Quality Assurance Procedure QAP 5945

Rev 9/7/18

Liquid Penetrant Inspection Procedure

1. SCOPE

1.1 This written procedure conforms to ASNT-SNTTC-1A and the Written Practice of Personnel Qualification per AASHTO/AWS D1.5M/D1.5 current edition and ASTM E 165. Additional specific requirements are detailed, which, while maintaining conformance to the above referenced specifications, further control variables of the procedures to assure an accurate, meaningful evaluation. Examination of discontinuities open to the surface applicable to in process and final quality of welds shall be performed using solvent removable visible or fluorescent liquid penetrants.

1.2 This method does not apply to materials such as anodized aluminum, galvanized steel, material which has acid or chromates present on the surface, or passivated stainless steel.

1.3 The primary purpose of the liquid penetrant test is to identify locations of cracks caused by fatigue, shrinkage, handling or residual hydrogen stresses. Typically the locations will be at the toe, termini (craters), or face of welds. This test is considered secondary in sensitivity to the Magnetic Particle Test, QAP5930. Discontinuities such as slag inclusions or cracks at the edges of butt joints where improper termination on the runoff tab, as well as, improper runoff tab removal are verified quite well using penetrant testing (radiography and ultrasonic testing is limited in sensitivity at these edges). Base metal cracking

caused by grinding, arc strikes, nonmetallic oxide inclusions (at the edges of base metals) and lack of fusion (at the exposed ends of welds) may also be also indicated.

1.4 Penetrant testing shall be used for verification of toe cracks and removal of planar indications found ultrasonically in butt welds, only when it is not practical to perform Magnetic Particle Inspection. Q.C. must supervise the removal of planar indications, otherwise, the defect will often remain in the repaired weld.

2. PERSONNEL

2.1 Personnel performing this examination shall be qualified in accordance with the Written Practice of Personnel Qualification and Certification for Nondestructive Testing per ASNT-SNT-TC-1A and AASHTO/AWS D1.5.

3. REFERENCE

3.1 AASHTO/AWS D1.5M/D1.5, Section 6.7.7 and 6.26.

3.2 ASTM Volume 3.03 , E165

3.3 NDT Handbook, McMaster Vol. 1

3.4 ASME Pressure Boiler Code, Article VI.

4. MATERIALS

4.1 Solvent-Removable Penetrants that are visible (ASTM E165 - Method B, Type 3) or fluorescent (ASTM E165 - Method A, Type 3) shall be used. A compatible (same manufacturer and family) solvent cleaner and dry or non-aqueous developer shall be used for the selected liquid penetrant. The developer and penetrant shall be evaluated for relative sensitivity using "Qualification of Liquid Penetrant Inspection Procedures and Material Sensitivity Tests", Section 5.1., QAP 5940.

The chlorine or sulfur content of the penetrant materials shall not exceed 1% when testing austenitic stainless steel or otherwise indicated in the plans and specifications.

4.2 3/8" x 2 1/2 " x 6" of 2024 aluminum alloy control specimen.

4.3 Depressed composite disc grinder.

4.4 Lint-free rags.

4.5 Flashlight capable of producing 50 footcandles.

4.6 10X, 30X Magnifier

4.7 Light Meter (footcandles).

4.8 Ruler (1/64 inch increments)

5. PROCEDURE

5.1 The temperature of the penetrant materials and the surface of the part to be tested shall be between 60 and 125 degrees Fahrenheit. Local heating or cooling is permitted provided the start temperature remains within the 60 to 125 degree F range throughout the examination and heat is not directly applied, after the start of the test, to the area being evaluated. When it is not 1/1/0 practical to conduct a liquid penetrant examination within this temperature range, it is necessary to qualify the procedure in accordance with "Qualification of Liquid Penetrant Inspection Procedures and Material Sensitivity Tests", Section 5.3.
5.2 The area to be tested shall be cleaned to remove all rust, scale, welding flux, spatter grease, paint, solvent, oily films, dirt, etc. that would interfere with penetration or interpretation of indications (background noise). Situations may arise where the weld profile, particularly overlap, may require contouring to verify a crack or lack of fusion (increase the signal to noise ratio). Cleaning shall be accomplished by applying a system compatible solvent lightly on a lint less cloth and rubbing with any finish marks on the specimen until all contaminants are removed. Care shall be taken to not leave solvent remaining on the test surface. Rust oxide on surfaces shall be removed by minimal grinding sufficient only to remove surficial oxides. Blasting of surfaces is not to be used as a cleaning method unless the blasting occurred prior to suspected fatigue cracking which is intentionally being evaluated.

5.3 The area cleaned shall be thoroughly dry prior to the application of penetrant. If this is not assured, a drying dwell time of 5 minutes prior to the application of penetrant shall be allowed or heating to not above 125 degrees Fahrenheit may be used to facilitate drying.

5.4 Penetrant may be applied by brush or spraying such that the entire area to be tested is uniformly covered with penetrant. The aerosol can should be held 3" - 6" from the test surface.

5.5 The penetrant dwell time shall be between 7 and 20 minutes. This time shall not apply to crack indications which are ground to remove oxides and retested to facilitate interpretation of the indication by observing the bleed-out of the penetrant. For testing outside of 60 - 125 degrees, the dwell times used for the penetrant and developer shall be in accordance with the Q.A.P. 2/13/18 Page 3 inspection range on the form "Procedure Values for Penetrant Testing Qualification".

5.5.1 If the penetrant dwell time has been exceeded, when testing at temperatures between the minimum qualified (or 60 degrees) through 125 degrees, additional penetrant shall be applied to the test surface and given a 5 minute dwell time prior to testing. If the base metal temperature is greater than 125 degrees F, the penetrant shall be reapplied and shall be given a dwell time as indicated on the form: "Procedure Values for Penetrant Testing Qualification".

5.6 Within the prescribed dwell time limits, remove excess penetrant by using clean lint less cloths, repeating the operation until most traces of the penetrant have been removed (never apply cleaner directly to the test surface). Then, lightly moisten the cloths with solvent and rub the surfaces in the direction of the finishing marks until all traces of excess penetrant have been removed. This necessitates checking the area or cloths with the black light when using fluorescent penetrants. Minimize excessive removal of the penetrant by avoiding the use of excess solvent. Flushing of the surface with solvent following the application of penetrant is prohibited.

5.7 After cleaning, drying of the surface shall be accomplished by evaporation or forced dry air. A minimum period of time shall be established to ensure that the cleaning solution has evaporated.

5.8 Apply the developer immediately after the excess penetrant has been removed and the part has dried. Apply the developer by spraying the part with a light uniform film. Several intermittent light applications shall be used if necessary rather than one heavy coat. Insufficient coating thickness may not draw the penetrant out of the discontinuities; conversely, excessive coating may mask discontinuities.

5.9 Dwell time for the developer prior to evaluation shall be at least 7 minutes but not more than 30 minutes. These dwell times do not apply if confirmation of cracks after grinding of oxides is desired. Developing time begins immediately after the application of the developer and as soon as the wet developer coating has dried. If, after the developer has dried, the test surface has a pink hue or fluorescence over the entire test area, the area shall be recleaned and re-tested.

5.9.1 For testing temperatures outside of 60 - 125 degrees, allow a dwell time as shown on the form "Procedure Values for Penetrant Testing Qualification".

5.10 Visible penetrant inspection shall be performed with a minimum of 32.5 footcandles of light on the test area. The entry of the penetrant and its bleeding pattern should be observed to aid in interpretation.

Observation of bleed-out from indications shall be observed with a minimum of 50 footcandles and a 10X magnifying lens when evaluating suspected cracks. Suspected cracks shall be lightly ground and the procedure repeated without solvent cleaning nor following the specified dwell times to facilitate interpretation as necessary. Use of 30x microscopy shall be used when necessary to facilitate interpretation.

5.11 Fluorescent penetrant inspection shall be performed when the ambient white light does not exceed 3 footcandles. Blacklight intensity shall be a minimum of 800 micro Watt / square centimeter or use of the reference sample to check sensitivity. Turn on the black light and allow 5 minutes to warmup prior to use. Allow 5 minutes to adjust the inspectors eyes to the dark.

5.12 Suspected cracks at the toes of the weld or rounded indications in craters require further examination (retesting or direct visual examination using 30X microscopy).

5.13 Cleaning of all surfaces tested prior to blasting of the member, for paint preparation or when welds will be repaired, shall require cleaning. Cleaning shall be accomplished by force spraying

the cleaner into the surface and wiping dry. All penetrant, developer and cleaner must be removed prior to welding to preclude inducement of defects.

5.14 Fluorescent penetrant examination shall not follow a color contrast penetrant examination or vice versa. Intermixing of penetrant materials from different families is not permitted.

6. EVALUATION and ACCEPTANCE

6.1 Sections of weld that are shown to have any of the following types of discontinuities are unacceptable:

6.1.1 Any type of crack

6.1.2 Lack of fusion between adjacent layers of weld metal and between weld metal and base metal.

6.1.3 Piping porosity in fillet welds greater in number than one in 4 inches or six in 4 feet in fillet welds. These indications must be visible without a PT indication to the eye. Any piping porosity greater than 3/32 inch in greatest dimension in fillet welds.

6.1.4 Welds containing unacceptable flaws shall be repaired and re-examined in accordance with this procedure. Sizing of PT indications shall be done using a ruler with increments of 1/64 inch with or without magnification (The size of the actual flaw and not the size of the indication). Indications that show excessive bleeding for the visible size indicated may require subsurface excavation for further evaluation (possible cracks or significant subsurface porosity - see D 1.5, Section 6.7.7, 6.26).

7.RECORDS

7.1 tests shall be documented and reported to CDOT Staff Bridge.