The NEMA standards also advocate that a minimum of 4000 counts be accumulated in the center pixel for uniformity measurements. We investigated the reproducibility of uniformity measurements at increasing count densities and have found that one can achieve consistent estimates of the best uniformity achievable only when the counts in the center pixel exceed 8000 (Fig. 1). Measurements made with several different scintillation cameras all resulted in curves similar to those shown in Fig 1. Note that the uniformity values decrease as the count density increases and, though it represents a somewhat arbitrary cut-off, a value of 8000 counts in the center pixel will give uniformity values that represent the best performance of the camera. This may require that as many as 30-40 million total counts need to be collected in the flood-field image and, though this may well be regarded as excessive for routine quality control (12), it is a small price to pay when an acceptance test is being made or as a less frequent, but more rigorous, periodic quality-control test giving a numerical result. Flood-field images of 30 million counts have also been recommended for SPECT calibration (13,14).

NEMA standards are gradually being used by manufacturers for the specification of scintillation-camera performance. However, they are by no means fully implemented and it would therefore be advisable for users to ascertain under what measurement conditions performance specifications for their camera were obtained. For example, in addition to differential uniformity discussed above, other questions arise: were all, or only some, specifications obtained with uniformity-correction circuitry in action? Or were specifications of maximum count rate actually obtained without re-peaking the analyzer window as required by the NEMA protocol? Because some manufacturers use their own protocols for final acceptance testing of their product before shipment, it is possible that acceptance testing at the user site using the NEMA protocols may result in measurements at variance with the manufacturer’s specifications.

In conclusion, those using the NEMA standards to quantitate scintillation-camera performance are strongly urged to examine closely the full document (NU 1-80) on performance measurements and to be aware of pitfalls when comparing results with those of others. Differential uniformity should be calculated over a six-pixel range and the maximum differential uniformity determined and reported. Accuracy and reproducibility of the uniformity measurement become assured only at a minimum pixel count density of 8000 counts per pixel.

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The London Liver Phantom

Various organ phantoms have been developed for specific purposes; e.g., the thyroid phantom was useful with rectilinear scanners, and the brain and liver phantoms developed by the College of American Pathologists are very suitable for interlaboratory comparison studies and self-evaluation of laboratory technique. For assessment of clinical performance and instrumentation quality control, accurate simulation of an organ demands that the phantom be three dimensional and provide the advantages of realism and the facility to exercise practical techniques.

The London liver phantom (1) is useful in several areas: (a) to study the dependence of tumor resolution on lesion size and depth within the liver with variable tumor sizes and positions, using the variant of the phantom; (b) as a routine total performance quality control test phantom with tumors fixed in specified position within the liver (Fig. 1); (c) for the study of fixed tumor sizes and positions in an interlaboratory comparison program, such as that undertaken by the Department of Health and Social Security (DHSS) (2) in the United Kingdom in 1976–1977, planned by WHO (3) in 1980 and is now in the process of analysis, and the program currently being undertaken in the United Kingdom by the DHSS as an extension of the work of Elliott, Short, Potter, and Barnes (4); and (d) to study ECT performance.

The purpose of this communication is to acquaint the nuclear medicine community with this liver phantom so that it can be made more readily available. * A standard version, which has been distributed by IAEA to several recognized nuclear medicine facilities in Latin America and Southeast Asia, is illustrated in Fig. 1. It contains three simulated tumors of various sizes and locations as follows: 2 cm on the anterior surface of the left lobe; 3 cm at the center of the posterior surface of the right lobe; and 2 cm on the
FIG. 1. Standard version of London liver phantom containing three simulated tumors using solid plastic spheres. Screw-threaded plastic cap is on lateral aspect of right lobe for easy filling and emptying of liver shell.

posterior surface in the region of the porta hepatis. The hard plastic liver shell containing the solid plastic sphere lesions is mounted on a plastic stand in the correct anatomical orientation. A plastic water tank, cross-section 30 cm by 30 cm and depth of 18.5 cm, is necessary to simulate the abdomen. The water level in such a tank is 1 cm above the top surface of the liver shell and 0.5 cm below the top of the tank. A plastic lid for the tank is advisable to prevent water splashing onto the collimator face—particularly important if a small amount of background activity has been introduced into the water. The emission-type phantom should be filled with water containing approximately 1 mCi technetium-99m activity. The alternative variant of the phantom is one without the plastic stand and water tank but instead uses a tissue equivalent rubber abdomen (2,3). This variant is suitable for interlaboratory comparison studies, and the liver shells can be covered with an opaque paint to ensure that the study is blind (2,3). Nonstandard variants can be constructed with different tumor sizes and locations.

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FOOTNOTE
* The phantom can be obtained directly from the Department of Medical Physics, Page Street Wing, Westminster Hospital, at the cost of materials and postage only.

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