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Performance Measurements of Positron Emission Tomographs (PET)

National Electrical Manufacturers Association

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Foreword

Reason for Changes

NEMA requires that its standards be reviewed and, if necessary, updated every five years. This standards publication was developed by the NU 2 Task Force chartered by the Molecular Imaging Section of MITA. Committee approval of the standard does not necessarily imply that all committee members voted for its approval or participated in its development. The task force was composed of the following members:

Yanic Bercier—Siemens Healthineers, Knoxville, TN
Michael A. Miller—Philips, Highland Heights, OH
Charles W. Stearns—GE Healthcare, Waukesha, WI
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In the preparation of this standards publication, input of users and other interested parties has been sought and evaluated. Inquiries, comments, and proposed or recommended revisions should be submitted to the concerned NEMA product section by contacting the:

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Changes to Tests

The changes made by the Task Force from the 2012 version of this standard include the addition of two new sections:

a. Section 8, to assess the coincidence timing resolution of tome-of-flight PET systems, and
b. Section 9, to assess the co-registration accuracy of hybrid PET/CT systems.

Other changes to the current version are relatively minor, mostly designed to make the tests easier to conduct, more reproducible, more clearly defined, or better harmonized with other performance tests. These are the most substantial changes to the tests (note that this is not intended to be an exhaustive list):

a. In Section 3, the spatial resolution test allows ^{22}Na as well as ^{18}F.
b. In Section 3, the spatial resolution test point source is specified in terms of point source dimensions as opposed to capillary tube dimensions. The capillary tube is specified as an option.
c. In Section 4 (and in Section 6 and Section 8, which use the same acquired data), the test phantom is to be positioned so that the trough of the table is positioned 15 ±1 cm below the center of the transverse field of view (FOV).
d. In Section 6, the analysis is to be conducted over the central 80% of the PET axial FOV.
e. In Section 7, the 28 mm and 37 mm diameter cold spheres are replaced with 28 mm and 37 mm diameter hot spheres. All six spheres are to be hot.
f. In Section 7, there is no option for a hot sphere-to-background fill ratio of 8:1.
g. In Section 7, the lung residual error analysis excludes slices that are within 30 mm of the axial edge of the lung insert; the previous value was 10 mm.
h. In Section 7, the description of phantom positioning is clarified. If the patient table cannot center the body phantom lung insert, adjust the patient table height to center the phantom as closely as possible. The phantom shall not be elevated above the patient table surface in order to center the phantom lung insert.

Scope

The philosophy and rationale of the standards measurements and illustrative examples of the analysis and results are presented in

> *Journal of Nuclear Medicine*, vol. 43, no. 10, 2002. Daube-Witherspoon ME, Karp JS, Casey ME, DiFilippo FP, Hines H, Muehllehner G, Simcic V, Stearns CW, Adam L-E, Kohlmyer S and Sossi V. “PET Performance Measurements Using the NEMA NU 2-2001 Standard.” pp. 1398-1409.

With the exceptions of Section 8 for time-of-flight systems and Section 9 for hybrid PET/CT systems, the Task Force has attempted to specify methods that can be performed on all positron emission tomographs. These include single and multiple slice, discrete and continuous detector, time-of-flight instruments, multi-planar and volume reconstruction models, and dedicated positron emission tomographs as well as other coincidence-capable imaging systems. Wherever possible, future developments that could be readily anticipated were taken into account.

While many PET tomographs are constructed as hybrid imaging systems such as PET/CT and PET/MR systems, the standards committee has not specified special methods to assess hybrid imaging performance with the exception of the PET/CT registration test described in Section 9. It is expected that the PET component of a hybrid imaging system can be assessed using the methods described in this standard, and other portions of the system can be assessed using other standards appropriate to that technology. The method for assessing the co-registration accuracy of hybrid PET/CT systems has the potential to be adapted to PET/MR systems. In the event a portion of any of the PET test methods described here cannot be executed in a hybrid imaging system, work-around methods may be used, but those methods must be described in the test report.