HAZARDS CONTROL PROGRESS REPORT NO. 54
January through June 1977

MS date: August 15, 1977
has obtained reliable density measurements even when the point of interest was covered by up to 8 cm of Lucite. Those measurements were made with a local x-ray dose to the tissue on the order of 15 mR. We intend to determine the accuracy of these methods and this system for measuring density and transmission as well as the local radiation dose to the tissue which is a consequence of the measurement. While these methods require simple equipment and simple sources, they are limited to measurements made with available γ-ray or x-ray sources. The lowest photon energy available with the present system is the 22 keV Cd L-x-ray group. A method has not been developed to infer transmission of Pu x rays from a transmission measurement made at 22 keV.

Another concern is the necessary stability of the photon paths during a measurement. It remains to be seen how the normal torso motions of a living individual would vary the attenuation over the photon trajectories, and whether this would interfere with a measurement in an important way. Finally, some work must be done to estimate the x-ray dose penalty to the individual during such a measurement, and whether the potential benefit warrants such an exposure.

Realistic Phantom Casting

In previous reports\textsuperscript{12-15} we have discussed progress in fabrication of a tissue-equivalent torso phantom that is to be used for calibration of \textit{in-vivo} heavy-element lung counters. In this report, we describe the process of casting the first torso.

As reported previously, the rib cage used in the phantom was cleaned and filled with tissue-equivalent wax to replace lost bone marrow. The rib cage was reassembled using nylon pins to fasten vertebrae and nylon line to hold the ribs at the proper spacing. We have made tissue-equivalent cartilage segments to connect the rib ends to the sternum. The assembled rib cage was then placed on a fiberglass mold of the organ cavity (Fig. 14). We added 5.8\% CaCO\textsubscript{3} to the polyurethane used for the cartilage pieces rather than the 4.3\% used for lean tissue to simulate the relative ratio of linear attenuation for low-energy x rays. Although the elemental composition is essentially the same, cartilage is about 10\% more dense than lean tissue.

Tissue-equivalent stand-off plugs were attached to the organ cavity mold so that we could maintain the proper chest wall thickness (16 mm). The mold with rib cage attached was then aligned in the mold of the chest surface (Fig. 15). Finally, the rear torso mold half was latched in place and the entire assembly inverted. The tissue-equivalent plastic was then evacuated to remove trapped air and poured into the mold.

After curing for 24 hours, the torso (still containing the organ cavity mold) was removed from the mold. We used an electric saw with a fine blade to cut open the chest plate and remove the mold. The finished torso is shown in Fig. 16.

Fig. 14: Rib cage with tissue-equivalent cartilage segments on fiberglass organ cavity mold.

Fig. 15: Rib cage and organ cavity mold positioned in front half of torso mold.
Of course, a major concern was that we not have significant voids in the torso after casting. After having the torso x-rayed at energies from 75 to 300 kV, we were unable to see significant voids (≥3 mm). A representative view is shown in Fig. 17. The chest plate is thin enough to be translucent, so we also were able to take an “optical x-ray” photograph using an incandescent back light (Fig. 18).

**Work to be Done.** Three main tasks remain before the first phantom is finished. First, we must complete casting the non-organ associated, tissue-equivalent motival to fill the organ cavity. These sections will include depressions for mock lymph nodes. Then we must cast a set of tissue-equivalent chest plates which will be used to provide a range of chest wall thicknesses (16 to 43 mm). Finally, we are now in the process of making sets of polyurethane foam lungs and solid polyurethane lymph nodes loaded with $^{238}$Pu, $^{239}$Pu and $^{241}$Am. One set of lungs loaded with $^{238}$Pu has been cast, but it was not assayed accurately.

**Acknowledgments.** Once again we want to thank Norm Boyer and Robert Taylor of the LLL Plastics Shop for their continued support.

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*Fig. 16.* (a) Molded torso, and (b) molded torso with foamed lungs in place.
We describe present methods and results for the first and second quarter 1977 samples, with increased attention given to methods and recovery efficiencies. Eight pesticides in recent use at the Laboratory were analyzed on a Finnigan 3000D GC/MS analyzer: benefin, bromacil, carbaryl, chlordane, dicofol, diuron, folpet, and simazine.

The water samples were further analyzed for diquat dibromide and arsenic by UV spectrophotometry and x-ray fluorescence, respectively.

**Methods**

**Sampling.** Water samples are collected quarterly after the first rain as the runoff leaves the LLL grounds at the northwest corner of the site. We collect 3-l samples in glass bottles which have been washed and rinsed with an 85:15 hexane:ether mixture. Bottle caps are lined with Teflon inserts. Samples are refrigerated, or preferably extracted immediately.

**Standards.** We prepare standard solutions from pure pesticides obtained from the Environmental Protection Agency. These are dissolved in appropriate solvents of pesticide analytical quality. Our working standards are made in dilutions from approximately 10 to 300 ng/μl. These are stored in screw-cap vials with Teflon-lined caps which are in turn kept in a bottle and refrigerated to minimize evaporation and decomposition.

**Extraction Procedure.** Extraction follows the EPA method except for our omission of the Florisil column clean-up which has been observed to lead to loss of pesticides. This is possible because we are dealing with relatively clean water samples, and because interfering chromatographic peaks can to a large extent be screened out by selective ion monitoring in the mass spectrometer.

The extraction procedure follows:

- The sample is filtered through pre-extracted glass fiber paper to remove suspended solids.
- Three consecutive 100-ml portions of 85:15 hexane:ether mixture are used to extract organics from the filtered 3-l water sample.
- The solvent extract is then evaporated to 3-ml in a Kuderna-Danish evaporator.
- The 3-ml volume is further concentrated to 1 ml in a warm water bath with a stream of dry air.

All glassware is washed in soap and water, rinsed with acetone, then prerinsed with hexane-ether mixture before use. All solvents are pesticide analytical...
References

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