NDT Specialists, Inc

Radiographic Inspection Procedure

Procedure No.	NDT-S-RT3	Page 1 of 7	Revision	504
Approved By	Lawrence J. Schneider Sr.	Level III	Date	04/27/05

SCOPE

This procedure describes the use of radiography, by means of either X-rays or Gamma rays, as a nondestructive testing method for the detection of surface and subsurface discontinuities in ferrous and non-ferrous materials, castings, and weldments in accordance with ASTM E 1742-95

GENERAL

Castings or forgings that are required to be examined shall be specified in applicable drawings, specifications, contracts or purchase orders. Written techniques shall be maintained on file.

REFERENCES

The following documents have been used in preparation of this procedure and may be used for reference. The latest edition as available shall be used.

ASTM E 1742-95
ASTM E 1254-97
ASTM E 1815
ASNT-SNT-TC 1A 1996 Edition

EQUIPMENT AND MATERIALS

Sources of radiation may be either X-ray or radioactive isotopes (Iridium 192 & Cobalt 60). Selection of the source shall be based on the requirements of the applicable specification and the thickness and type of material to be examined.

A source decay chart showing the capsule number, the dated decay curve and the physical dimensions of the source material shall accompany each gamma source used. The drive cables and source tubes are considered a part of the projector. Their design shall allow for proper positioning of the source.

Each X-ray unit shall be used and maintained in accordance with the manufacturer's recommendations.

Radiation detection and monitoring devices, such as survey meters, dosimeters, and film badges, shall be used.

Radiographic examinations shall be performed in accordance with state and federal safety requirements, which are specified in the NDT Specialists Radiation Safety Control Procedures.

Film holders shall be either flexible or rigid type for the size film required. The interior of the film holders shall be kept clean and free of foreign material. Film holders shall be examined, as often as necessary, to prevent development of light leaks.

Intensification screens shall be of the lead type and may be used with or without paper or rubber backing. These screens shall be kept clean and free of foreign material, pits, wrinkles, or scratches. Unless

specifically approved by the customer, fluorescent screens shall not be used. Screens shall be of thickness of .001" thru .020" for gamma sources.

Radiographic film shall be in accordance with ASTM E 1815, Class I or Class II. Unexposed film shall be stored in such a manner that it is protected from the effects of light, pressure, excessive heat, excessive humidity, damaging fumes or vapors, or penetrating radiation. Storage should be on a first in, first out basis. Film shall be handled with care to prevent crimping or other conditions that produce artifacts that may mask or hinder interpretation.

Darkroom facilities shall be maintained in a clean and orderly condition and shall capable of producing uniform blemish free radiographs.

Safe lights shall be checked periodically to assure that the filters are not cracked, scratched, or can in any way leak white light.

Processing equipment may be either manual or automatic. Film driers shall be capable of drying film free of artifacts and in a reasonable period of time. The equipment shall be maintained in good working condition.

Processing solutions shall be compatible with the type of film being processed. Solutions shall be used in accordance with the manufacturer's recommendations.

A densitometer or density strip shall be used for assuring compliance to film density requirements. It shall be calibrated annually. Calibrated density strips shall be used to check the accuracy of the densitometer. This density strip shall be traceable to the National Bureau of Standards (NBS).

Film viewers shall be of the high intensity type with a variable intensity control. They shall produce sufficient illumination to permit adequate viewing of the film at the maximum film density permitted.

PERSONNEL

Personnel performing Radiographic inspection shall be qualified and certified in accordance with Personnel Qualification Procedure NDT-S-PQ1 Rev. 504 that is established from the American Society for Non-Destructive Testing Recommended Practice SNT-TC-1A.

PREINSPECTION

Pre-inspection shall be made of the test item to determine the surface requirements. Surface preparation shall be the responsibility of the customer. Surfaces shall be considered satisfactory, if there are not conditions that might interfere with the test procedure or accurate interpretation of the results.

IDENTIFICATION

The Exposure Set-up shall be made in such a way as to produce optimum test results. Collimators shall be used whenever possible to reduce scatter radiation.

Location markers - The images of the location markers shall appear on the film without interfering with the interpretation and in such an arrangement as to assure complete coverage. The marker positions shall be marked on the part and the position of the markers shall be maintained on the part during radiography.

Film identification shall be provided in such a way as to show positive identification. The following information should be shown plainly and permanently on each film: identification of organization making the radiograph, date of exposure, job number or customer, identification of the part and, where applicable, the view in the part, whether the radiograph is an original or repair.

Film identification may be made with lead figures, by light printing, or with any permanent means. Placement of the identification markers shall be such that the projected image does not overshadow or interfere with the area under examination. Identification markers shall be placed on the part wherever possible and not on the cassette.

Location markers shall be placed as follows:

Source Side Markers (single wall viewing): Flat components or longitudinal joints in cylindrical or conical components, curved or spherical components whose concave side is toward the source and when the source material distance is less than the inside radius of the component, curved or spherical components whose convex side is toward the source.

Film Side Markers (single wall viewing): Curved or spherical components whose concave side is toward the source and when the source to material distance is greater than the inside radius.

Either Side Markers (single wall viewing): Curved or spherical components whose concave side is toward the source and the source to material distance equals the inside radius of the component.

Double Wall Viewing - At least one location marker shall be placed on the outside surface adjacent to the weld (or on the material in the area of interest) for each radiograph. When inaccessibility or other limitations prevent the location of markers as stated above, a dimensional map of the actual placement marker shall accompany the radiographs and shall show that full coverage has been obtained.

GEOMETRIC UNSHARPNESS

Geometric unsharpness equals source size times thickness divided by the object to source distance plus the thickness of the part.

$$UG = T+(FT/D)$$

Where: UG = Geometric unsharpness

F = Source size in inches max effective dimension.

D = Distance in inches from source of radiation to weld or other object being radiographed.

T = Thickness in inches of the casting or other object being radiographed, assuming the film is against the casting or object; otherwise, it is the thickness of the casting or object plus the space between the film and casting or object.

For Radiography performed to this procedure the geometric unsharpness below shall not to be exceeded.

Material thickness	Geometric unsharpness
Under 2"	.020”
Over 2" through 4"	.030”
Over 4"	.040”

PENETRAMETERS

Penetrameters shall be used for all radiography, and the image used to determine radiographic quality level. Penetrameters shall be in accordance with ASTM E 1742-95 Figure 1.

Penetrameters shall be fabricated of material of the same composition or of a radiographically similar material. The dimension and identification of the Penetrameters shall conform to the requirements of ASTM E 1742-95 Figure 1.

Selection shall be based upon the nominal wall thickness plus any allowable reinforcement.

IQI PLACEMENT

The placement of the IQI(s) shall be on the source side of the test part whenever possible or when the applicable specification stipulates the use of a film side IQI. The plane of the IQI shall be normal to the radiation passing through the part. When it is impractical to use a source side IQI, a film side IQI may be used. Selection shall be as follows; through demonstration a source side IQI shall be placed on an exposure of like section and a series of smaller IQI’s shall be placed on the film side. If the required source side IQI indicates the specified quality level, the image of the smallest or thinnest IQI visible on the film side shall be used as the proper film side IQI. A lead letter “F” shall be placed adjacent to film side IQI’s. When configuration or size prevents placing the IQI(s) on the object, it may be placed on a separate block of like part/product section. When inspecting parts of or objects of an irregular nature the IQI shall be placed on the object farthest from the film.

If the density through the test area varies more than minus 15% or plus 30% from the density through the penetrameter, within the minimum/maximum limits stated below, then an additional penetrameter(s) shall be used for the exceptional area(s). When one penetrameter represents the lightest area and one represents

the darkest area of interest the intervening densities shall be considered as having acceptable penetrameter coverage.

The film density through the test area shall be:

1.5 - 4.0 for radiographs made with single film technique.
2.0 - 4.0 for radiographs made with multiple film technique (composite viewing).

Single film viewing shall be used except when the customer permits double viewing or where impractical due to the characteristics of the item(s) being examined.

The essential hole size and designated penetrameter shall be as specified in the applicable specification. A smaller hole or thinner penetrameter than listed for each range may be used provided the other requirements of the specification are met.

EXPOSURE

Film holders shall be positioned in such a way as to insure close contact with the test part whenever possible.

Care shall be taken in making exposure set-ups to minimize backscatter radiation to the film. Lead shielding shall be used, whenever practical, behind the film holder to prevent scattered radiation from the floor, walls, or other surrounding objects from fogging the film. To determine the level of fogging which may occur, each film holder should have a lead letter "B" fastened to the back of the film holder within the area of film to be read, but outside the area to be read for acceptance. The lead letter shall be a minimum of ½ inch high and a minimum of 1/16 inch thick. If a light image of the "B" appears on a darker background of the radiograph, protection from backscatter is insufficient and the radiographs shall be unacceptable. A dark image of the "B" on a lighter background is acceptable.
All radiographs produced with an exposure of 150KV or greater shall have a front and back lead screen of 0.001 - 0.010 thick in close contact with the film.

Radiographic Technique

Single-Wall Technique - Radiography, regardless of the configuration of the material, shall be done using a single-wall radiographic technique whenever practicable. Penetrameter size and placement shall be made in accordance with this procedure. An adequate number of exposures shall be made to demonstrate that the required coverage has been obtained.

If the nominal internal dimensions are 4 inches or less a double wall technique may be used.

Double-Wall Technique - When it is not practical to use a single-wall technique, one of the following double-wall techniques shall be used. An adequate number of exposures shall be made to demonstrate that the required coverage has been obtained.

Single-Wall Viewing - for materials and for welds in components, a technique may be used in which the radiation passes through 2 walls and only the weld (material) on the film side is viewed for acceptance. An adequate number of exposures shall be made to demonstrate that the required coverage has been obtained. When complete coverage is required for circumferential welds, a minimum of 3 exposures taken 120 degrees to each other shall be made.

Double-Wall viewing - when components are 3-1/2 inches or less in nominal outside diameter, a technique may be used in which the radiation passes through the weld/material and 2 walls. Both walls are then viewed for acceptance on the same radiograph. For double-wall viewing, a source side penetrameter shall be used and placement shall be as in this procedure. Care must be exercised to ensure that the required geometric unsharpness is not exceeded. If the geometric unsharpness cannot be met, then single-wall viewing shall be used.

For welds, the radiation beam may be offset from the plane of the weld at an angle sufficient to separate the image of the source side and film side portions of the weld so that there is no overlap of the areas to be interpreted. When complete coverage is required, a minimum of 2 exposures taken at 90 degrees to each other shall be made for each joint.

As an alternative, the weld may be radiographed with the radiation beam positioned so that the images of both walls are superimposed. When complete coverage is required, a minimum of 3 exposures taken at either 60 degrees or 120 degrees to each other shall be made for each joint. Additional exposures shall be made if the required radiographic coverage cannot be obtained using the minimum number of exposures indicated above

FILM PROCESSING

Film processing shall be performed in accordance with the manufacturers recommendations.

Film shall be processed in such a manner as to assure quality radiographs. Radiographs having mechanical, chemical, or other processing defects in the area of interest that could interfere with proper interpretation of the radiograph shall be considered unsatisfactory. Examples of processing defects are: fogging, streaks, water marks, chemical stains, scratches, finger marks, crimps, dirtiness, static marks, smudges, or tears.

INTERPRETATION

Interpretation of radiographs shall be done in an area with low background lighting.

A high intensity viewer as described in this procedure shall be used. The intensity should be adjusted to provide optimum viewing conditions. The viewer shall be capable of transmitting at least 2 foot-candles of light through the darkest acceptable density not to exceed 4.0. The reading of the foot-candles shall be taken at the surface of the film viewer. Radiographs shall be checked for proper placement and accuracy of identification. Location markers shall be checked to assure that proper coverage of the test item has been achieved.

ACCEPTANCE CRITERIA

Acceptance of the casings or objects shall be as specified on the drawing, contract documents, or purchase order.

DOCUMENTATION

Documentation shall include a Radiographic Shooting Sketch, Radiographic Technique and a Radiographic Inspection Report.

RECORD OF REVISION

Date	Revision	Detail of Revision
04/27/2005	504	Reformat to current style & PQ-1 Update