

Acoustic Emission Testing Course

Level II - Outline

- I. Principles of AE Testing
 - a. Characteristics of AE Testing
 - i. Introductory concepts of source, propagation, measurement, display, evaluation
 - ii. Relationships between AE and other NDT methods
 - iii. Significance of applied load in AE testing
 - iv. Basic Math review
 - b. Materials and Deformation
 - i. Constitution of crystalline and noncrystalline materials
 - ii. Stress and strain
 - iii. Elastic and plastic deformation; Crack growth
 - c. Sources of AE
 - i. Burst emission, Continuous emission
 - ii. Emission signals/levels, units of amplitude measurement
 - iii. Sources in crystalline materials
 - 1. Dislocations – plastic deformation
 - 2. Phase transformations
 - 3. Deformation twinning
 - 4. Nonmetallic inclusions
 - 5. Subcritical crack growth
 - a. Subcritical crack growth under increasing load
 - b. Ductile tearing under increasing load
 - c. Fatigue crack initiation and growth
 - d. Hydrogen embrittlement and cracking
 - e. Stress corrosion and cracking
 - iv. Sources in nonmetals
 - 1. Microcracking
 - 2. Gross cracking
 - 3. Crazing
 - 4. Other sources in nonmetals
 - v. Sources in composites
 - 1. Fiber breakage
 - 2. Matrix cracking
 - 3. Fiber-matrix debonding
 - 4. Delamination
 - 5. Fiber pull-out, relaxation
 - 6. Friction
 - vi. Other sources
 - 1. Pressure leaks
 - 2. Oxide and scale cracking
 - 3. Slag cracking
 - 4. Frictional sources
 - 5. Liquefaction and solidification

- 6. Loose parts, intermittent contact
 - 7. Fluids, and nonsolids
 - 8. Crack closure
- d. Wave Propagation
 - i. Near-field impulse response
 - ii. Modes of propagation
 - iii. Mode conversion, reflection and refraction
 - iv. Wave velocity in material
 - v. Anisotropic propagation in composites
 - vi. Specimen geometry effects
 - e. Attenuation
 - i. Geometric attenuation
 - ii. Dispersion
 - iii. Scattering, diffraction
 - iv. Attenuation due to energy loss mechanisms
 - v. Attenuation vs. frequency
 - f. Kaiser and Felicity Effects, and Felicity Ratio
 - i. In metals
 - ii. In composites
 - iii. In other materials
 - g. Terminology (ASTM E1316)
- II. Sensing the AE Wave
- a. Transducing processes (piezoelectricity, etc.)
 - b. Sensors
 - i. Construction
 - ii. Conversion efficiencies
 - iii. Calibration (Sensitivity curve)
 - c. Sensor attachment
 - i. Coupling materials
 - ii. Attachment devices
 - iii. Waveguides
 - d. Sensor utilization
 - i. Flat response sensors
 - ii. Resonant response sensors
 - iii. Integral-electronics sensors
 - iv. Special sensors (directional, mode responsive)
 - v. Sensor selection
- III. Instrumentation and Signal Processing
- a. Cables
 - i. Coaxial cable
 - ii. Twisted pair cable
 - iii. Noise problems in cables
 - iv. Impedance matching
 - v. Connectors
 - b. Signal conditioning

- i. Preamplifiers
 - ii. Amplifiers
 - iii. Filters
 - iv. Units of gain measurement
- c. Signal detection
 - i. Threshold comparator
 - ii. Units of threshold measurement
 - iii. Sensitivity determined by gain and/or threshold
- d. Signal processing
 - i. Waveform characteristics
 - 1. Amplitude analysis
 - 2. Pulse duration analysis
 - 3. Rise time analysis
 - 4. Event and event rate processing
 - 5. MARSE
 - ii. Discrimination techniques
 - iii. Distribution techniques
- e. Source location techniques
 - i. Single channel location
 - ii. Linear location
 - iii. Planar location
 - iv. Other location techniques
- f. AE test systems
 - i. Single channel systems
 - ii. Multi-channel systems
 - iii. Dedicated industrial systems
- g. Accessory techniques
 - i. Audi indicators
 - ii. X-Y and strip chart recording
 - iii. Oscilloscopes
 - iv. Magnetic recorders
 - v. Others
- h. Advanced signal processing techniques
 - i. Signal definition
 - ii. Signal capture
 - iii. Frequency analysis
 - iv. Pattern recognition

IV. AE Test Techniques

- a. Factors affecting testing equipment selection
 - i. Material being monitored
 - ii. Location and nature of emission
 - iii. Type of information desired
 - iv. Size and shape of test part
- b. Equipment calibration and setup for test
 - i. Calibration signal generation techniques
 - ii. Calibration procedures
 - iii. Sensor placement
 - iv. Adjustment of equipment controls
 - v. Discrimination technique adjustments
- c. Loading procedures

- i. Type of loading
 - ii. Maximum test load
 - iii. Load holds
 - iv. Repeated and programmed loadings
 - v. Rate of loading
 - d. Special test procedures
 - i. High temperature/low temperature tests
 - ii. Interrupted tests (including cyclic fatigue)
 - iii. Long term tests
 - iv. Tests in high noise environments
 - e. Data display
 - i. Selection of display mode
 - ii. Use and reading of different kinds of display
 - f. Noise sources and pre-test identification techniques
 - i. EM noise
 - ii. Mechanical noise
 - g. Precautions against noise
 - i. Electrical shielding
 - ii. Electronic techniques
 - iii. Prevention of movement
 - iv. Attenuating materials and applications
 - h. Data interpretation
 - i. Recognizing noise in the recorded data
 - ii. Noise elimination by data filtering techniques
 - iii. Relevant and nonrelevant AE response
 - i. Data Evaluation
 - i. Methods for ranking, grading, accepting/rejecting
 - ii. Comparison with calibration signals
 - iii. Source evaluation by complementary NDT methods
 - j. Reports
 - i. Purpose
 - ii. Content and structure
 - iii.
- V. Codes, Standards, Procedures and Societies
 - i. Guide-type standards (glossaries, calibration, etc)
 - ii. Standardized/codified AE test procedures
 - iii. User-developed test procedures
 - iv. Societies active in AE
- VI. Applications of AE Testing
 - a. Laboratory Studies (Material Characterization) – At least 3 categories
 - i. Crack growth and fracture mechanics
 - ii. Environmentally assisted cracking
 - iii. Dislocation movement (metals)
 - iv. Clarifying deformation mechanisms (composites)
 - v. Phase transformations and phase stability
 - vi. Creep
 - vii. Residual stress
 - viii. Corrosion
 - ix. Fatigue
 - x. Rupture

- xi. Ductile/brittle transition
 - xii. Other material characterization applications
- b. Structural Applications – At least 4 categories
- i. Pressure vessels (metal)
 - ii. Storage tanks (metal)
 - iii. Composite pressure vessels/storage tanks
 - iv. Piping and pipelines
 - v. Bucket trucks
 - vi. Aircraft
 - vii. Bridges
 - viii. Mines
 - ix. Dams, earthen slopes
 - x. Pumps, valves, etc.
 - xi. Rotating plant
 - xii. In-process weld monitoring
 - xiii. Leak detection and monitoring
 - xiv. Other structural applications