Designation: ~~E2698 – 10~~ E2698 – 18

Standard Practice for ~~Radiological~~Radiographic Examination Using Digital Detector Arrays[1]

This standard is issued under the fixed designation E2698; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice establishes the minimum requirements for ~~radiological~~radiographic examination ~~for~~of metallic and nonmetallic ~~material~~materials using ~~a~~ digital detector ~~array (DDA) system.~~arrays (DDAs).

1.2 The stated requirements of this specification are based on the use of an X-ray generating source. Additionally, some of the tests and requirements may not be applicable to X-ray energy levels >450kV.

1.3 The requirements in this practice are intended to control the quality of ~~radiologic images~~ radiographic examinations obtained using DDAs and are not intended to establish acceptance criteria for parts or materials.

1.4 This practice covers the ~~radiologic~~radiographic examination with DDAs including DDAs described in Practice ~~E2597~~E2597/E2597M such as a device that contains a photoconductor attached to a Thin Film Transistor (TFT) read out structure, a device that has a phosphor coupled directly to an amorphous silicon read-out structure, and devices where a phosphor is coupled to a CMOS ~~(Complementary~~(complementary metal–oxide–semiconductor) array, ~~a Linear Detector Array (LDA)~~ or a CCD (charge coupled device) crystalline silicon read-out structure.

1.5 The requirements of this practice and Practice E2737 shall be used together. The requirements of Practice E2737 will provide the baseline evaluation and long term stability test procedures for the DDA system. The user of the DDA system shall establish a written procedure that addresses the specific requirements and tests to be used in their application and shall be approved by the Cognizant Radiographic Level 3 before examination of production hardware. This practice also requires the user to perform a system qualification suitable for its intended purpose and to issue a system qualification report (see 9.1).

1.6 The DDA shall be selected for an NDT application based on knowledge of the technology described in Guide E2736, and of the selected DDA properties provided by the manufacturer in accordance with Practice ~~E2597~~E2597/E2597M.

~~1.5 The requirements of this practice and Practice E2737 shall be used together and both be approved by the CEO Level 3 in Radiography before inspection of production hardware. The requirements of Practice E2737 will provide the baseline evaluation and long term stability test procedures for the DDA system.~~

~~1.6 The requirements in this practice shall be used when placing a DDA into NDT service and, before being placed into service, an established baseline of system qualification shall be performed in accordance with Practice E2737.~~

1.7 Techniques and applications employed with DDAs are diverse. This practice is not intended to be limiting or restrictive. Refer to Guides ~~E94~~E94/E94M, E1000, and E2736, Terminology E1316, ~~Practice~~Practices E747 and E1025, ~~Fed. Std. Nos. 21CFR 1020.40 and 29 CFR 1910.96~~ and Federal Standards 21-CFR-1020.40 and 29-CFR-1910.96 for a list of documents that provide additional information and guidance.

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

~~E94~~E94/E94M Guide for Radiographic Examination Using Industrial Radiographic Film

[1] This practice is under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.01 on Radiology (X and Gamma) Method.

Current edition approved ~~April 15, 2010~~Feb. 1, 2018. Published ~~July 2010~~April 2018. Originally approved in 2010. Last previous edition approved in 2010 as E2698 – 10. DOI: 10.1520/E2698-18.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

E543 Specification for Agencies Performing Nondestructive Testing
E747 Practice for Design, Manufacture and Material Grouping Classification of Wire Image Quality Indicators (IQI) Used for Radiology
E1000 Guide for Radioscopy
E1025 Practice for Design, Manufacture, and Material Grouping Classification of Hole-Type Image Quality Indicators (IQI) Used for Radiography
E1165 Test Method for Measurement of Focal Spots of Industrial X-Ray Tubes by Pinhole Imaging
E1316 Terminology for Nondestructive Examinations
~~E1647~~E1742/E1742M Practice for ~~Determining Contrast Sensitivity in Radiology~~Radiographic Examination
~~E1742~~E1817 Practice for ~~Radiographic Examination~~Controlling Quality of Radiological Examination by Using Representative Quality Indicators (RQIs)
E2002 Practice for Determining Total Image Unsharpness and Basic Spatial Resolution in Radiography and Radioscopy
E2339 Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE)
~~E2597~~E2597/E2597M Practice for Manufacturing Characterization of Digital Detector Arrays
E2699 Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE) for Digital Radiographic (DR) Test Methods
E2736 Guide for Digital Detector ~~Arrays~~Array Radiography
E2737 Practice for Digital Detector Array Performance Evaluation and Long-Term Stability
E2903 Test Method for Measurement of the Effective Focal Spot Size of Mini and Micro Focus X-ray Tubes

2.2 *AWS Documents:*[3]
AWS A2.4 Symbols for Welding and Nondestructive Testing

~~2.3 *Aerospace Industries Association Document:*~~[4]
~~NAS 410 Certification & Qualification of Nondestructive Test Personnel~~

2.3 *Government Standards:*
NIST Handbook 114 General Safety Standard for Installations Using ~~Non-medical~~Non-Medical X-ray and Sealed Gamma Ray Sources, Energies up to 10 MeV[4]
~~DoD Contracts any specifications called out on the DoDISS (Department of Defense Index of Specifications and Standards) cited in the solicitation.~~
21-CFR-1020.40 Safety Requirements of Cabinet X-ray Systems
29-CFR-1910.96 Ionizing Radiation
NCRP 144 Radiation Protection for Particle Accelerator Facilities
~~SMPTE RP 133 Specifications for Medical Diagnostic Imaging Test Pattern for Television Monitors and Hard-Copy Recording Cameras~~

2.4 *Other Documents:*[5]
DICOM PS 3.14 Digital Imaging and Communications in Medicine (Dicom) Part 14: Grayscale Standard Display Function
ANSI/NCSL Z540-3 Requirements for the Calibration of Measuring and Test Equipment
ANSI/ASNT CP 189 Standard for Qualification and Certification of Nondestructive Testing Personnel
EN 4179 Aerospace Series - Qualification and Approval of Personnel for Non-destructive Testing
NAS 410 National Aerospace Standard Certification and Qualification of Nondestructive Testing Personnel
SNT-TC-1A Recommended Practice - Personnel Qualification and Certification in Nondestructive Testing
ISO 9712 Non-destructive Testing - Qualification and Certification of NDT personnel
ISO/CIE 19476 Characterization of the Performance of Illuminance Meters and Luminance Meters
SMPTE RP 133 Specifications for Medical Diagnostic Imaging Test Pattern for Television Monitors and Hard-copy Recording Cameras

3. Terminology

3.1 Definitions relating to the ~~radiological~~radiographic examination, which appear in Terminology E1316, shall apply to the terms used in this practice.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 ~~*component*—~~*bad pixel*—~~the part(s) or element of a system assembled or processed to~~a pixel identified with a performance outside of the specification range for a pixel of a DDA as defined in Practice E2597/E2597M~~the extent specified by the drawing, purchase order, or contract.~~.

[3] Available from American Welding Society (AWS), 550 NW LeJeune Rd., Miami, FL 33126, http://www.aws.org.
[4] Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 1070, Gaithersburg, MD 20899-1070, http://www.nist.gov.
[5] Available from Aerospace Industries Association of America, Inc. (AIA), 1000 Wilson Blvd., Suite 1700, Arlington, VA 22209-3928, http://www.aia-aerospace.org.

3.2.2 *energy*—a property of radiation that determines the penetrating ability. In x-ray radiography, energy machine rating is determined by kilo electron volts (keV), million electron volts (MeV). In gamma ray radiography, energy is a characteristic of the source used.

3.2.3 *like section*—a separate section of material that is similar in shape and cross section to the component or part being radiologically inspected, and is made of the same or radiologically similar material.

3.2.4 *material group*—materials that have the same predominant alloying elements and which can be examined using the same IQI. A listing of common material groups is given in Practice E1025.

3.2.5 *NDT facility*—the facility or entity performing the radiologic examination.

3.2.2 *digital detector array basic spatial resolution detector ($iSR_b^{detector}$(DDA)—)*—an electronic device that converts ionizing or penetrating radiation into a discrete array of analog signals which are subsequently digitized and transferred to a computer for display as a digital image corresponding to the radiologic intensity pattern imparted upon the input region of the device. The conversion of the ionizing or penetrating radiation into an electronic signal may transpire by first converting the ionizing or penetrating radiation into visible light through the use of a scintillating material. These devices can range in speed from many minutes per image to many images per second,the smallest geometrical detail, which can be resolved by a digital detector without geometric magnification as defined in Practice E2597/E2597Mup to and in excess of real-time radioscopy rates..

3.2.3 *digital driving level (DDL)—cluster kernel pixel (CKP)*—for computer graphics display boards, the digital value that corresponds to a particular monochrome grayscale level. A particular DDL "drives out" a particular visible shade of gray. For example, in ana bad pixel, as defined in Practice E2597/E2597M8-bit display, a DDL assumes 256 values from 0 to 255., that does not have five or more good pixels as neighbors and is therefore not correctable.

3.2.4 *grayscale—Cognizant Radiographic Level 3*—2the^N signal levels for an N-bit systemcertified Level 3 Radiographer holding final technical responsibility for the radiographic facility and staff.

3.2.9 *gray level*—one of 2^N signal levels for an N-bit digital system

3.2.5 *mean gray level—compensation principle*—the average of all the pixel gray levels in a given region of interest.practice of permitting an examination scenario where the total image unsharpness fails to meet the required value, but the image quality exceeds the required value by at least one quality level. See Guide E2736 for additional information regarding this term.

3.2.11 *window width and level*—contrast (window width) and brightness (window level) adjustment of a digital image by changing how the Gray levels translate into displayed brightness levels.

3.2.6 *signal-to-noise ratio (SNR)—component*—quotient of mean value of the intensity (signal) and standard deviation of the intensity (noise). The SNR depends on the radiation dose and the DDA system properties.the part(s) or element of a system assembled or processed to the extent specified by the drawing, purchase order, or contract.

3.2.7 *contrast-to-noise ratio (CNR)*—quotientquotient of the difference in the mean values of the intensity (signal) in an area in the object subtracted from the mean value of the intensity of the background, and standard deviation of the intensity (noise). The CNR depends on the radiation dose and quality, thickness/attenuation of the object and the DDA system properties.

3.2.8 *basic spatial resolution (SRb)—digital driving level (DDL)*—indicates the smallest geometrical detail, which can be resolved using the DDA. It is similar to the effective pixel size/pitch and corresponds to for computer graphics display boards, the digital value that corresponds to a particular monochrome grayscale level. A particular DDL "drives out" a particular visible shade ½of the measured unsharpness.gray. For example, in an 8-bit display, a DDL assumes 256 values from 0 to 255.

3.2.9 *effective pixel size*—Effective pixel size is equal to $iSR_b^{detector}$.

3.2.10 *energy*—a property of radiation that determines the penetrating ability. In x-ray radiography, energy machine rating is determined by kilo electron volts (keV), million electron volts (MeV). In gamma ray radiography, energy is a characteristic of the source used.

3.2.11 *ghosting*—residual signal or image from a prior exposure in a current image. Signal or image can be negative or positive and may affect interpretation of the image.

3.2.12 *grayscale*—2^N signal levels for N-bit system.

3.2.13 *like section*—a separate section of material that is similar in shape and cross section to the component or part being radiographically examined, and is made of the same or radiographically similar material.

3.2.14 *bad pixel—material group*—a pixel identified with a performance outside of the specification range for a pixel of a DDA as defined materials that have the same predominant alloying elements and which can be examined using the same IQI. A listing of common material groups is given in Practice E2597E1025.

3.2.15 *mean gray level*—the average of all the pixel gray levels in a given region of interest.

3.2.16 *NDT facility*—the facility or entity performing the radiographic examination.

3.2.17 *pixel value*—one of 2^N signal levels for an N-bit digital system

3.2.18 *relevant cluster*—a ~~cluster with a~~ grouping of bad pixels with at least one cluster kernel pixel ~~(CKP), where there are fewer than five good neighboring pixels surrounding this pixel as defined in Practice~~(CKP) in the ~~E2597. A CKP is a pixel that does not have sufficient good neighboring pixels to perform interpolation, and is therefore not correctable.~~grouping.

3.2.19 *window width and level*—contrast (window width) and brightness (window level) adjustment of a digital image by changing how the Gray levels translate into displayed brightness levels.

4. Significance and Use

4.1 This practice establishes the basic parameters for the application and control of the digital ~~radiologic~~ detector array radiographic method. This practice is written so it can be specified on the engineering drawing, specification, or contract. It will require a detailed procedure delineating the technique or procedure requirements and shall be approved by the ~~CEO.~~Cognizant Engineering Organization (CEO).

5. Basis of Application

5.1 The following items are subject to contractual agreement between the parties using or referencing this standard.

5.1.1 *Personnel Qualification*—~~If specified in the contractual agreement, personnel~~ Personnel performing examinations to this ~~standard~~practice shall be qualified in accordance with ~~a nationally or internationally recognized NDT personnel qualification practice or standard~~ NAS410, EN 4179, ANSI/ASNT CP 189, ISO 9712, or SNT-TC-1A and certified by the employer or certifying ~~agency,~~agency as applicable. ~~The practice or standard to be used and its~~ Other equivalent qualification documents may be used when specified on the contract or purchase order. The applicable revision shall be ~~identified~~ the latest unless otherwise specified in the contractual agreement between ~~the using~~ parties.

5.1.2 If specified in the contractual agreement, NDT agencies shall be qualified and evaluated as described in Specification E543. The applicable edition of Specification E543 shall be specified in the contract.

6. Environment and Safety

6.1 The premises and equipment shall present no hazards to the safety of personnel or property. NCRP 144, and/or NIST Handbook 114 may be used as guides to ensure that ~~radiologic~~radiographic procedures are performed so that personnel shall not receive a radiation dosage exceeding the maximum permitted by the city, state, or national codes.

6.2 Environmental conditions conducive to human comfort and concentration will promote examination efficiency and reliability. A proper examination environment will take into account temperature, humidity, dust, lighting, access, and noise.

6.3 Dust and dirt need to be kept to a minimum and the image display face needs to be cleaned often to prevent interference with interpretation.

7. Equipment

7.1 Different examination system configurations are possible. It is important that the user understands the advantages and limitations of each (see Practice ~~E2597~~E2597/E2597M and Guide E2736). The provider and the user of the examination system should be fully aware of the capabilities and limitations of each system proposed.

7.2 The DDA cannot be operated without computing hardware and software for image acquisition, image display and image storage/retrieval.

7.2.1 The software shall be capable of acquiring images frame by frame from the DDA and integrating, or averaging the frames, or both.

7.2.2 The software shall perform an image calibration to correct the inhomogenities of the detector and to determine and correct bad pixels (that is, bad pixel ~~map) as~~ map). Bad pixels are defined in Practice ~~E2597~~E2597/E2597M.

7.2.3 The software to display resulting imagery from a DDA shall have the following capabilities at a minimum:

7.2.3.1 *Line Profile*—A line profile function capable of displaying the pixel values (PVs) along a user defined line as a graph. The line profile tool should also be capable of adjusting the line width where the values of the line profile are averaged from multiple parallel lines of equivalent length.

7.2.3.2 *Region of Interest Tool*—A histogram type tool capable of displaying the PVs of a user defined Region of Interest (ROI) as a graph. The ROI tool shall also display the size of the ROI (in other words, x pixels by y pixels), and as a minimum, the statistical mean and standard deviation of the ROI PVs.

7.2.3.3 *Negative/Positive Image Display*—Display images in either negative or positive gray scale (negative or inverse).

7.2.3.4 *Linearized Pixel Values*—The software shall be capable of performing calculations using linearized pixel values as a function of dose.

7.2.3.5 *Digital Image Magnification (Zoom)*—Adjust and display the digital magnification level, as well as display the image at 1:1 pixel mapping (in other words, each pixel of the image is mapped to an image display monitor pixel).

7.2.3.6 *Image Pan*—Capability to pan the image.

7.2.3.7 *Window Width and Window Level (Window/Level)*—Adjust window width (contrast) and window level.

7.2.3.8 *Size Measurement Tool*—Perform measurements for distance or sizing of discontinuities. The software shall be capable of calibrating the measuring tool to a reference standard.

7.2.3.9 A tool or tools capable of performing area measurements.

7.2.3.10 *Image Format*—Lossy compression shall not be allowed for images that are used for final product disposition. For systems that are not DICONDE compliant, TIFF images are recommended.

7.2.3.11 The software shall be capable of saving a copy of the radiographic image with image processing applied.

7.2.3.12 For systems that are DICONDE compliant the software shall be capable of storing images in accordance with Practices E2339 and E2699.

7.3 ~~The software to display resulting imagery from a DDA shall be capable to scale images in size (geometrical magnification—zoom) and gray levels (window and level adjustment—brightness and contrast, for example from 16 bit to 8 bit). Additional functions shall be required such as a line profile measurement, histogram, and statistics window for measuring an region of interest (ROI) (mean and standard deviation).~~For systems used in the examination of castings, as well as other examinations where reference radiographs are used, the software shall have the ability to direct the viewing properties of the production image and a reference radiograph image in accordance with the applicable ASTM or other digital reference radiograph standard or specification.

7.4 *The Digital Detector Array (DDA):*

7.4.1 Only DDAs shall be used in practice as established in Guide E2736.

7.4.2 Users shall comply with the manufacturers' requirements of temperatures and humidity conditions for both operation and shipping.

7.4.3 The DDA shall be calibrated using the manufacturers' recommendation both for frequency of calibration and the method used. Other calibration methods are allowed as long as approved by the CEO.

7.4.4 The user shall ensure that all exposures are within the linear operating range of the DDA, using either information obtained from the manufacturer or data obtained by the user/CEO.

7.5 ~~The image display~~ Image display monitors used for interpretation shall meet the following requirements as a minimum. Alternate image displays or requirements may be used with CEO approval.

7.5.1 The minimum brightness as measured off the image display monitor screen at maximum Digital Driving Level (DDL) shall be 250 cd/m^2.

7.5.2 The minimum contrast as determined by the ratio of the image display monitor screen brightness at the maximum DDL compared to the screen brightness at the minimum DDL shall be 250:1.

7.5.3 The image display monitor shall be capable of displaying linear patterns of alternating pixels at full contrast in both the horizontal and vertical directions without aliasing.

7.5.4 The image display monitor shall be free of discernable geometric distortion.

7.5.5 The image display monitor shall be free of screen flicker, characterized by high frequency fluctuation of high contrast image details.

7.5.6 The image display monitor shall be capable of displaying a 5 % DDL block against a 0 % DDL background and simultaneously displaying a 95 % DDL block against a 100 % background in a manner clearly perceptible to the user. An image display test pattern, in accordance with the requirements of SMPTE RP 133, shall be configured for the system display resolution and aspect ratio. Alternate test patterns may be used provided they include the features described in SMPTE RP 133 required to perform the quality tests specified in this practice.

7.5.7 The image display monitor shall be capable of discriminating the horizontal and vertical low contrast (1 %) modulation patterns at the display center and each of the four corner locations.

7.5.8 The image display monitor shall be capable of displaying no less than 256 unique shades of gray.

7.6 *Image Quality Indicators (IQI):*

7.6.1 IQIs shall be in accordance with a recognized standard or approved by the Cognizant Engineering Organization. Hole plate type indicators shall comply with Practice E1025 or Practice ~~E1742~~E1742/E1742M, Annex 1. Wire type indicators shall be in accordance with Practice E747 and correlated to the hole type penetrameters in accordance with Practice E747.

7.6.2 The IQI shall be constructed from material in the same material group (see Practice E1025) as the material to be ~~radiologically inspected.~~radiographically examined. If an IQI material of the same material group is not available, a material that is ~~radiologically~~radiographically less dense shall be used.

7.6.3 ~~The use of alternative IQIs that are~~ Representative quality indicators (RQIs) may be used if approved by the ~~CEO~~ Cognizant Engineering Organization. RQIs shall be ~~documented in a written procedure with the design, materials designation,~~in accordance with the requirements of Practice E1817~~and thickness identification or documented on a drawing and that drawing referenced in the procedure.~~.

7.6.4 The IQIs shall be procured or fabricated to the requirements of Practice E1025, Practice E1742/E1742M (Annex 1), or Practice E747 with a manufacturer's certification of compliance with respect to alloy and dimensions. Users shall visually inspect IQIs for damage and cleanliness in accordance with Appendix X1.

7.7 *Radiation Sources:*

7.7.1 *X-Radiation Sources*—Selection of appropriate X-ray voltage and current levels is dependent upon variables regarding the specimen being examined (material type and thickness) and exposure time. The suitability of these exposure parameters shall be demonstrated by attainment of the required radiographic quality level and compliance with all other requirements stipulated herein.

7.7.2 *Gamma Radiation Sources*—Isotope sources that are used shall be capable of demonstrating the required radiographic quality level.

7.8 *Photometers or Light Meters*—Photometers or light meters used for determining display monitor brightness and contrast and ambient background light, shall meet the requirements of ANSI/NCSL Z540-3 or ISO/CIE 19476.

8. Equipment Monitoring Requirements

8.1 The image display monitor shall be checked in accordance with Appendix X1.

8.1.1 *Image Viewing Stations*—Image viewing stations shall be arranged to exclude any objectionable illuminance that could cause a reflective glare from the display monitor and shall have light controls to achieve ambient (background) lighting levels of no greater than 30 lux.

8.1.2 Ambient light shall be measured at the viewing surface with the display monitor off.

8.2 _Radiographic images shall be free of ~~relevant~~visible bad pixels or other artifacts which may interfere with image interpretation ~~(See~~(see Practices ~~E2597~~E2597/E2597M and E2737).

8.3 Detailed schedule and tests for monitoring the DDA performance over time shall be performed in accordance with Practice E2737.

8.4 The user shall adopt the manufacturer's recommendations for DDA gain, offset and bad pixel identification and calibration, methodology and the frequency thereof, and alterations as needed defined by the CEO based on the object under test.

8.4.1 In the event that any non-uniformities or artifacts (other than bad pixels) appear in an image between recommended intervals of gain and offset calibration, the detector is to be ~~immediately~~ recalibrated for gain and offset correction so that these ~~discontinuities are removed.~~anomalies are removed prior to continuing production imaging. If these anomalies could be found to either mask a relevant discontinuity or be interpreted as a relevant discontinuity, then the effected product shall be re-imaged. When non- uniformities and artifacts occur outside of the area of interest within an image, re-imaging is not required as they do not interfere with interpretation.

8.4.2 In the event that any detector-related non-uniformities or artifacts remain in the area of interpretation in ~~an~~a flat x-ray field image (no object) after recalibration, then the detector shall be tested in accordance with Practice E2737 for requalification and long term stability testing, where a determination will be made if the detector needs to be removed from service. If the detector is removed from service, ~~than~~then the part or parts under question will be ~~re-inspected~~re-examined with a fully qualified detector, and this new detector will be used for ~~all~~ future ~~inspections.~~examinations. If the detector is returned to service following testing with recommended changes to methodology, these changes shall be approved by the CEO and implemented prior to ~~re-inspection and approved by the CEO.~~the detector being placed back into service.

8.5 ~~In the event that any new bad pixels appear in an image between recommended intervals of bad pixel mapping and are in the area of interest and interfere with interpretation and~~ If any new relevant clusters are identified, any parts evaluated since the establishment of the previous bad pixel map shall be assessed to determine if the newly identified relevant cluster had any impact on the proper disposition of the ~~object, a new bad pixel map is~~ affected product, and whether re-examination of the product is required. When deemed necessary by the CEO, the detector shall be tested in accordance with Practice E2737~~to be generated so that these bad pixels may be corrected. The object is to then be re-imaged with the fresh bad pixel map.~~ for re-qualification and for long term stability testing. A determination will then be made by the CEO if the detector needs to be removed from service. If the detector is removed from service, then the part(s) under question will be re-examined with a fully qualified detector, and this detector will be used for future examinations. If the detector is returned to service following testing with recommended changes to methodology, these changes shall be approved by the CEO and implemented prior to the detector being placed back into service.

~~8.5.1 In the event that these new bad pixels still appear in the image following the bad pixel recalibration for example cluster kernel pixels (uncorrectable pixels), then the detector shall be tested in accordance with Practice E2737 for re-qualification and for long term stability testing where a determination will be made by the CEO if the detector needs to be removed from service. If the detector is removed from service, than the part under question will be re-inspected with a fully qualified detector, and this detector will be used for all future inspections. If the detector is returned to service following testing with recommended changes to methodology, these changes shall be implemented prior to re-inspection and approved by the CEO.~~

9. Procedural Requirements

9.1 Digital detector array systems shall be qualified by the CEO ~~for a particular material type, thickness range, application, and product acceptance. The radiologic parameters specified during qualification shall be used to develop the inspection techniques and procedure for~~prior to the examination of production hardware. The DDA system shall be tested to establish baseline performance as required in Practice E2737~~production inspection. It shall be the responsibility of the user NDT facility to develop a workable~~, as well as its suitability for its intended application. In addition to the Practice E2737 ~~examination technique recorded as a written procedure that~~ tests, the following minimum tests shall be conducted: