技術報告

韓國非破壞檢査學會誌
Journal of the Korean Society for Nondestructive Testing
第14號 Vol. 8, No. 1, (1988)

ECONOMY IN RADIOGRAPHY THROUGH QUALITY

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Summary Quality and economy in radiography can be achieved by using the right techniques and the film material available on the market. Pre-packing with or without lead, under vacuum or not, play an important role provided the right kinds of procedures are applied.
The author explains some of the ways used by different N.D.T. companies to achieve the best quality in an economical way.

1. INTRODUCTION

Film radiography, the earliest of the N.D.T. methods, discovered by W. Roentgen, is still the most widely used technique.

Marketing studies and comparative results demonstrate that, although growth figures have stabilised, film radiography remains the best method for defects in various fabrications.

The silver crisis and the increase in the costs of the constituents of film products created a less competitive position for film radiography. Some customers started to consider real time radiography as a possible means of replacing film. Although one cannot deny that a number of important changes have taken place in the quality of real time radiography because of the use of microfocus X-Ray units, image processing and better viewing monitors, one should realise that X-ray film has a resolution of 100-200 lines compared with 10-20 lines with the best of the existing real time imaging systems.

The aim of any N.D.T. method is to achieve correct quality of results. Not "quality at any price," but in relation to a well-defined quality programme established in the production and marketing plan of the product. This means that the economics will have a strong influence on the whole process.

Throughout the years, companies have been very conscious of this necessity and have been putting a lot of effort into manufacturing products which respond to the highest demands in quality, combined with a strong accent on ease of operation and competent, customer-friendly back-up systems. As early as the year 1969 the pre-packed film and the Rollpack film was introduced. This meant that film with or without screens were prepacked in correct sizes and rolls. The aim was to reduce handling time on pipelines, gas storage tanks, mass production products, aeroplane maintenance, large pressure vessels' etc.

The results came quickly as N.D.T. operators realised that, apart from the gain in handling time, such other problems as dust, scratches, handling marks and finger marks before processing were largely eliminated.

Films could immediately be placed onto a vessel and rolls carried along the pipeline without any darkroom preparation. With some customers, however, remained some doubts. This was quite normal as not all N. D. T. personnel were informed about all the possibilities, and to break through in some ca-ses, new procedures had to be established. Not ev-eryone wanted to be the first to make such a br-eakthrough.

How can one achieve film radiography more ec-onomically? The best way is to examine a few sa-mples of jobs carried out in different areas. For example, pipelines, gas storage tanks and large re-actors.

2. PIPELINES

Rollpacks with lead was an incredible advantage for pipeliners and even more so was the pre-pack ed, precut, rollfilm with lead. "Precut" means that each length of film is cut to the diameter of the pi-peline to be examined, overlapping included.

There was no necessity to tape the film ends, no scissors needed, just both hands and a precut roll. On the pipelines the work is greatly simplified but it needs, however, careful prepartion.

First a careful analysis of the number of differ-ent diameters has to be made. The kind of crawl-er X-ray or γ-ray used will determine the type of film. The number of tie-ins have to be determined. When this preparation has taken place, the saving in time is important because ;-

a. there is no requirement to load film in the da-rkroom, thus excluding manipulation defects as on the screens, and the introduction of dust or other materials.
b. on site, strips of film are torn off one by one can carried in a box. Only a few pieces of str-ong and good quality tape are required to keep the film in place.
c. in the darkroom, the film can easily be removed and processed manually or automatically.

Managers always like to see these advantages translated into hard figures, which should not be too difficult. If only one person was allowed along the pipeline, it would be possible, with the kind of cra-wlers available today, to handle a line with that man but, because of safety regulations, two men will be used.

3. GAS STORAGE TANKS

To radiograph a gas storage tank of 36 metres in diameter and a maximum thickness of 50mm at the centre, would normally take two months using the direct beam technigues with two portable x-ray units and X-ray films of the size 10×48cm. Inst-ead, the following procedure was used during fabr-ication. All T-joints were ultrasonically checked, to-gether with the critical welds. Later, when all the welding was completed, all the welds were covered with pre-packed film in roll, with lead, and a Co60 source of 100 curies was used. The Co60 source contained in a depleted uranium container was ejected electrically into the centre of the spheric-al storage tank and an exposure of 5 ½ hours to-ok place. Test strips were located at different po-ints of the storage tank for density cannot during pre-processing After the exposure, the X-ray film were processed in the following way : the test strips were developed to determine that all proce-ssing parameters are correct, so that the total am-ount of 1, 200 metres of film could be processed w-ithout any mistakes.

The total work was performed in one week. Th-is included the positioning of the film on the sphe-re, as well as the test-strips, the exposure time, the removal, the processing, the evaluation and the inspection of the film, using a crew of five persons. Similar smaller tanks have been inspected, adopting the same technique, but using Ir 192 varying from 100 to 200 Curies or panoramic X-ray units and depending, of course, on the thickness of the weld. The use of prepacked film in roll, with lead, made it possible to achieve a 2% ASME sensitivity in a relatively short time. Economically speaking, it resulted in a reduction to one quarter the estimated customer budget for N. D. T.

As early mentioned, to carry out such work preparation, coordination with the customer is essential. It involved:

a. the acceptance of all N. D. T. procedures by the customer
b. co-ordination with the engineer on site
c. availability of crews and equipment at the appropriate time
d. processing quality must be high, prepared and checked throughly
e. surveillance of safety standards and quality level

4. LARGE REACTORS

This example involves the radiography of a large reactor vessel made of chrome-molybdenum steels ls and where several welds were made of a thickness 36mm, and some of 48mm. The reactor had an overall diamter of approximately 5 meters. In some areas, the plates of 48mm and 36mm were welded together. The radiography could only be done at night for safety reasons, and the proposed technique was to radiogiaphy the welds with a 300KV self-rectified directional beam X-ray unit. The quality required a fine-grain film to be used. The work required very long exposures and the N. D. T. team was not in a position to radiograph all the available work in one night-shift. Consequently they quickly started to run behind schedule. In this particular case it was decided to a 400KV constant potential X-ray unit.

The X-Ray unit was positioned at a focal spot-film distance so as to have 2 metres of exposed film in one exposure. The important part was to overcome the problem of great density difference in the area where the two plates of 36 and 48mm were welded together. As mentioned, a pre-packed roll film with lead was used in 100mm widths so as to accommodate the large weld configuration.

The available welds were carried Out in one night-shift, and the quality requirements were met.

Again all processing was done automatically. In this case, the N. D. T. team recouped the time lost in previous operations and achieved a better quality. They met the allocated budgetary costs. The essential point, however, was that the customer did not have late delivery of the reactors due to the N. D. T. and, as such, avoided the payment of important penalties.

5. PARAMETERS AFFECTING QUALITY AND ECONOMICS

These examples demonstrate that good quality can be achieved economically with the appropriate technique and based on a sound coordination between N. D. T. and fabrication.

In 1979, three N. D. T. specialists made several experiments on the with normally packed film with screens and films packed with screens under vacuum. Measurements of relative contrast and inherent unsharpness in relation to increasing film screen distance were made. The effects of image quality and flaw detectability were examined. In most cases, radiographic films are exposed with screens as they shorten the exposure time due to the intensification.

On the other hand, film contrasts and inherent unsharpnss are usually increased by the film screens. Due to the fact that improvement of contrast compensates for the increase in inherent unsharpness, the overall effect is improved image quality and, consequently, flaw sensitivity.

Nevertheless, this is valid in as far as good contact between screen and film is achieved. For this reason, experiments were made to evaluate the loss in image quality in relation to the increase between film and screen distance. The energies concerned were 150kV to 300kV, Ir192 and Co60T-he test-plates were respectively 10mm for 150kV and 30mm for 300kV, Ir192 and Co60. The density was 2.5. With Ir192, very little distance was ne-eded between the front screen and the film, and a-lso between front and back screen and film to me-et the unsharpness of Co60 exposures with steel screens and for little more important distances, th-e quality of Co60 with lead screens were quickly exceeded.

With 300kV exposures, distances of 0.2mm be-tween front and back screen and the film gave the same inherent unsharpness as with Ir192. A furt-her distance gave approximately the same results as with Co60 and steel screens.

With 150kV, the comparison in quality moves ve-ry quickly to a 300kV exposure if the front or b-ack screen does not have a good film screen con-tact, and Ir192 quality is reached quickly if a slig-ht distance exists between both screens and film.

In short, one could say that, for all energies stat-ed above, the inherent poor definition increases by a factor 2 if the distant between front screen and film exceeds 0.1mm. Higher distances generate greater geometric unsharpness.

Wire sensitivity is generally not affected, but th-ere is a very great influence on detectability of fl-aws in the case where the poor definition is gre-ater the dimension of the defects, especially for c-cracks. Therefore, the total inherent unsharpness is a very important element in radiographic specifica-tion.

Not only unsharpness plays an important role, of course, but also contrast which is the second main influence on flaw detectability and is also influenced by inadequate film screen contact. Experiments sh-owed that the greatest drop in contrast was met when the front and back screen were lifted off sim-ultaneously. In such conditions, a distance of 0.1mm already caused a decrease of contrast of 25%. If the front screen only is lifted off, the drop is lower. However, with a distance of 0.2mm between the back screen and the film, the drop of contrast decreased again by 25%. For evaluation of radio-raphs, it means that as you reach 25% in contra-st drop, you lose one I Q I wire and, sometimes, e-ven two, compared with good screens film contact. The drop of one I Q I wire means that a radiogra-ph of 30mm of steel, exposed with 300kV and 0.1 mm screens, only reaches the I Q I value of 50mm of steel.

In summary, one can say that intensifying scree-ns used together with radiographic film normally i-ncrease the quality of radiographs. Inadequate con-act between filmand screen will merely annihilate t-his positive effect, and good contact screen to film will reduce exposure times and increase sharpness and contrast.

As a result of those experiments, it was decided to produce films with lead screens packed under vacuum.

Due to higher sharpness and contrast, one N.D.T. company was able to prove they could use D7 film instead of D4 and achieve the same quality re-quirements, thanks to the use of this type of film.

Apart from having an exposure time approximate-ly 3,5 shorter, the film was now also completely s-afe from weather conditions, as the foil is made of polyethylene with damped-on aluminium.

This kind of packing also permits underwater ra-diography and some tests in depths of up to 100 metres have already deen carried out successfully.

The same packing, of course, can also be used w-ithout screens for the radiography of composite m-aterials, thus avoiding the possibility of seeing the paper texture of the packing at very low kV.

6. CONCLUSIONS

As a conclusion, radiography is and will remain for some time in the future, an important N.D.T.

tool. Radiography with film will remain a major requirement because of the existence of a document which can be achieved for many years and can be consulted when accidents or other mishaps occur.

Economics of radiography can be achieved not only by the price of the film product, but mainly with a correct relationship between the quality requirements, the management and the adequate co-ordination, at all stages, of engineering production and quality control.