

FIELD RADIOGRAPHY OF VERY LARGE PRESSURE VESSELS USING A PORTABLE LINEAR ACCELERATOR

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A new coal gasification process, developed to correct many of the problems associated with high sulfur coal, is being integrated into the network of coal fired power generators across the United States. This proprietary system incorporates very large, high pressure reactor vessels, which, because of their size and great weight, must be fabricated on-site. In the case of the inspection described in this report, on-site meant in a field adjacent to an existing conventional coal burning power plant. Certain fracture critical welds in the structures were mandated for complete ASME Code Section VIII, 1, UW-51 radiographic inspection. The job was beyond the capabilities of conventional radiographic systems, but well within the scope of a linear accelerator.

The system chosen was a Varian Mini-Linatron operated by High Energy Services Corp. of Redwood City, Ca. The equipment utilizes standard s-band technology common to most industrial linacs, and produces the same high radiographic quality through thick sections as can be expected from these fixed units. The overall system has been condensed and repackaged for field use. It consists of a power supply cabled to a small remote control, an R.F. generator and the small linear accelerator itself.

Typically, the R.F. generator and accelerator are set up at the inspection site and the power supply and control are remotely cabled to a safe location several hundred feet away. In this case the system was operated from behind a concrete retaining wall about two hundred feet from each of the vessels. Since the source is well collimated, careful planing ensures a safe working environment for the operator and plant personnel.

The welds to be inspected were located midway along the vessels and from 10 to 20 feet above the ground. A scaffold was erected as a working platform and the R.F. generator and accelerator were lifted into place with a small hand cranked lift. The R.F. generator is a sealed cabinet (2'x3'x1') connected to the accelerator (1'x1'x1') by flexible waveguide.

The waveguide delivers the microwave energy (R.F.) used drive the accelerator. The distance from generator to accelerator can be in excess of fifty feet, which allows the source to be positioned in very small spaces. The lift itself was then raised onto the platform and used to position the accelerator along the vertical run of the weld. Since the 8" weld was on a cylindrical section of the vessel, the source had to be raised and rotated for each shot to remain centered on the inspection area and perpendicular to the tangent at that point. This alignment was crucial to proper coverage and film overlap. Since source to film distance was limited by physical obstructions to < 2 meters, any mis-alignment could easily shift the image enough to cause a loss of overlap.

A standard number belt with 3" spacing was attached to the outer wall of the vessel for reference. Inside the vessel, flexible film cassettes were taped to the inner wall. Since the inspection was taking place in series with the overall fabrication process, the metal was still hot from annealing, above 200 degrees F in one case. To avoid film damage, an insulating layer of cardboard was placed under the cassette and the whole was held in place with aluminum tape. On a surface free of dust or oil, this tape held fast at all temperatures. The film was attached at the last moment to minimize heat uptake. The technique was flawless and completely protected the film.

Since shot times were so short (6-10 minutes) compared to set-up times for a re-shot (approx. 30 minutes), a 50% film overlap was used. This allowed for mistakes in positioning the source and film and ensured sufficient coverage. Exposures were monitored directly from a small probe placed behind the film. This unit drives a display that gives a read-out of total dose and rate at the operators location and greatly simplifies exposure control. Film used was Kodak AA with .010 lead screens front and back. Wire and plaque penetrameters were used in all shots. The equipment routinely provided .5% sensitivity which exceeded code, and easily showed surface grinding marks from weld prep.

The two vessels were inspected over two consecutive nights. Each session, including site clearance, set-up and inspection, and film processing and interpretation lasted about twelve hours. Film was developed on-site by a local radiographic service in a truck mounted darkroom.

This project joins a growing list of applications where the availability of a portable linear accelerator has made possible inspections that would have been impossible in the past. The ability to clearly define material status in vessels like these, as well as other thick sections such as bridges and nuclear power plants, is giving planners, engineers and safety personnel new.