

This paper has been written as an overall view of current applications and possible field applications of portable linear accelerators.

This discussion will cover the following aspects of portable linear accelerators:

1. Field application determination and site surveys
2. Advantages of portable linacs
3. Radiation Safety
4. Reliability and performance
5. Acquiring this technology

Let's first explore field applications of portable linear accelerators and the importance of the site survey. Every field application has its own set of parameters and obstacles to be addressed. A site survey must be performed to identify and provide solutions for accessibility to the object being inspected EXAMPLE.

- 1) Is the object in a location and in orientation to provide adequate coverage?
- 2) Is lifting equipment reqd? Man lifts, scissors lifts, special fixturing
- 3) What power is available, Linacs require 240V, 3 phase, and 30 amp power. If power is not available then a portable generator must be brought in.
- 4) What are we looking for: defects such as cracks in castings, forgings, extrusions, and weld penetrations due to cycling, over pressurization, stress-corrosion, are we looking for foreign object obstruction commonly caused when parts loosen in a system and become lodged in a piping system, a valve, a strainer, or into a pump. In the power industry when one failure occurs it would be prudent to check other similar systems and avoid costly shutdowns, the NRC has provided a mandated expedient data sharing system as a safety measure, but problem areas in the other power related industries are much slower forthcoming. Are we trying to verify performance conditions? Linacs have been used extensively to verify check valve performance, and pumps and turbine blade clearances and seals.

Portable linear accelerator advantages

- 1) In most cases it is assumed that inspections must be performed with the system shut down. An advantage of Linacs is that they have enough power to penetrate the object while in use and still provide code sensitivity. Certain conditions such as excess heat which might hinder inspection can be taken care of by insulating the film which can handle about 150° F. and any geometric unsharpness due to insulation build-up is within code requirements due to the small focal spot of the linac and also, if necessary, by increasing the source to film distance. System vibration which limits other inspection techniques has very little affect as shot times with linacs are very short.
- 2) Portable linacs as an example a 6 Mv unit can penetrate up to 16" of steel single wall or 8" steel double wall.
- 3) Linacs have the ability to inspect internal mechanical parts such as malfunctioning check valves or control valves due to excessive fluttering, stuck open, or debris obstruction.
- 4) Where accessibility of the area of interest becomes a problem due to obstructions in the piping system the portable linac can be carefully aimed using laser pointers and can take shots up to 20 feet source to film distances. Additionally, if there are obstructions directly in the line with the object, by positioning the Linac head directly against the obstruction and shooting through the part which will affectively blow it off the film and only expose the areas of interest.
- 5) Because of the power of the Linac, complete circumferential welds of large pressure

- vessels can inspected in one exposure using a specially designed panoramic x-ray head.
- 6) Portable linacs penetrating ability provides the highest sensitivity levels, shortest shot times, short shot times provides not only quick inspections, but most importantly safe operation which happens to be the next topic of discussion.

#### Portable Linear accelerator Safety

The essential elements of radiation safety for portable linear accelerators are the site survey, time, space, setting up boundaries, and traffic monitoring.

The primary beam of a portable linear accelerator typically is collimated to a 30° cone and can be further shaped using lead or tungsten bricks to limit the forward beam to only the area of interest. Special designed lead enclosures have even been designed to completely cover the x-ray head and object. Of course this requires heavy lifting equipment.

While these techniques can be employed, a more practical means of radiation management for field radiography is utilized to meet the radiation safety guidelines, and in fact typically we maintain a 1 mR/hr boundary.

The most important factor for a safe inspection is the Site survey which will determine the degree or type of safety measures to be employed. For most high traffic applications, the best safety procedure is time. The short exposure times of the Linac mean that the radiation “on” mode for an average inspection is less then one minute making it easier to control an area. The other time factor for high traffic area is administering the inspection after hours when most people are tucked safely in their homes.

Still when even time is on our side, maintaining safe distances, setting up boundaries, using existing barriers, and monitoring traffic is essential not only to the safety of the public but also for the safety of the x-ray techs.

Power plant inspection can and has been done safely over the past 20 years using a combination of the above mentioned methods as well as the power plant itself providing plant employees with a daily job scheduling reminders of when and where work is being performed and to stay away.

#### Acquiring this technology

The bottom line of any advanced technology is not only what the product can do for you but also does the ends justify the means. How will this technology save us money? The simple answer is by detecting potential costly failures; by verify acceptable conditions of known problem areas and ultimately keeping the plant running. Other cost savings can be achieved by inspection and detection of problems before scheduled plant shutdowns which will allow for more controlled purchasing of replacement parts and timely scheduled labor.

There are basically two ways of acquiring this technology, purchasing the equipment or contracting the service. As can be imagined there is a very limited selection of manufacturers of portable linear accelerators and it is not an off the shelf item. The machines and replacement parts are expensive and require highly trained personnel

My advice to you is hire a professional. That’s why I’m in business.

I will know try to answer any questions you may have.