0815	*Welcome & Introduction*
0815 – 0830	***PRE-TEST***
0830 – 0930	***Principles & Practice of Failure Analysis*** *Introduction to Failure Analysis & Prevention • The Failure Analysis Process • Organization of Failure Investigation*
0930 – 0945	*Break*
0945 – 1045	***Principles & Practice of Failure Analysis (cont'd)*** *Conducting a Failure Examination • Determination & Classification of Damage • Examination of Damage & Material Evaluation*
1045 – 1200	***Tools & Techniques in Failure Analysis*** *Practices in Failure Analysis • Photography in Failure Analysis • Chemical Analysis of Metals in Failure Analysis • Characterization of Plastics in Failure Analysis*
1200 – 1215	*Break*
1215 – 1315	***Tools & Techniques in Failure Analysis (cont'd)*** *Stress Analysis & Fracture Mechanics • X-ray Diffraction Residual Stress Measurement in Failure Analysis • Metallographic Techniques in Failure Analysis • Scanning Electron Microscopy*
1315 – 1420	***Metallurgical Failure: Case Studies*** *Case Study # 1: Cracking in Gas Turbine Blades* *Case Study # 2: Stresses in a Pressurized Cylindrical Section* *Case Study # 3: Use of XRD to Assess the Effects of Heat Treatment on Residual Stress in Steel Coil Springs*
1420 – 1430	***Recap***
1430	*Lunch & End of Day One*

Day 2

0730 – 0830	***Fracture*** *Fracture Appearance & Mechanisms of Deformation & Fracture • Mechanisms & Appearances of Ductile & Brittle Fracture in Metals • Fatigue Fracture Appearances Intergranular Fracture*
0830 – 0945	***Metallurgical Failure: Case Studies*** *Case Study # 4: Intergranular Fracture of Steam Generator Tubes* *Case Study # 5: Forming Cracks on Stainless Steel Wire* *Case Study # 6: Overload Failure of a Bronze Worn Gear* *Case Study # 7: Valve Seat Fractures* *Case Study # 8: Fracture of a Cast Steel Bracket*
0945 – 1000	*Break*
1000 – 1115	***Fracture (cont'd)*** *Fracture of Plastics • Fracture Modes & Appearances in Ceramics • Overload Failures*
1115 – 1230	***Metallurgical Failure: Case Studies*** *Case Study # 9: Failure of a Jack Cylinder* *Case Study # 10: Stress-Relief Cracking of a Welded Alloy Steel Tube* *Case Study # 11: Failure of a Steel Superheater Tube* *Case Study # 12: Hydrogen Embrittlement Failure of Cap Screws*
1230 – 1245	*Break*
1245 – 1420	***Fracture (cont'd)*** *Fatigue Failures • Creep & Stress Rupture Failures • Thermomechanical Fatigue: Mechanisms & Practical Life Analysis*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Two*

Day 3

0730 – 0930	***Metallurgical Failure: Case Studies*** *Case Study # 13: Weld Cracking of a Stainless Steel Heat Exchanger* *Case Study # 14: Failure of an Overhead Crane Drive Shaft Due to Rotating-Bending Fatigue* *Case Study # 15: Torsional-Fatigue Fracture of a Large 4340 Steel Shaft that was Subject to Cyclic Loading & Frequent Overloads* *Case Study # 16: Prediction of Residual Life in a Turbine Casing*
0930 – 0945	*Break*
0945 – 1030	***Corrosion-Related Failures*** *Analysis & Prevention of Corrosion-Related Failures • Forms of Corrosion • Effect of Environment on the Performance of Plastics*
1030 – 1145	***Metallurgical Failure: Case Studies*** *Case Study # 17: Analysis of Pitting & MIC of Stainless Steel Piping* *Case Study # 18: Analysis of a Corrosion Failure of an Aboveground Storage Tank* *Case Study # 19: Preventive Maintenance for Buried Pipelines* *Case Study # 20: Structural Epoxy Rehabilitation of Steel & Reinforced Concrete Structures* *Case Study # 21: Uniform Corrosion of Carbon Steel Boiler Feedwater Tubes*
1145 – 1230	***Corrosion-Related Failures (cont'd)*** *Corrosion Failures of Industrial Refractories & Technical Ceramics • Hydrogen Damage & Embrittlement*
1230 – 1245	*Break*

1245 – 1420	***Metallurgical Failure: Case Studies*** *Case Study # 22: Uniform Corrosion of a Copper Pipe Coupling* *Case Study # 23: Pitting Corrosion of Stainless Steel by Potable Water in an Organic Chemical Plant Condenser* *Case Study # 24: Corrosion by "Green Death" in Reboiler Bypass Duct Damper in Power-Generation Plant* *Case Study # 25: Crevice Corrosion of a Carbon Steel Brine Tank* *Case Study # 26: Weld Craters in Stainless Steel Heat Exchanger Tubes*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Three*

Day 4

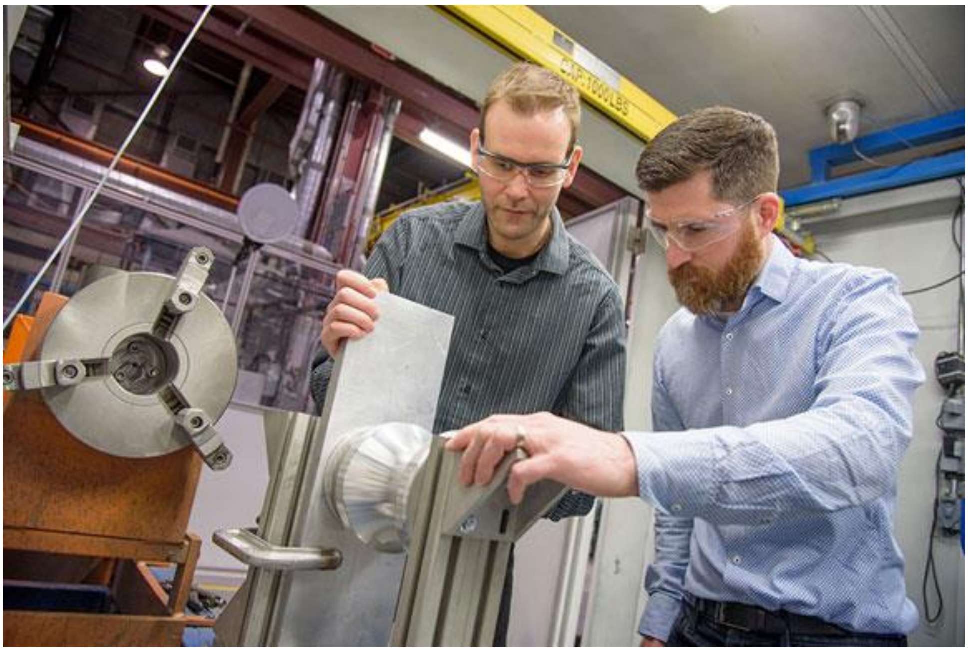
0730 – 0830	***Corrosion-Related Failures (cont'd)*** *Stress-Corrosion Cracking • Liquid Metal & Solid Metal Induced Embrittlement*
0830 – 0930	***Metallurgical Failure: Case Studies*** *Case Study # 27: Leaking Welds in a Ferritic Stainless Steel Wastewater Vaporizer* *Case Study # 28: Hydrogen Embrittlement of a Type 431 Stainless Steel Mushroom-Head Closure* *Case Study # 29: Leaking Carbon Steel Weldments in a Sulfur Recovery Unit* *Case Study # 30: Metallurgical Analysis of Steam Turbine Rotor Disc* *Case Study # 31: Eddy-Current Inspection of Pitting & SCC of Type 316 Stainless Steel Evaporator Tubes in a Chemical Processing Operation*
0930 – 0945	*Break*
1000 – 1115	***Corrosion-Related Failures (cont'd)*** *High-Temperature Corrosion-Related Failures • Biological Corrosion Failures*
1115 – 1230	***Metallurgical Failure: Case Studies*** *Case Study # 32: SCC of an Inconel 600 Safe-End on a Reactor Nozzle* *Case Study # 33: SCC of Aluminum Alloy Fittings in a Marine Atmosphere* *Case Study # 34: SCC of Copper Alloy C27000 Ferrules in Storage & in Service in Chemical Plants* *Case Study # 35: Reaction Control System Oxidizer Pressure Vessels* *Case Study # 36: High-Temperature Degradation of a Gas Turbine Transition Duct*
1230 – 1245	*Break*
1245 – 1420	***Wear Failures*** *Fundamentals of Wear Failures • Abrasive Wear Failures • Fretting Wear Failures • Rolling Contact Fatigue • Rolling-Contact Fatigue of Ceramics • Impact Wear Failures • Spalling from Impact Events*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Four*

Day 5

0730 – 0900	***Metallurgical Failure: Case Studies*** *Case Study # 37: Jaw-Type Rock Crusher Wear* *Case Study # 38: Electronic Circuit Board Drill Wear* *Case Study # 39: Grinding Plate Wear Failure Analysis* *Case Study # 40: Impact Wear of Disc Cutters*
0900 – 0915	*Break*
0915 – 1000	***Wear Failures (cont'd)*** *Corrosive Wear Failures • Erosive Wear Failures • Cavitation Erosion • Liquid-Impact Erosion • Wear Failures of Plastics • Wear Failures of Reinforced Polymers*

1000 – 1200	***Metallurgical Failure: Case Studies*** *Case Study # 41: Fretting Failure of Raceways on 52100 Steel Rings of an Automotive Front-Wheel Bearing* *Case Study # 42: Fretting of Freon-Compressor Shaft because of a Loose Bearing* *Case Study # 43: Wear Failure of an Antifriction Bearing*
1200 – 1215	*Break*
1215 – 1300	***Distortion & Deformation Failures*** *Analysis of Distortion & Deformation*
1300 – 1345	***Metallurgical Failure: Case Studies*** *Case Study # 44: Distortion Failure of an Automotive Valve Spring* *Case Study # 45: Seizing of a Spool-Type Hydraulic Valve* *Case Study # 46: Deformation of a Gas-Nitrided Drive-Gear Assembly*
1345 – 1400	***Course Conclusion*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Course Topics that were Covered During the Course*
1400 – 1415	***POST-TEST***
1415 – 1430	*Presentation of Course Certificates*
1430	*Lunch & End of Course*

Practical Sessions
This practical and highly-interactive course includes real-life case studies and exercises: -



Course Coordinator
Mari Nakintu, Tel: +971 2 30 91 714, Email: mari1@haward.org