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Development of a Line-Pair Gauge and Standard Test Method for Measuring Basic Spatial Resolution of Neutron Imaging Systems

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Standards are required for commercial and quality-controlled processes. All current standards for neutron radiography are intended for use with film, but there are currently no standards that technically apply to modern digital neutron radiography systems. Trends in the neutron imaging community show a move towards digital systems that have many advantages compared to traditional film neutron radiography methods. Digital neutron imaging systems are widely used for research applications with great success. Unfortunately, the lack of applicable standards has hindered use of modern digital neutron imaging systems for industrial applications. Standards that apply to digital systems would allow use of advanced digital systems for commercial applications that require quality control with standards.

Members of the American Society for Testing and Materials (ASTM) E07.05 Committee for Neutron Radiography are developing a standard test method and device for measuring basic spatial resolution and total image unsharpness that would apply to any neutron imaging system. Line pair gauges, such as the duplex-wire gauge described in ASTM E2002, are image quality indicators frequently employed in x-ray and gamma radiography to establish basic spatial resolution. The ability to discern two closely spaced lines on the images of the device is related to the image unsharpness and basic spatial resolution of the imaging setup. Current efforts to develop a line-pair gauge are based on the same approach used in ASTM E2002, but with materials suitable for use with neutrons instead of x-rays.

The E07.05 Committee composed an initial testing procedure, and prototype line-pair gauges were designed and fabricated for validation studies to determine the suitability of this device as a new ASTM standard. The proposed method accommodates neutron images produced with any neutron image acquisition method using neutron beam lines with cold or thermal neutron spectra. It would cost nearly the same as the sensitivity indicator and beam purity indicator devices described in ASTM E545, which are already in wide use in the neutron imaging community. The gauge is small (25 mm by 50 mm) to maximize the field-of-view available for objects being examined. The gauge uses gadolinium to absorb neutrons on a 3-mm thick substrate of relatively neutron-transparent glass, with the line pairs laser etched from the gadolinium. Measurements using the gauge are easy and straightforward to perform, yet provide meaningful image quality information.

The committee has completed the first set of round robin testing, which included multiple facilities with a wide range of imaging systems. Each facility acquired images using the test procedure and provided the resulting radiographs to the committee along with comments and input for improvements. Overall, the approach seems promising, and a second prototype is being designed based on lessons learned in the first round robin tests.

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