SAFER Radiography – a New Process

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SafeRad has pioneered and developed a new method of carrying out radiography that supersedes the traditional methods and overcomes the problems of disruption associated with radiography.
The SAFER **S**mall **A**rea **F**or **E**xposure **R**adiography developed by SafeRad does not require evacuation of any personnel. This allows continuous operations to be carried out in the immediate area where radiography is being performed.
The use of radiography as an inspection method has been on the decline for some time, mainly due to its disruptive effects on other activities in the area.
The traditional method for mobile radiography normally requires the exposure of a gamma radiation source, often Iridium-192. The source is generally driven from a shielded container into an unshielded guide tube. When the source is in the guide tube the radiation emitted requires all personnel in a wide area to be evacuated. This causes severe disruption to any ongoing work in the surrounding area. It can also trigger nucleonics type instruments used in petrochemical plants, causing them to malfunction and shut the plant down.

The SAFER method overcomes all these problems and significant advantages are achieved by using this new method. These are:
No disruption to personnel
Cost savings due to continuous working
Maximisation of plant and capital equipment
Overall reduction in downtime compared with 'traditional' radiography
Easier to monitor barriers
Emergency exits remain accessible
Less risk of radiation incidents
Shorter exposure times
Improvements in radiographic quality

The new SAFER radiography system makes use of a number of components, each one designed to complement the others. These are

- a multifunctional ISO 3999 certified exposure container that can be used in directional, panoramic and projection modes, functions that have previously required separate equipment for each mode.
- the gamma radiation source used in the exposure container is a Selenium-75 isotope
- shielding is provided by a patented novel high density flexible plastic material named 'GammaBlok'.
- Optional digital imaging

The SafeRad exposure container is certified in accordance with ISO 3999 for up to 80 Curies of Selenium-75 and is manufactured by GammaMat exclusively for SafeRad under a long term agreement.
The design of the SafeRad exposure container and ancillary equipment for positioning and holding it in place allows it to be used to suit any configuration of pipework or structural examination. The exposure container is small, compact and easy to handle. The surface dose rate from the container is very low and less than 75% of the requirements of ISO 3999. It is operated by a traditional manual remote control cable which ensures that it is acceptable to the majority of radiographers without too much training

In the directional mode radiography can be carried out in complete safety with 'controlled area' barriers set as close as 0.5metre with less than 7.5 microSieverts measured at the barriers.
In the panoramic mode barriers can also be set at 0.5metre away from the external surface of the pipework.
Changing from one mode to another is a simple safe operation that can be carried out in seconds due to the unique design and engineering.
The SafeRad container does not suffer any of the limitations of other single mode containers and is extremely versatile. The ability to operate in several modes means that this equipment is an extremely cost effective solution for those companies considering changing to Selenium-75 radiography.
Safety interlocks ensure that the source cannot be moved from its fully shielded docking position until the operator has followed the correct procedures. Each stage of the operating sequence requires the operator to activate a security device on the exposure container.

SafeRad Container
in directional mode

After each exposure of the source the operator is required to activate the source release mechanism otherwise the remote control winding gear remains locked to prevent inadvertent exposure.
The container has been engineered to ensure that the surface dose rate is very low compared to other containers and well within the requirements of ISO 3999. Radiation dose rates to personnel using the equipment on a regular basis are extremely low, normally less than 0.1MSv per month.
In practice, barriers are normally set at 1.5 metres away to allow the radiographers sufficient space to work.

This therefore eliminates the need to evacuate other personnel or cease other operations while radiography takes place. It also means that multiple teams of radiographers can work together without interfering with each other's activities.
Radiation control legislation in the UK has been changed (November 1999) which now requires radiography to be carried out in accordance with the ALARP principle (As Low As Reasonably Practicable).
In order to achieve acceptability by the statutory authorities, the SAFER method has been demonstrated to the UK Health and Safety Executive's Radiation specialists. Even with sources with activities of 70 Curies of Se-75 it has been demonstrated that the controlled area can be less than 1 metre. The SAFER system has been demonstrated to many organisations and potential customers including the UK National Radiological Protection Board. In Scandinavia SafeRad has successfully demonstrated the SAFER method to the regulatory authorities. The SAFER system has been used in very close proximity to nucleonics instruments and it has been shown that radiography can now be carried out in close proximity to these types of instruments without causing malfunction or plant shutdown due to the containment of unwanted radiation.

The SafeRad concept is the complete elimination of unwanted radiation. 'Unwanted radiation' is defined by SafeRad as 'any radiation in excess of that required to produce the radiographic image'. This has been successfully achieved by the provision of collimators designed specifically to shape the radiation beam to target only the film size being used. The shape of the radiation beam has been designed to correct any barrelling effect on the film.
The precise collimation produces a highly shaped beam of radiation to target only the area under examination. A typical image plate or film using the SafeRad radiography equipment has a narrow white border showing that the radiation beam is highly collimated and that there is a significant reduction in radiation outside of the film area.
The SafeRad Radiography System uses conventional radiographic film or it can be used in conjunction with digital imaging techniques. Digital imaging requires shorter exposure times thereby improving productivity rates and further enhancing radiation safety.

A new flexible material, GammaBlok, is used to attenuate the unwanted radiation, that is, scatter and the radiation beam emerging from the back of the film. GammaBlok has a half value thickness with Se-75 of 6mm. A simple calculation based on the source to film distance and the source activity provides the operator with the thickness of GammaBlok required to achieve a safe barrier distance.
GammaBlok is used to reduce scatter radiation emerging from the area under examination and is held in place using back to back Velcro® strips.
This novel material can be used in a number of radiation attenuating situations and is particularly effective with x-radiation up to 450kv, gamma radiation, radiation contaminated pipelines and to shield nucleonics type instruments. GammaBlok is very flexible, strong, long lasting and can be cut to shape or moulded to suit any particular requirements. It is entirely non-toxic, lead free and is made in an environmentally friendly process. It can also be recycled to conserve the earth's resources.
There is a significant reduction in ionising radiation from GammaBlok. The use of GammaBlok shielding causes less fogging of film from back scatter than is normal when using lead shielding. Comparisons have been carried out to demonstrate that GammaBlok causes less darkening of a film than lead.

The use of Selenium-75 as the gamma radiation source has significant benefits. SafeRad has produced numerous comparison radiographs for specifying companies to allow them to judge for themselves the improvements that are achieved. The radiographic films produced are comparable to x-ray quality when compared to Iridium 192. The 'soft' radiation spectrum emitted by Selenium gives improved contrast and sensitivity. Typically two more IQI wires are visible on thinner materials and one more on thicker materials. The limits for producing acceptable radiographs are from 4mm penetrated thickness up to 75 mm penetrated thickness. For example, radiographs of 34mm thick wall 10" diameter duplex stainless steel have been produced for a major certifying authority.
As a result of these comparison trials a number of major companies in the UK have now changed their specifications to include the use of Selenium.

Cost savings due to continuous working using the SAFER method can be substantial. One SafeRad client in a ship-building and submarine repair facility has calculated that savings of 25,000 man hours per year can be achieved. Another client has calculated that on an offshore project where the principles of the SafeRad concept were applied, over £3million sterling was saved due to a significant shortening of the offshore construction programme. On that occasion over one thousand butt welds were radiographed without any interruption to the construction activities.

The SafeRad exposure container can be used instead of a traditional type of container to carry out projection radiography by the attachment of a short source guide tube. A tubular GammaBlok sheath over the guide tube can be used to reduce the transient radiation dose as the gamma source travels along the guide tube. The use of this combination of short guide tube and GammaBlok can reduce the controlled area to approximately 5 metres. Even a reduction to this extent means significant benefits can be derived due to the ease in which barriers can be monitored.

We recognise that this SAFER method of radiography introduces a number of concepts that require a thorough understanding by the personnel using the SafeRad Radiography System. In order to ensure that the potential of the equipment in terms of SAFER working and cost savings are achieved it is essential that they complete a SafeRad training course. This training builds on the basic radiographer's knowledge of exposure set-ups and provides a thorough understanding of radiation safety and how it can best be achieved.

The SafeRad Radiography System and the SAFER technique method has, we believe, rekindled an interest in radiography as a preferred method of non-destructive testing, due to the elimination of the disruption normally associated with all other forms of radiography.