



Best Technology Solutions (BTS)

Metallurgical Failure Analysis & Prevention Training program

Introduction:

This training course is designed to give a semi-detailed discussion of Metallurgical failure analysis in order for the course material to suit participants with or without a metallurgical background. The course is divided into three main areas: Analysis methodologies and investigation techniques, Failure modes and mechanisms and Failures involved in different engineering parts. In addition several case studies are explained to the audience and discussion of case studies which might have been encountered by some of the participants.

At Course Completion

Upon successful completion of this course, participants will be able to:

- Differentiate between different types of failures
- Be able to choose the appropriate failure analysis technique(s)
- Relate different failures to their possible causes
- Write a failure analysis report

Who Should Attend?

Design engineers, Inspection engineers and technicians, process engineers, welding engineers, welding inspectors and other welding personnel, maintenance engineers and technicians, manufacturing engineers, product development engineers and managers, mechanical engineers with or without experience in metallurgy / failure analysis. Others who may benefit from this training course are commercial liability insurance underwriters and claims adjusters and trial lawyers specializing in product liability cases.



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Training Methodology

- Training will be delivered mainly through lectures with emphasis on practical examples and case studies practical sessions would be provided when and wherever possible.

Course Objectives:

By the end of this course delegates will learn about:

- To familiarize participants with the main tools and equipment used for metallurgical failure analysis.
- To introduce participants to different types of failures.
- To explain to participants the relationship(s) between design aspects, loading and/or manufacturing techniques and the different types of failures.
- To train participants to carry out a systematic failure analysis of failed parts.
- To describe and enhance necessary skills needed for successful failure analysis.
- To help the participants prevent future failures by proper inspection and or operation practice
- To train participants how to prepare a failure analysis report

Course Outline

- **General procedures for failure analysis.**
 - Collection of data and samples
 - Preliminary examinations
 - Mechanical testing
 - Macroscopic and microscopic examination
 - Preparation and examination of metallographic sections
 - Fractography



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▪ Types of failure and stress

- Fracture
- Wear
- Fatigue
- High temperature failures
- Types of stress
 - Tensile
 - Compression
 - Torsion
 - Shear
 - Residual stresses

▪ Ductile and Brittle Fracture

- Definitions and Comparisons
- Plastic deformation
- Dimple rupture
- Tearing and Shearing
- Ductile-Brittle transition
- Intergranular fracture
- Cleavage
- Thermally-induced and environmentally assisted cracking

▪ Fatigue failures

- Factors affecting fatigue life
- Stages of fatigue fracture
- Fatigue Cracking
- Effect of loading variables
- High temperature fatigue
- Fatigue characterization



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▪ Wear failures

- Abrasive wear
- Adhesive wear
- Friction
- Lubricated and non-lubricated failures
- Wear examination
- Microstructure and hardness
- Wear rates

▪ Corrosion failures

- Electro-chemical reactions
- Types of corrosion
- Velocity affected corrosion
- Corrective and preventive measures
- Material selection
- Corrosive environments
- Stress corrosion cracking
- Analysis of corrosion failures

▪ Elevated temperature failures

- Creep
- Stress rupture
- Thermal fatigue
- Effect of environment
- Testing techniques and evaluation



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- **Examples and case studies of failures encountered in engineering parts and materials**
 - Failures of Cast part
 - Failures in welded parts
 - Failures of tools and dies
 - Failures of gears and gear-tooth
 - Failures of shafts and bearings
 - Failures of boilers and heat exchangers
 - Failures of pressure vessels

- **Discussion of failure examples encountered by the participants**