

## CP25 – ANNEX A - GENERAL SPECIFICATION FOR VISUAL TESTING

This document is intended for use during PCN Visual Testing training and examination for the Level 2 Sector Specific Practical instruction writing and Level 3, Part C<sub>3</sub> written procedure, until such time as a national, European or international standard giving guidance in this area is published.

### 1.0 SCOPE

This specification contains methods and minimum requirements for visual testing of cast, wrought or fabricated items, including metallic and non-metallic materials for use in general engineering or aerospace applications. Visual testing in accordance with this specification may be carried out during manufacture, on final inspection or in-service to detect undesirable discontinuities. Stage of inspection shall be subject to agreement by contracting parties.

### 2.0 DEFINITIONS

Terms and definitions shall be as defined in Section 12 of the Non-Destructive Testing Handbook - Second Edition, Volume 8 entitled "Visual and Optical Testing".

### 3.0 RESPONSIBILITY

The responsibility for conducting visual tests shall be that of the owner. The owner being the manufacturer until the said item is sold.

The owner shall ensure safe working environments for visual testing personnel to conduct examinations. Areas of hazard shall be strictly legislated by safe working codes and maximum exposure limits.

Hazardous areas may constitute employment of remote inspection techniques.

### 4.0 QUALIFICATIONS

Personnel working in accordance with the minimum requirements of this specification shall be currently certified to an internationally recognised scheme in the specific discipline related to product form and industrial sector.

Visual acuity shall be a minimum of Snellen 20/30 for general testing and Snellen 20/20 for critical testing.

### 5.0 PROCEDURE

A written procedure shall be prepared by the NDT Level 3 to include at least the following:-

- I. Stage of testing
- II. Type of surface condition
- III. Cleaning instructions
- IV. How the test is to be performed
- V. Illumination technique and measurement of illumination
- VI. Sequence of performing the test
- VII. Data to be tabulated
- VIII. Check list for testing
- IX. Report forms

X. Permanent records - if any

XI. Specialised equipment if required for hazardous areas

The written procedure shall define scope of coverage and may be limited to specific tasks.

The procedure shall contain a reference report form and a check list to prompt inspectors during surveillance of the test area. The checklist shall include all facets related to the specific surface examination and may be used to verify that the required observations were performed.

## 6.0 PROCEDURE QUALIFICATION

The written procedure shall be proven by demonstration that a fine artificial flaw of 0.7mm wide or less can be detected utilising the techniques stated therein.

The artificial flaw shall be included into a sample with representative surface texture and accessibility constraints of that requiring examination during production or in-service.

Information as to the location of artificial flaws shall not be divulged to personnel conducting procedure qualifications tests.

Failure to locate artificial flaw locations may constitute revision of techniques outlined in the procedure.

A fully documented report of procedure qualification shall be maintained for verification by third parties.

## 7.0 DIRECT VISUAL TESTING

Direct visual testing may usually be made when access is sufficient to place the eye within 600mm of the surface to be examined. The visual angle between plane of vision and surface being tested shall not be less than 30°. Mirrors may be utilised to improve the angle of vision.

Magnification aids may be employed for critical work between 2X and 10X magnification. General purpose testing should not be conducted with magnification levels above 5X.

Illumination of the test surface shall be 500 lux minimum for general examinations and 1000 lux minimum for critical work. Illumination shall be verified by a calibrated photometer. Positioning of a light source determines illumination levels. With increase in distance from source to test surface the intensity is decreased obeying the inverse square law. Calculation of expected illumination levels can therefore be determined by:-

$$E = I/d^2$$

E = Illumination in lux

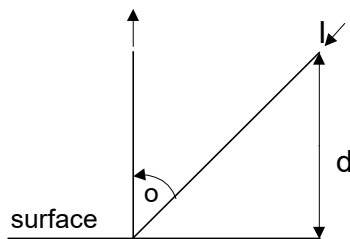
I = Luminous intensity of source

d = Distance between source and point

Angulation of the light source to the test surface decreases intensity of illumination.

Illumination at the surface for an inclined source can be calculated using the Lambert Cosine Law.

$$E = I/d^2 \cos \theta$$



## 8.0 REMOTE VISUAL TESTING

Remote visual testing personnel shall demonstrate Snellen 20/20 vision or better. Use of remote visual testing equipment is often dictated by environmental factors and restricted access. Procedures that adopt remote vision techniques shall prove suitability by simulated trials. Records shall be maintained for third party scrutiny from all performance trials.

Illumination levels may be reduced for orthicon tube cameras. Chip cameras require higher illumination levels. Remote testing in very high radiation fields shall be conducted with Vidicon tube cameras.

Data storage on video tape using *conventional* VCR machines is prohibited. High resolution VCR machines with a minimum of 500 line horizontal resolution may be used.

## **9.0 TRANSLUCENT VISUAL TESTING**

Translucent visual testing is a supplement of direct visual testing. The method is based upon back lighting of a translucent material to aid examination of such material for internal and surface flaws. Light sources used shall be sufficiently diffused as to prevent glare obscuring fine detail. Light sources should have adjustable intensity for adaptation to changing sessions or material structures.

## **10.0 NON-METALLIC MATERIALS TESTING**

Ceramics, laminates, polymers and composites require specific attention to observe impact damage. Surface deformation may not always be evident and use of alcohol or dye being swabbed across the test surface to aid visual detection will be mandatory. Caution must be taken to ensure such chemicals do not degrade the test item. Specialist advice is recommended prior to application.

## **11.0 APPLICATION**

Analysis of profile and topographical features may be required. Silicone rubber replication can be used where flexibility is required. Cellulose acetate tape shall be used for fracture surface replication due to the superior resolution achieved.

## **12.0 ALTERNATIVE METHODS OF TESTING**

Ambiguous indications may warrant supplementary test techniques. Suitability of such tests shall be determined by the NDT Level 3.

## **13.0 EVALUATION**

All tests shall be evaluated in terms of the acceptance criteria of this specification. Where specific detail is not included in the acceptance criteria then agreement between contracting parties shall be required. All observations outside acceptable limits shall be reported with reference to location and dimensional position.

## **14.0 REPORTS**

A written report shall be completed by the person(s) conducting the tests. The report shall include:-

- I. Component identity
- II. Stage of manufacture
- III. Surface condition as found
- IV. Illumination level
- V. Type of light source
- VI. Specialised equipment used
- VII. Flaw locations
- VIII. Datum points used
- IX. Complementary NDT methods advised
- X. Statement of compliance/non-compliance
- XI. Acceptance criteria used
- XII. Name and qualification details of person conducting test
- XIII. Date of test
- XIV. Signature of person conducting test

## **15.0 RECORDS**

Records of tests shall be held on file for a period of five years. Access to all documentation shall be made available to contracting parties and any designated third party.

## **16.0 ACCEPTANCE CRITERIA**

The acceptance criteria is sub-divided into the following product forms:-

Cast components

Wrought components

Fabricated components including welding

Non-metallic components

### 16.1 Acceptance Criteria - Cast Products

The following shall not be acceptable:-

Cold shuts exceeding 5mm in length

Cracks/tearing of any length

Porosity/blow holes exceeding 1mm diameter individually or grouped exceeding 25mm<sup>2</sup> surface area

Areas of sink/concavity exceeding 1mm deep with length exceeding 15mm

Surface breaking shrinkage cavities

Non-metallic inclusions exceeding 3mm in length

Any severe condition limiting complete testing due to contamination, incomplete fettling, corrosion or heavy grinding, chisel marks, arc strikes shall be reported for remedial action prior to completion of the test.

### 16.2 Acceptance criteria - Wrought Components

The following shall not be acceptable:-

Cracks of any length

Laps exceeding 5mm in length

Bursts of any length

Seams, stringers or rokes exceeding 5mm in length

Laminations exceeding 5mm in length

Non-metallic inclusions exceeding 3mm in length

Blisters of any length

Exfoliation of any length shall be reported for further investigation by complementary NDT methods

### 16.3 Acceptance Criteria - Fabricated Components including Welding

The following shall not be acceptable:-

#### 16.3.1 Welded fabrications

##### 16.3.1.1 General

Angular distortion/misalignment exceeding 1.5mm in any 100mm length

Undercut exceeding 0.5mm deep with length exceeding 2mm

Concavity/underflushing of the weld reinforcement or root penetration in excess of 1mm deep x 5mm long

Cold overlap/lack of fusion in excess of 3mm length

Lack of penetration exceeding 3mm long

Weld reinforcement (cap height) in excess of 3mm high x 10mm long

Excess root penetration in plate butt welds plate exceeding 2mm height x 5mm length.

##### 16.3.1.2 Butt welds in pipe

Penetration of root bead:

| nominal size of pipe (I/D) | max penetration in bore* | max restriction in bore* |
|----------------------------|--------------------------|--------------------------|
| mm                         | mm                       | mm                       |
| < 12                       | 1                        | 1.5                      |
| 12 - 24                    | 1.5                      | 2                        |
| 25 - 49                    | 2.5                      | 3                        |
| 50 - 99                    | 3                        | 5                        |
| >99                        | 3                        | 6                        |

\* Values rounded to nearest 0.5mm

Porosity: Individual pores exceeding 1mm diameter or grouped porosity in excess of 25mm<sup>2</sup> surface area.

Inclusions exceeding 3mm long

Spatter exceeding 3 pieces in any 50mm length

Detectable cracks are not permitted regardless of length

#### **16.3.1.3 Fillet welds**

Fillet weld leg length and throat thickness sizes shall be +/- 10% of the nominal contract drawing size

Any severe condition such as contamination, oxidation or heavy grinding, chisel marks, arc strikes and undressed tacks, that limits complete examination shall be reported for remedial action prior to testing.

#### **16.3.1.4 Bolted fabrications**

The following shall not be acceptable:-

Visibly loose nuts

Absence of washers under nuts

Absence of bolts from holes

Bolted joints where less than one full bolt thread protrudes through a nut

Bolts that do not seat flat for at least 75% of head area

Nuts or bolts with severe mechanical damage

Cracked nuts or bolt heads

#### **16.3.1.5 Riveted fabrications**

The following shall not be acceptable:-

Incompletely formed rivets

Lack of protrusion or through wall penetration

Visibly loose rivets

Absence of rivets

Cracked rivets

Severe mechanical damage to rivets and adjacent material

Evidence of fretting wear

### **16.4 Acceptable Criteria - Non-Metallic Materials**

The following shall not be acceptable:-

Cracks exceeding 2mm in length

Delamination exceeding 10mm<sup>2</sup> area

Inclusions exceeding 2mm in length

Voids exceeding 2mm in length

Impact damage shall be reported regardless of length for further investigation by complimentary NDT methods