Verification and Validation of Computational Models for Ultrasonic Testing

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The Pacific Northwest National Laboratory (PNNL) is conducting confirmatory research for the U.S. Nuclear Regulatory Commission (NRC) for the verification and validation of computational models used in ultrasonic testing (UT). This paper discusses some of the findings obtained from simple geometrical reflectors in isotropic, fine-grained, homogeneous materials with conventional ultrasonic transducers. A total of 348 ultrasonic raster scans were acquired using pulse-echo conventional probes with different diameters, beam angles, wave modalities, and frequencies. The raster scans contained reflections from machined notches (flaws) of different sizes and orientations. High frequency pencil beam models, and flaw scattering models employing the Kirchhoff and geometric theory of diffraction approximations, were then used to simulate the corresponding experimental measurements. CIVA, a semi-analytical nondestructive evaluation (NDE) simulation platform developed by the French Commissariat à l’Energie Atomique (CEA), was used to run simulations based on the approximation models. The experimental measurements were compared to their modeled counterparts using quantitative metrics obtained from the C-scans, B-scans and A-scans. To address uncertainties in the input parameters to the computational model, parametric studies and sensitivity analyses were conducted on all the relevant inputs. Sources of discrepancies between the experiment and simulated results are discussed in terms of numerical model errors and uncertainties in the experiments and model input parameters.

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