

## Case History Citation Improves NDT for its Structural Aluminum Castings

Citation Corp.'s Butler, Ind., metalcasting facility produces a variety of permanent mold aluminum castings for primarily automotive applications. As part of its continuous improvement program, the firm identified the process-compensated resonant test (PCRT) method developed by Magnaflux-Quasar Products, Albuquerque, N.M., as a potential alternative method of non-destructive testing (NDT). Introduction of the new method required extensive process validation to convince the OEM and Tier 1 customers to accept the challenge.

Two pairs of castings were chosen to develop the new NDT method through an extensive process validation—a 15-lb., A356 aluminum control arm and a 7-lb., A356 aluminum rear knuckle. Both castings are produced at a rate of 700,000 pairs per year.

The engineering specifications for the two parts called for 100% dye penetrant (PT) inspection and 100% resonant testing (RT). As these were new product launches, PT was performed by an outside supplier, while RT was performed onsite. The cost of transportation and PT was about 4% of the cost of the parts.

PCRT sorts parts by measuring

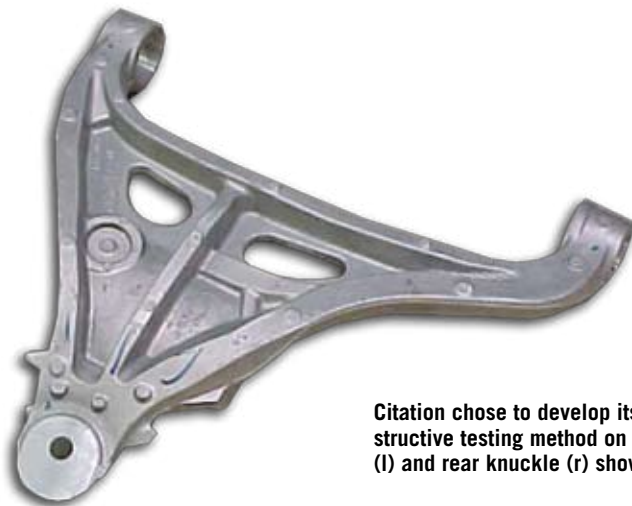


The front control arm is undergoing testing on the PCRT fixture at Citation Corp.

their resonant frequencies, which are explicitly determined by the parts' stiffness and mass. However, acceptable process variations also affect the resonant frequency, sometimes to the extent that they mask the effect of even a severe defect. PCRT compensates for the variations by measuring several resonances for each part and applying a pattern recognition algorithm that separates the acceptable variations from the unacceptable. Since PCRT tests the entire part simultaneously, it detects all defects, independent of their location. Since it is computer implemented, it eliminates human judgement and provides a quantitative result that is

correlated to the part's performance on the vehicle.

During 2002 and 2003, Citation procured and installed the PCRT systems for the two parts. Each installation was customized to the size of the part and material handling considerations. In the control arm system, a robot unloads the part from a heat treat rack and places it on the PCRT test station, which contains tooling that precisely locates the part with respect to the transducers. The PCRT system measures several (typically eight) resonant frequencies and uses the computer algorithm to make the pass/fail decision. The robot then loads the passed parts onto a



Citation chose to develop its new nondestructive testing method on the front control arm (l) and rear knuckle (r) shown.

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conveyor, where it proceeds to visual inspection and shipping. Failed parts are placed into a reclaim bin.

In the rear knuckle system, a work cell approach is used, where the PCRT is combined with a Brinell hardness test. Parts are loaded into the cell, and a carousel moves them to the Brinell test and onto the PCRT test station, which uses a single electronics package to alternately test left and right knuckles. The throughput for both the control arm and rear knuckle installations are 132 pairs per hour.

The implementation of PCRT was approved for production by the OEMs and Tier 1 companies in 2004 after it demonstrated greater than 99% reliability vs. 89% for PT in a controlled reliability test. As Citation had projected, its NDT cost was reduced by 75%. In the three years since PCRT was accepted for production, customer returns have been reduced to single digit PPM. **MC**

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A rear knuckle is loaded onto the PCRT test fixture.