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Test Standard for the Determination of the Visible Entrance Field Size of an X-ray Image Intensifier System

NEMA

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION ■ 2101 L STREET, N.W., WASHINGTON, D.C. 20037

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XR 15

TEST STANDARD FOR THE DETERMINATION OF THE VISIBLE ENTRANCE FIELD SIZE OF AN X-RAY IMAGE INTENSIFIER SYSTEM

Published by

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Foreword

This NEMA Standards Publication is one of a series of test standards developed by the X-ray Imaging Products Section and the medical diagnostic imaging industry for the measurement of performance characteristics governing the image quality of X-ray image intensifier (XRII) systems. These test standards are intended for the use of equipment manufacturers, prospective purchasers, and users alike. Manufacturers may find these standards useful in establishing standard test conditions for the determination of system performance specifications. Prospective equipment purchasers may benefit from these standards as the employment of standard test conditions and methods enables meaningful comparisons to be made of NEMA-referenced, competitive, equipment performance specifications. Users may also benefit from these standards through a better appreciation of the performance of XRII systems.

Characterizing the parameters that govern image quality is a non-trivial task. The assessment of image quality lies in the eye of the beholder and so is a somewhat subjective measure influenced by the spatial, temporal, contrast, and noise characteristics of the image. Historically, many techniques have been developed employing varying degrees of sophistication to establish subjective and objective measures of these parameters, and the following non-exhaustive list of parameters can be considered as relevant to image quality:

Contrast Ratio
Detective Quantum Efficiency (DQE)
Fixed Pattern Noise
Gain
Image Signal Uniformity
Lag
Limiting Spatial Resolution
Modulation Transfer Function (MTF)
Noise Power Spectrum
Radial Image Distortion
Signal to Noise Ratio
Visible Entrance Field Size

These parameters are not all independent and some of them may partially overlap in assessing the image quality. Moreover, it must be recognized that not all of these parameters lend themselves to measurement at the installation site. Some parameters require instrumentation better suited to factory measurements while others require the facilities of an instrumentation laboratory to assure the stable test conditions necessary for reliable measurements. The NEMA X-ray Image Intensifier Systems Subcommittee intends to make a selection from the above-mentioned list of parameters where practical and technically feasible measurements can be made at the system level and to prepare a set of NEMA standards.

This publication has been prepared by the X-Ray Imaging Products Section of NEMA which periodically reviews it for revisions necessary to keep it up to date with advancing technology.

Comments or proposed revisions are welcomed and should be submitted to:

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Introduction

This document defines the NEMA test standard method for the determination of the visible entrance field size of an X-ray image intensifier (XRII) system. These systems include direct viewing systems, video systems, photofluorographic film recording systems, and cine film recording and projection systems.

The visible entrance field size is a measure of the area imaged by an X-ray image intensifier system.

Scope

The procedures in this standard determine the visible entrance field size of an X-ray image intensifier system.

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Section 1
REFERENCED STANDARDS AND TERMINOLOGY

1.1 REFERENCED STANDARDS

None

1.2 DEGREE OF REQUIREMENTS

A statement incorporating the auxiliary verb "shall" indicates that compliance with a requirement is mandatory for compliance with the standard.

Statements incorporating other auxiliary verbs such as "should," "may," etc., refer to authorized engineering information and not to procedures required for compliance with the standard.

1.3 DEFINITIONS

1.3.1 Actual Focal Spot

Area on the surface of the X-ray tube target that intercepts the beam of electrons.

NEMA Standard 8-28-1991.

1.3.2 Center of the Image

That point in the entrance plane of the XRII system which corresponds to the center of the smallest circle circumscribing the image.

NEMA Standard 8-28-1991.

1.3.3 Central Axis of the X-ray Field

The line perpendicular to the entrance plane of the xrii system passing through the center of the actual focal spot.

NEMA Standard 8-28-1991.

1.3.4 Entrance Plane of the XRII System

The plane perpendicular to the axis of the XRII and grazing that part of the XRII, including its housing, which protrudes most in the direction of the radiation source. The following components shall not be considered elements of the XRII housing:

Antiscatter grid
Collision sensors
Ionization chambers
Protective cover
Removable magnetic shields and coils
Spot film device

NEMA Standard 8-28-1991.

1.3.5 Geometric Magnification

Magnification of an object in the X-ray field attributable to the relative distances of the object and the entrance plane of the XRII from the actual focal spot.

NEMA Standard 8-28-1991.

1.3.6 Output Image of the XRII System

The image produced by the XRII system that is visually perceivable by a human observer. Output image channels of the system include:

a. processed photofluorographic film
b. processed cine film
c. television monitor display screen
d. direct viewing system.

NEMA Standard 8-28-1991.

1.3.7 Source-To-Entrance Plane Distance (SED)

The distance from the actual focal spot to the entrance plane of the XRII system measured along the central axis of the X-ray field.

NEMA Standard 8-28-1991.

1.3.8 Visible Entrance Field Size

The dimensions in the entrance plane of the XRII system of the field that is used for transmission of the X-ray pattern measured along two specified axes.

NEMA Standard 8-28-1991.

1.3.9 X-ray Image Intensifier (XRII) Systems

That portion of an X-ray imaging system consisting of the XRII with its housing and the subsequent components of the imaging chain responsible for transmitting and displaying the detected X-ray patterns. The following components shall not be considered elements of the XRII SYSTEM: antiscatter grid, spotfilm device, collision sensors, removable magnetic shields and coils.

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Section 2
TEST EQUIPMENT—IMAGE CALIBRATION TEMPLATE

An image position calibration template is used to locate the center of the image and to measure the visible entrance field size. A suggested template is shown in Figure 2-1 consisting of a thin X-ray transparent panel with X-ray absorbing demarcations along which distance measurements are made. The overall size of the template shall be larger than the visible entrance field size to be measured.

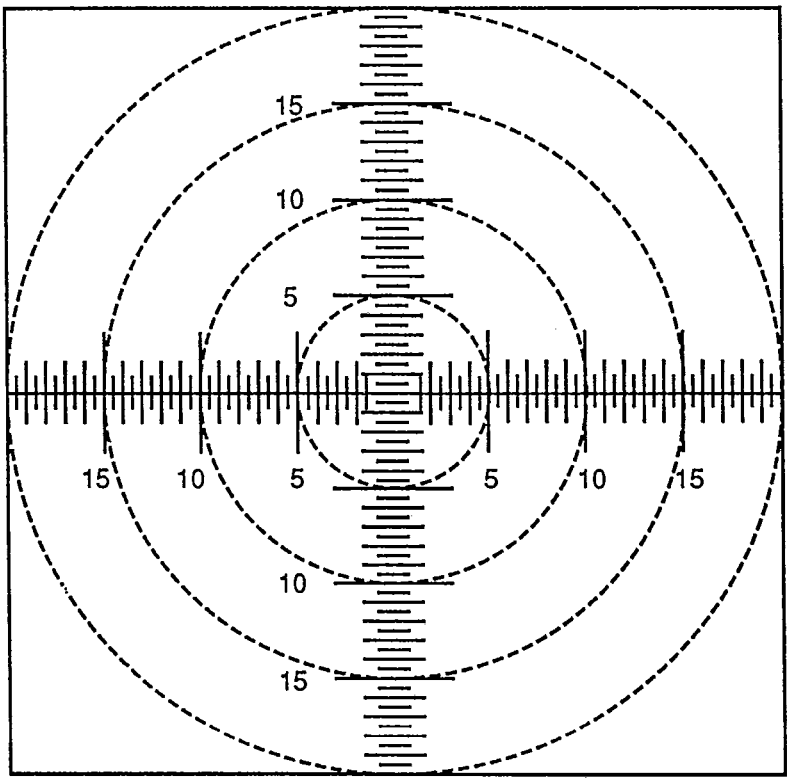

Figure 2-1
Image Position Calibration Template

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Section 3
STANDARD TEST CONDITIONS

3.1 GENERAL REQUIREMENTS

The system shall be set up according to the specifications of the manufacturer, except as noted in paragraphs below. During the test, except where explicitly permitted, no change shall be made to the system setup. This includes, but is not limited to, adjustment of the X-ray image intensifier and video camera, as well as the focus of the XRII and any lenses and video cameras.

It is recognized that under some conditions it will be necessary to remove a grid or disassemble a window covering to satisfy the test conditions. Deviations from the standard test conditions are permitted only where it is impractical to meet those conditions. Such deviations must be explicitly stated in the Presentation of Results.

NEMA Standard 8-28-1991.

3.2 SOURCE TO ENTRANCE PLANE DISTANCE (SED)

The standard SED shall be 100 ± 1 cm. Equipment of fixed SED or whose adjustment range does not span the standard SED shall be tested at the spacing recommended by the manufacturer and such spacing shall be reported in the Presentation of Results.

NEMA Standard 8-28-1991.

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Section 4
DETERMINATION

4.1 MEASUREMENT PROCEDURES

4.1.1 The visible entrance field size shall be measured along two axes, as specified below, which are orthogonal in the entrance plane of the XRII system and intersect at the center of the image.

NEMA Standard 8-28-1991.

4.1.2 The image position calibration template shall be placed as close as possible to the entrance plane of the XRII system. If necessary, objects shall be removed between the X-ray source and the entrance plane of the XRII system such as grid holders, cones, compression devices and the like. If it is impossible to place the calibration template at the entrance plane of the XRII system, the distance from the template to the entrance plane of the XRII shall be stated and the data corrected for the geometric magnification introduced.

NEMA Standard 8-28-1991.

4.1.3 Video System

a. The kV and mA as well as the monitor controls shall be adjusted so that the calibration template is clearly viewed.
b. One of the two orthogonal axes shall be parallel to the video raster lines. Using the template, the lengths shall be measured along both axes in the entrance plane of the XRII system which are visualized in the image.

NEMA Standard 8-28-1991.

4.1.4 Photofluorographic and Cine Cameras

a. The kV, mA and exposure time shall be adjusted so that a usable image of the calibration template is obtained with standard processing techniques.
b. One of the two orthogonal axes shall be parallel to the longer edge of the film frame. For a square image frame, the reference edge shall be specified in the Presentation of Results. Using the template, the lengths shall be measured along both axes in the entrance plane of the XRII system which are visualized in the image along these axes.

NEMA Standard 8-28-1991.

4.1.5 Direct Viewing System

a. Adjust the kV and mA of the system shall be adjusted such that the calibration template can be clearly viewed.
b. One of the two orthogonal axes shall be parallel to the maximum image dimension. Using the template, the lengths shall be measured along both axes in the entrance plane of the XRII system which are visualized in the image. If the image is circular, then only the diameter shall be reported.

NEMA Standard 8-28-1991.

4.2 PRESENTATION OF RESULTS

The Presentation of Results shall specify the following:

a. XRII system identification
b. Output channels measured
c. The dimensions in centimeters along the two orthogonal axes as specified in Section 4.1.4 (or the diameter in the special case of a circular image) for each system output image. A statement of accuracy of results.
d. Deviations from standard test conditions.

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Section 5
STATEMENT OF COMPLIANCE

If a manufacturer states that a product is in compliance with this NEMA standard, the presentation of the results of the determination shall be according to Section 4.2. Any deviations from the standard test conditions shall be stated.

Compliance with this Standard shall be stated as "visible entrance field size per NEMA Standard XR 15-1991."

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NEMA STANDARDIZATION

The purpose of NEMA Standards, their classification and status are set forth in certain clauses of the NEMA *Standardization Policies and Procedures* manual and are referenced below:

Purpose of Standards

National Electrical Manufacturers Association Standards are adopted in the public interest and are designed to eliminate misunderstandings between the manufacturer and the purchaser and to assist the purchaser in selecting and obtaining the proper product for their particular needs. Existence of a National Electrical Manufacturers Association Standard does not in any respect preclude any member or nonmember from manufacturing or selling products not conforming to the standard.

(Standardization Policies and Procedures, p. 1)

Definition of a Standard

A standard of the National Electrical Manufacturers Association defines a product, process or procedure with reference to one or more of the following: nomenclature, composition, construction, dimensions, tolerances, safety, operating characteristics, performance, rating, testing, and the service for which they are designed.

(Standardization Policies and Procedures, p. 2)

Dimensions

Where dimensions are given for interchangeability purposes, alternate dimensions satisfying the other provisions of the Standards Publication may be capable of otherwise equivalent performance.

(Standardization Policies and Procedures, p. 8)

Categories of Standards

National Electrical Manufacturers Association Standards are of three classes:

1. NEMA Standard, which relates to a product, process or procedure commercially standardized and subject to repetitive manufacture, which standard has been approved by at least 90 percent of the members of the Subdivision eligible to vote thereon;
2. Suggested Standard for Future Design, which may not have been regularly applied to a commercial product, but which suggests a sound engineering approach to future development, which standard has been approved by at least two-thirds of the members of the Subdivision eligible to vote thereon.
3. Adoptive Standard, which is adopted in whole or in part from the standards of another organization, either domestic, regional, or international.

(Standardization Policies and Procedures, pp 7 & 16)

Authorized Engineering Information

Authorized Engineering Information consists of explanatory data and other engineering information of an informative character not falling within the classification of NEMA Standard or Suggested Standard for Future Design, which standard has been approved by at least two-thirds of the members of the Subdivision eligible to vote on the standard.

(Standardization Policies and Procedures, pp. 7 & 16)

Official Standards Proposal

An Official Standards Proposal is an official draft of a proposed standard which is formally recommended to an outside organization(s) for consideration, comment and/or approval, and which has been approved by at least 90 percent of the members of the Subdivision eligible to vote thereon. *(Standardization Policies and Procedures, pp 7 & 16)*

Identification of Status

Standards in NEMA Standards Publications are identified in the foreword or following each standard as "NEMA Standard" or "Suggested Standard for Future Design." These indicate the status of the standard. These words are followed by a date which indicates when the standard was adopted in its present form by the Association.

The material identified as "Authorized Engineering Information" and "Official Standards Proposal" is designated similarly.

July 17, 1990

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