

VT

VISUAL TESTING TOPICAL OUTLINES

Visual Testing Level I Topical Outline

Note: The guidelines listed below should be implemented using equipment and procedures relevant to the employer's industry. No times are given for a specific subject; this should be specified in the employer's written practice. Based upon the employer's product, not all of the referenced subcategories need apply.

1.0 Introduction

- 1.1 Definition of visual testing (VT)
- 1.2 History of VT
- 1.3 Overview of VT applications

2.0 Definitions

Standard terms and their meanings in the employer's industry

3.0 Fundamentals

- 3.1 Vision
- 3.2 Lighting
- 3.3 Material attributes
- 3.4 Environmental factors
- 3.5 Visual perception
- 3.6 Direct and indirect methods

4.0 Equipment (as applicable)

- 4.1 Mirrors
- 4.2 Magnifiers
- 4.3 Borescopes
- 4.4 Fiberscopes
- 4.5 Video borescopes
- 4.6 Remote visual inspection systems
- 4.7 Light sources and special lighting
- 4.8 Gauges (welding, go/no-go, etc.) templates, scales, micrometers, calipers, special tools, etc.
- 4.9 Automated systems
- 4.10 Computer-enhanced systems

5.0 Employer-Defined Applications

(Includes a description of inherent, processing, and service-induced discontinuities.)

- 5.1 Mineral-based material
- 5.2 Metallic materials, including welds
- 5.3 Organic-based materials
- 5.4 Other materials (employer defined)

6.0 VT to Specific Procedures

- 6.1 Selection of parameters
 - 6.1.1 Inspection objectives
 - 6.1.2 Inspection checkpoints
 - 6.1.3 Sampling plans
 - 6.1.4 Inspection patterns
 - 6.1.5 Documented procedures
- 6.2 Test standards/standardization
- 6.3 Classification of indications per acceptance criteria
- 6.4 Reports and documentation

Visual Testing Level II Topical Outline

The guidelines listed below should be implemented using equipment and procedures relevant to the employer's industry. The employer should tailor the program to the company's particular application area. Discontinuity cause, appearance, and how to best visually detect and identify these discontinuities should be emphasized. No times are given for a specific subject; this should be specified in the employer's written practice. Depending upon the employer's product, not all the referenced subcategories need apply.

A Level I class should precede every Level II class. When a Level II certification is sought in one step, the Level I topics shall be blended into this Level II topical outline. The combined outline must be reviewed and accepted by the responsible Level III.

1.0 Purpose and Scope of VT

- 1.1 Scope
 - 1.1.1 Internal quality control
 - 1.1.2 Quality control by the customer
 - 1.1.3 Quality control by authorities
- 1.2 VT looks for:
 - 1.2.1 Discontinuities
 - 1.2.2 Shape and geometry deviations
 - 1.2.3 Surface finish
- 1.3 Time of application
 - 1.3.1 During manufacture
 - 1.3.2 In service

2.0 Elements of Vision

- 2.1 Mechanics of vision
- 2.2 Adaptation and accommodation
- 2.3 Vision limitations
 - 2.3.1 Perception and environmental conditions
 - 2.3.2 Orientation, visual angle, and distance
 - 2.3.3 Ophthalmic disorders

- 2.3.4 Mental attitude and fatigue
- 2.3.5 Physiology and health
- 2.4 Vision acuity examination and charts
 - 2.4.1 Vision acuity tests
 - 2.4.2 Color and gray shade differentiation
- 3.0 **Elements of Lighting**
 - 3.1 Fundamentals of light
 - 3.2 Light sources
 - 3.2.1 Incandescent radiators
 - 3.2.2 Luminescent radiators (fluorescent light, high-intensity discharge light, light-emitting diodes, lasers)
 - 3.3 Adequate light levels
 - 3.4 Glare and fatigue
 - 3.5 General lighting requirements
- 4.0 **Contrast and Resolution**
 - 4.1 Reflection at smooth and rough/textured surfaces
 - 4.2 Law of illumination
 - 4.3 Reflectivity and luminance
 - 4.4 Luminous contrast
 - 4.5 Influence of cleanliness on contrast
 - 4.6 Dark-field contrast
 - 4.7 Colors and contribution of colors to contrast
 - 4.8 Surface geometry and contrast
- 5.0 **Optics**
 - 5.1 Transmission of light through solid and liquid media
 - 5.2 Refraction of light
 - 5.3 Refractive indexes of glasses
 - 5.4 How prisms change the direction of light
 - 5.5 How lenses focus and disperse light
 - 5.6 Lens optics and lens trains
 - 5.7 Fiber optics and fiber bundles
 - 5.8 Digitization and digital technology
- 6.0 **VT Equipment**
 - 6.1 Generic tools such as magnifiers and mirrors
 - 6.2 Rigid borescopes
 - 6.3 Fiberscopes
 - 6.4 Video borescopes
 - 6.5 Video borescopes measurement techniques
 - 6.5.1 Comparison technique
 - 6.5.2 Shadow technique
 - 6.5.3 Stereo technique
 - 6.5.4 Laser-based measurements
 - 6.6 Specialized inspection systems
 - 6.6.1 Push-tube cameras
 - 6.6.2 Pipe crawler camera systems
 - 6.6.3 Subsea remote camera systems
- 7.0 **Visual Appearance of Discontinuities**
 - 7.1 Primary manufacturing discontinuities (e.g., castings)
 - 7.2 Secondary manufacturing discontinuities (e.g., forgings)
 - 7.3 Service-induced discontinuities
 - 7.3.1 Caused by mechanical loads (e.g., fatigue)
 - 7.3.2 Caused by thermal loads (e.g., thermal shock)
 - 7.3.3 Caused by corrosion (e.g., pitting)
 - 7.3.4 Caused by abrasive wear (e.g., erosion)
 - 7.4 Inherent discontinuities
- 8.0 **Evaluation and Reporting**
 - 8.1 General evaluation scheme (ASTM E1316)
 - 8.2 Evaluation criteria
 - 8.2.1 Verbal descriptions
 - 8.2.2 Comparison standards or catalogs (e.g., photos/replica)
 - 8.2.3 Size-based criteria (measures)
 - 8.2.4 Mixtures of the above
 - 8.3 Evaluation techniques
 - 8.3.1 Visual-tactile recognition
 - 8.3.2 Grading by comparison with a standard
 - 8.3.3 Measurement
 - 8.4 Reporting and documentation
 - 8.4.1 Technique reports
 - 8.4.2 Data reports
 - 8.4.3 Image reports (sketches, hard-copy photo, or digital photo)
 - 8.5 Completion of testing confirmed with a checklist
- 9.0 **Codes, Standards, and Specifications**
 - 9.1 VT as an engineering task
 - 9.2 VT as a technician task
 - 9.3 US standards (e.g., ASME BPVC, AWS D1.1)
 - 9.4 European standards (based on PED)
 - 9.5 ISO standards
- 10.0 **Employer-specific Topics**
 - 10.1 Applications and techniques
 - 10.2 Specifications
 - 10.3 Lighting techniques
 - 10.4 Materials tested
 - 10.5 Special evaluation criteria
 - 10.6 Safety rules
- 11.0 **Glossary**
 - 11.1 Refer to Chapter 13 of ASNT, 2010, *Nondestructive Testing Handbook, Vol. 9: Visual Testing*, third edition
 - 11.2 Topics may be deleted if the VT is only required to perform direct visual inspection

Visual Testing Level III Topical Outline

1.0 Principles/Theory

- 1.1 Vision and light
 - 1.1.1 Physiology of sight
 - 1.1.2 Visual acuity
 - 1.1.3 Visual angle and distance
 - 1.1.4 Color vision
 - 1.1.5 Physics and measurement of light
- 1.2 Environmental factors
 - 1.2.1 Lighting
 - 1.2.2 Cleanliness
 - 1.2.3 Distance
 - 1.2.4 Air contamination
- 1.3 Test object characteristics
 - 1.3.1 Texture
 - 1.3.2 Color
 - 1.3.3 Cleanliness
 - 1.3.4 Geometry

2.0 Equipment Accessories

- 2.1 Magnifiers
- 2.2 Mirrors
- 2.3 Dimensional
 - 2.3.1 Linear measurement
 - 2.3.2 Micrometers/calipers
 - 2.3.3 Optical comparators
 - 2.3.4 Dial indicators
 - 2.3.5 Gauges
- 2.4 Borescopes
 - 2.4.1 Rigid
 - 2.4.2 Fiber-optic
 - 2.4.3 Special purpose
- 2.5 Video systems (robotics)
 - 2.5.1 Photoelectric devices
 - 2.5.2 Microscopy
 - 2.5.3 Video borescopes
 - 2.5.4 Video imaging/resolution/image processing (enhancement)
 - 2.5.5 Charge-coupled devices (CCDs)
- 2.6 Automated systems
 - 2.6.1 Lighting techniques
 - 2.6.2 Optical filtering
 - 2.6.3 Image sensors
 - 2.6.4 Signal processing
- 2.7 Video technologies
- 2.8 Machine vision
- 2.9 Replication
- 2.10 Surface comparators
- 2.11 Chemical aids
- 2.12 Photography
- 2.13 Eye

3.0 Techniques/Standardization

- 3.1 Diagrams and drawings
- 3.2 Raw materials
 - 3.2.1 Ingots
 - 3.2.2 Blooms/billets/slabs
- 3.3 Primary process materials
 - 3.3.1 Plates/sheets
 - 3.3.2 Forgings
 - 3.3.3 Castings
 - 3.3.4 Bars
 - 3.3.5 Tubing
 - 3.3.6 Extrusions
 - 3.3.7 Wire
- 3.4 Joining processes
 - 3.4.1 Joint configuration
 - 3.4.2 Welding
 - 3.4.3 Brazing
 - 3.4.4 Soldering
 - 3.4.5 Bonding
- 3.5 Fabricated components
 - 3.5.1 Pressure vessels
 - 3.5.2 Pumps
 - 3.5.3 Valves
 - 3.5.4 Fasteners
 - 3.5.5 Piping systems
- 3.6 In-service materials
 - 3.6.1 Wear
 - 3.6.2 Corrosion/erosion
 - 3.6.3 Microscopy
- 3.7 Coatings
 - 3.7.1 Paint
 - 3.7.2 Insulation
 - 3.7.3 Cathodic protection (conversion coatings)
 - 3.7.4 Anodizing
- 3.8 Other applications
 - 3.8.1 Ceramics
 - 3.8.2 Composites
 - 3.8.3 Glasses
 - 3.8.4 Plastics
 - 3.8.5 Bearings
- 3.9 Requirements
 - 3.9.1 Codes
 - 3.9.2 Standards
 - 3.9.3 Specifications
 - 3.9.4 Techniques (direct, indirect, video, etc.)
 - 3.9.5 Personnel qualification and certification

4.0 Interpretation/Evaluation

- 4.1 Equipment variables affecting test results including type and intensity of light
- 4.2 Material variables affecting test results including the variations of surface finish
- 4.3 Discontinuity variables affecting test results
- 4.4 Determination of dimensions (e.g., depth, width, length, etc.)
- 4.5 Sampling/scanning procedure variables affecting test results
- 4.6 Process for reporting visual discontinuities
- 4.7 Personnel (human factors) variables affecting test results
- 4.8 Detection
 - 4.8.1 Interpretation
 - 4.8.2 Evaluation

5.0 Procedures and Documentation

- 5.1 Hard copy – general applications
 - 5.1.1 Mineral-based materials
 - 5.1.2 Organic-based materials
 - 5.1.3 Composite materials
 - 5.1.4 Metallic materials
- 5.2 Photography – specific applications
 - 5.2.1 Metal joining processes
 - 5.2.2 Pressure vessels
 - 5.2.3 Pumps
 - 5.2.4 Valves
 - 5.2.5 Bolting
 - 5.2.6 Castings
 - 5.2.7 Forgings
 - 5.2.8 Extrusions
 - 5.2.9 Microcircuits
- 5.3 Audio/video – requirements
 - 5.3.1 Codes (AWS, ASME, etc.)
 - 5.3.2 Standards (ASTM, NAVSEA, MIL-STD, etc.)
 - 5.3.3 Specifications
 - 5.3.4 Procedures (Level III exam specific)
- 5.4 Electronic and magnetic media
- 5.5 Personnel qualification and certification

6.0 Safety and Health

- 6.1 Electrical shock
- 6.2 Mechanical hazards
- 6.3 Lighting hazards physiological deleterious effects of light
- 6.4 Chemicals contamination
- 6.5 Radioactive materials
- 6.6 Explosive environments

VISUAL TESTING LEVEL I, II, AND III TRAINING REFERENCES

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