

#### 1.4.15. FILM REPLACEMENT BY DIGITAL TECHNIQUES APPLIED TO WELD INSPECTION

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Nowadays, industrial segments, related to equipment inspection, make an intense effort to replace the radiographic technique using conventional films with the so-called digital techniques, in which the use of phosphor plates or Digital Detector Arrays (DDAs) provide all the advantages of working with digitized images shown in a computer screen. However, due to the insufficient resolution of these new detectors and to the unfilled knowledge and practical experience gaps, this replacement is carried out in a cautious way and always after validation in comparison to conventional films. This work discusses the commitment between image quality, detectability and fulfillment of regulative requirements based on the practical experience of Petrobras in its research and field works, within the Double Wall Double Image (DWDI) technique application range, evidencing that the substitution by digital techniques is possible, but the fulfillment of the specific requirements of detectability and quality for these techniques must be taken into account. In present days, conventional radiography still presents higher quality than that of Computed Radiography, although it is surpassed by Direct Radiography.

#### RESULTS AND DISCUSSION

**Computed Radiography.** In order to assess the quality of the image obtained using Computed Radiography (CR), it is necessary to determine the radiographic sensitivity through the use of contrast IQIs (Image Quality Indicators). However, two additional parameters appear: Basic Spatial Resolution ( $SR_b$ ) and Normalized Signal to Noise Ratio ( $SNR_N$ ).

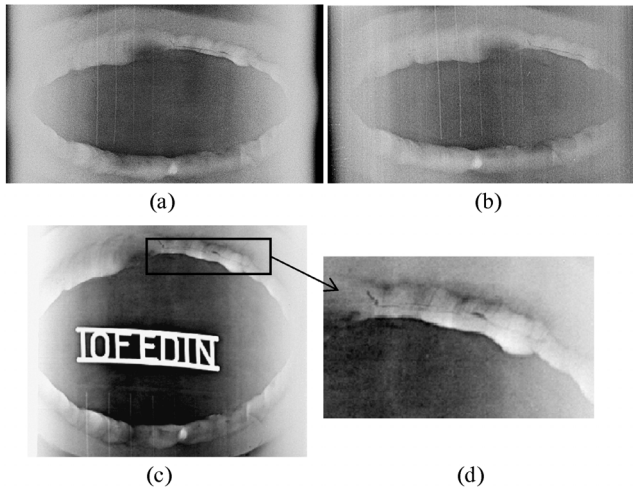
As far as regulation is concerned, two European (EN14784 – parts 1 and 2 – Non-Destructive Testing – Industrial Computed Radiography With Storage Phosphor Imaging Plates) and North American (basically the ASME V mandatory Appendix) standards stand out, guiding the use of Computed Radiography for weld inspection. In the European concept, there are requirements in respect to sensitivity to contrast, normalized signal to noise ratio and basic spatial resolution. The ASME V mandatory appendix has requirements in respect to the sensitivity control with the use of IQIs only. Generally speaking, the requirements of sensitivity to contrast are the same as those used for the conventional technique.

However, the mere fulfillment to the current regulative requirements for Computed Radiography (CR), basic spatial resolution ( $SR_b$ ), sensitivity to contrast and normalized signal to noise ratio ( $SNR_N$ ), does not warrant that the radiographies obtained by this method are equivalent to those obtained by the conventional technique in terms of detectability. It has been shown the necessity of working with a certain combination of voltage and exposition, for a given radiographic arrangement, from which the detectability will be equivalent. This condition seems to reveal itself through a threshold of  $SNR_N$ , which has proven to be characteristic of each CR system. Detectability has continually improved with the increase in the dose, and equivalence was attained for radiation energy values close to those used for conventional radiography. As far as exposition is concerned, there was a general tendency of reduction.

**Direct Radiography.** The detectors used are DDAs (digital detector arrays), including flat panels and linear detectors. Related specifically to DR, there are still no standards regulating the radiographic practice with DDAs, but proposals are being discussed.

Before the inspection begins, DDAs must be calibrated so the response from the sensor matrix is standardized. These detectors have, in average, worse spatial resolution than that obtained with the Computed Radiography technique, but this can be compensated through an optimized multi-gain calibration procedure, and the quality of the image obtained may exceed the performance of conventional films tenfold or even more. By extension, it can be inferred that Direct Radiography may exceed computed radiography by an even greater factor.

Fig. 1 shows the comparison between film radiography, CR and DR for the same sample.



**Fig. 1. (a) Class I film – contrast W14 D = 2.5 HD;  
(b) HDCR (W14 SNR<sub>N</sub> = 299); (c) DDA (W15 SNR<sub>N</sub> = 181);  
(d) Magnification of detail in (c)**

**Conclusion.** The replacement of conventional radiography by digital radiography techniques is perfectly viable. Currently, conventional radiography still provides superior quality to that of CR, while it is surpassed by DR.