Report for the Co-ordinated Research Programme "Neutron-based Techniques for the Detection of Illicit Material and Explosives", Mumbai India, November 12-16, 2007.

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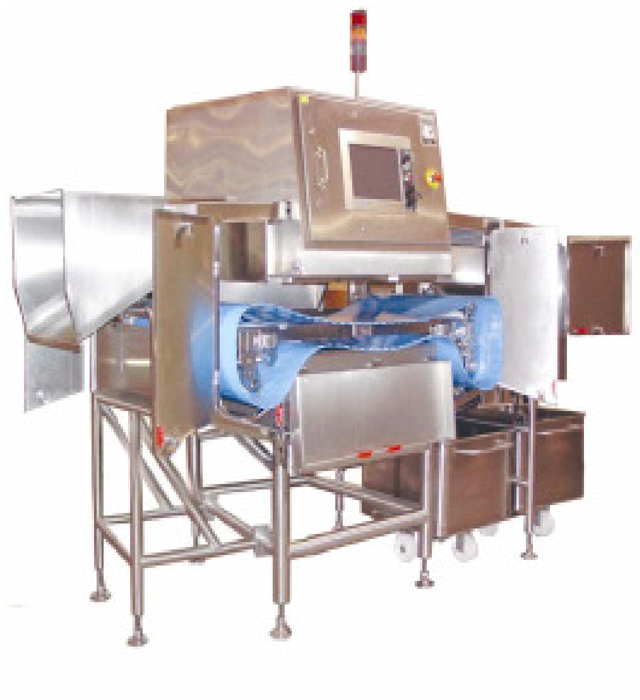
(i). Work Undertaken by the GNS Science Group Relating to this CRP in the last few years.

The multi-energy imaging team is part of a international group developing and commercialising new scanning systems to assess primary products on conveyors at high throughputs. In the meat processing industry ratios of fat/lean-meat content are assessed. Earlier combined beams of neutrons and gamma rays [1] were used with transmitted radiations detected with large scintillation detectors using pulse shape discrimination. The approach now is to pass dual energy beams x-rays (DEXA) through the product. The Eagle Bulk scanner system development is part of a joint venture between GNS Science and a NZ Food company working in collaboration with the manufacturer Smiths Detection, Tennessee, USA. (see Figure 1).

Using the Eagle FA any changes in the ratio of the photo-electric absorption to Compton scattering in the product [2] are detected and interpreted in terms of fat content. The measurement system is able to distinguish less than 1% changes in fat content [3,4] and well as providing detailed images for the detection of physical contaminants.

This technology is at the leading edge and is transferable to detection/analysis for illicit materials and explosives in a wide range or environments; wet, dry, indoors or outdoors wherever threat materials may arise. The basic cost of the components is moderate while maintaining a capability for 100% screening not possible with other methods.

Fig.1 The Eagle FA BULK (2007).



- AMI Cleanability
- IP 69K
- Tool less belt change
- **Automatic Calibration**
- **Simple to convert from hopper to conveyor feed**

The GNS team is part of the National Isotope Centre with expertise in use of low cost radiation-based source/detector systems, nuclear physics, regulatory matters and geological research including use of geophysical prospecting tools in the field. (GNS Science is a combined Geological and Nuclear Institute). Novel instrumentation based on combinations of large scintillators and fast modular electronics including use of pulse shape discrimination have been developed. Instruments have been designed that utilise the advantages of using neutrons, x-rays and gamma ray transmission [4,5]. Collaborative work is undertaken with the local university on development of new detection materials such as scintillators. The aim is to discover new scintillators with improved high Z, higher density and light output and lower afterglow [6]. Such materials contribute to advances in the linear imaging arrays used in the advanced x-ray scanners

<u>(ii). Scientific Scope of the New Zealand CRP project “Developing low cost systems for detection of threat materials”.</u>

The applications in this CRP project are based on two case studies utilising:

- Novel means of deploying source/detector systems to best image the threat materials hidden in bulk materials and industrial installations
- Practical demonstrations of procedures in deploying complete systems.
- Undertaking two case studies demonstrating the progress in the research.

<u>(iii). Work Plans</u>

Work Plan during 2006/07 was:

1. Use of geological and geophysical tools and use of low cost source/detector systems.
2. Development of novel means of detection threat materials in wet/dry and internal/external settings. Report on a practical demonstration.
3. Ongoing optimisation of a strategy for source/detector interactions.
4. Develop a website for the CRP.

Proposed Work Plan for the period 2007/09:

1. Use of low cost tools and portable radiation probes to locate/detect large (e.g. 100 lb) depositions of threat materials. Radiation sources used will typically be radioisotopes such as Cs-137 or Cf-252. Lower cost equipment investigated for explosives and illicit material detection usually take advantage of count-rates comparisons such as in multiple detectors or in detectors having dual radiation detection sensitivities. Applications in the field are of particular interest.

   Two ongoing case studies for transferring advancements in industrial scanning systems such as to:
   a. Detection and analysis of threat bulk materials in a field environment
   b. Applications to detection of threat materials in industrial and/or indoor environments

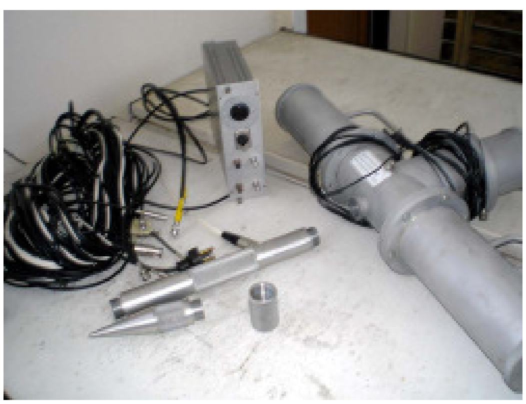
The advancements transferable for the Eagle Bulk system will be a central focus. An objective is to achieve 100% detections an higher rates than are currently possible.

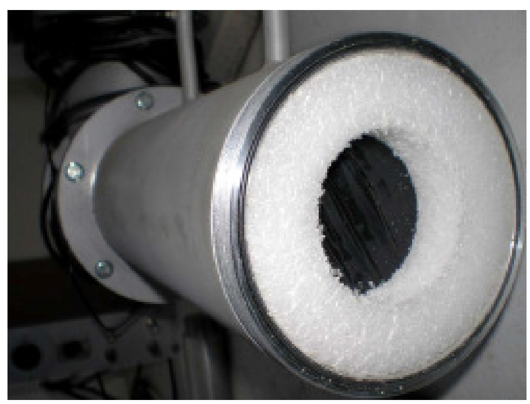
(iv). Results of this programme until now in this CRP.

1. Use of geological and geophysical tools and use of low cost detector systems

Where basic tools are used the CRP objectives are supported by published material on techniques of geophysical prospecting e.g. ‘interpretations based on indirectly observable phenomena’. Techniques include ground-search methods, probing, coring and drilling and well as methods of deploying sources/detectors into the ground e.g. penetrometers. We report development of low cost devices. One example of a prototype low-cost radiation-based portable probe is the ‘Rad-Pod’ which uses a radioisotope source and two detectors at different viewing angles. The instrument illustrated in figure 2 is useable by non-specialists working under the supervision of a licensee.

Fig.2. The principal components of the ‘RAD-POD’ are shown. Left: Components and Right: end view of the detector location in one arm.





2. Development of novel means of the detection of threat materials in wet/dry and internal/external settings by transferring capability from adaptation of state-of-the-art industrial scanners . Report on a practical demonstration.

Threat materials are envisaged as assemblages hidden in some instances in loose materials such as may be piled above the surface or deposited in bunkers underground.

These situation have a direct parallel in the processing industries where Eagle FA operations can be seen providing applicable field trials. The Eagle FA has been installed in demanding situations involving bulk product scanned loose on a conveyor belt as transferred from one bulk storage location to another. Small changes in atomic number are detectable by the robust and automated system. The high sensitivity now available extends the objectives of the CRP to distinguish threat and non-threat materials

Installations of the Eagle FA in the USA and elsewhere will be discussed. Capability to distinguish and discriminate small amounts of material on the basis of composition, density and imaging (shape recognitions) will be discussed.

The complementary improvements in the engineering of the physical equipment and the parallel developments in the inbuilt algorithms which underpin the capability of the system leads to conceptually new approaches to detection.

References;

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