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Results of Using Frequency Banded SAFT for Examining Three Types of Defects

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A multitude of concrete-based structures are typically part of a light water reactor (LWR) plant to provide the foundation, support, shielding, and containment functions. Concrete has been used in the construction of nuclear power plants (NPPs) because of three primary properties; its inexpensiveness, structural strength, and ability to shield radiation. Examples of concrete structures important to the safety of LWR plants include the containment building, spent fuel pool, and cooling towers. This use has made concrete's long-term performance crucial for the safe operation of commercial NPPs. Extending reactor life to 60 years and beyond will likely increase susceptibility and severity of known forms of degradation. Additionally, new mechanisms of materials degradation are also possible.

Specially designed and fabricated test specimens can provide realistic flaws that are similar to actual flaws in terms of how they interact with a particular Nondestructive Evaluation (NDE) technique. Artificial test blocks allow the isolation of certain testing problems as well as the variation of certain parameters. Because conditions in the laboratory are controlled, the number of unknown variables can be decreased, making it possible to focus on specific aspects, investigate them in detail, and gain further information on the capabilities and limitations of each method. To minimize artifacts caused by boundary effects, the dimensions of the specimens should not be too compact. In this paper, we apply the frequency banded SAFT technique to a m x 2.134 m x 1.016 m concrete test specimen with twenty deliberately embedded defects. These twenty embedded defects simulate voids (honeycombs), delaminations, and embedded organic construction debris.

Using the time-frequency technique of wavelet packet decomposition and reconstruction, the spectral content of the signal can be divided into two resulting children nodes. The resulting two nodes can then also be divided into two children nodes with each child node containing half of the bandwidth (spectral content) of its parent node. This process can be repeated until bandwidth of the children nodes is sufficiently small. Once the desired bandwidth has been obtained, the band limited signal can be analyzed using SAFT enabling the visualization of reflectivity of a frequency band and that band's interaction with the contents of the concrete structure. In general, the analyzed nodes were selected based on:

1. The knowledge that the ultrasonic array system used produces an ultrasonic pulse with a nominal center frequency of 50 kHz.
2. The percentage of total signal energy contained in each node.
3. Child nodes of parent nodes containing the nominal center frequency, so as to narrow frequency band around nominal center frequency or even divide the band containing the nominal center frequency.
4. Child nodes of a parent node containing a high energy percentage. Even if the node did not contain the nominal center frequency.

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