

Magnaflux Quasar

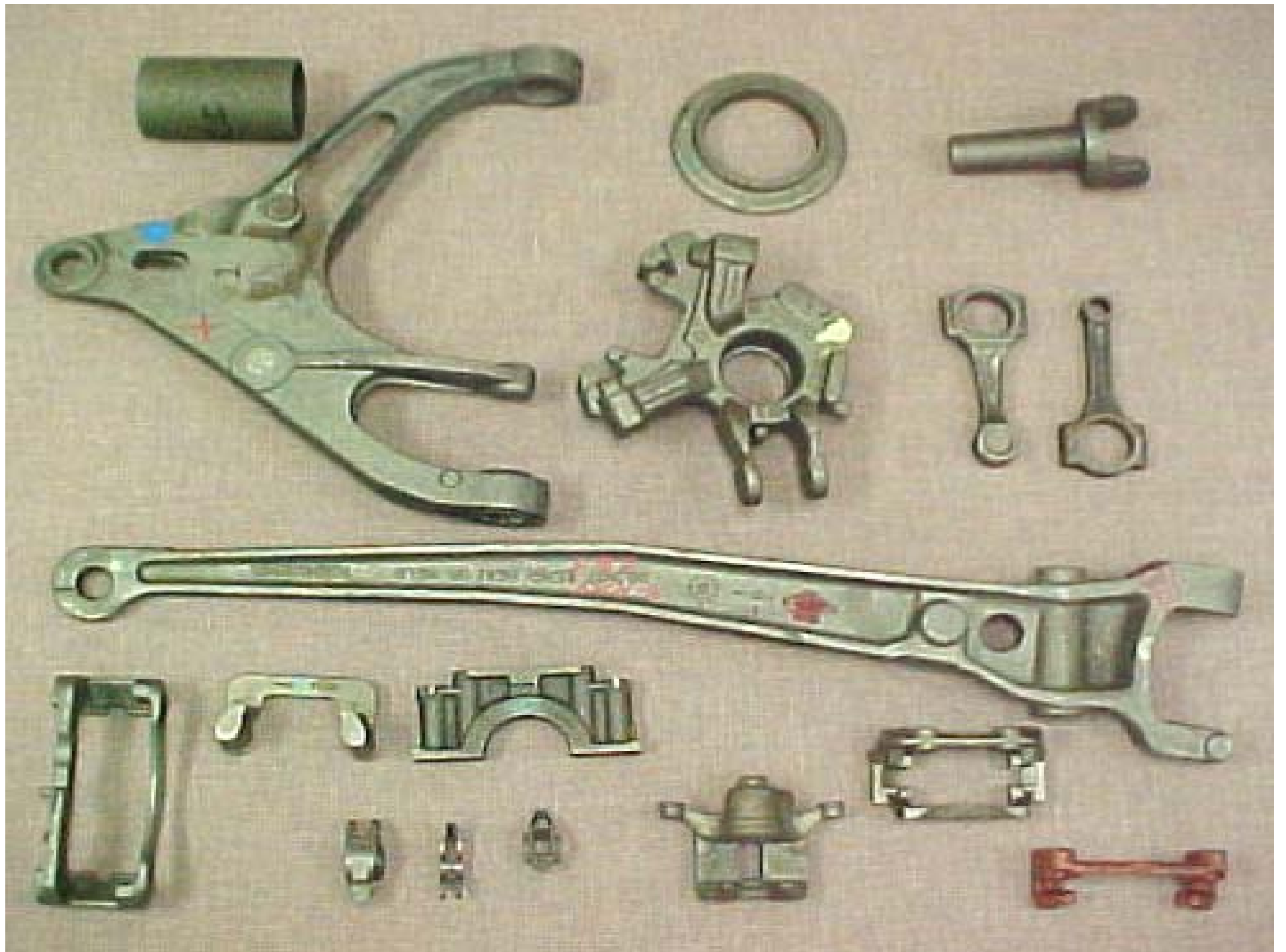
Process Compensated Resonant Testing for Ductile Iron

12 May 2010

Vancouver BC Canada

Quasar Rejects Ferrous Castings with Significant Structural Defects

- Low Nodularity
- Excessive Carbidity (even when only in thin sections)
- Cracks
- Inclusions, alloy films, carbon films
- Cold Shuts, misruns (even when very tight and “invisible”)
- Cold Spatter
- Sand chunk inclusions (not surface sand)
- Missed or wrong heat treatment (thermal history)
- Blow Holes
- Shrink Porosity
- Wrong grain structure or alloy
- Missing Features
- Non-fill or short pour
- Dimensions
- Broken or shifted cores







Some Quasar Applications

- Ductile Iron suspension castings at Hitachi (HMAC)
 - Automated, 8 different parts now, 4 more in planning
- Steel investment cast rocker arms for GM and Chrysler
 - 21 million per year for GM (originally, now reduced)
 - Major quality improvement and cost reduction
 - 5 years of production testing, only 1 GM rocker failed
- DI Brake calipers, anchors, suspension components
- Crankshafts

GM Steel Rocker Arms

- The Most Rigorously Proven Quasar Application
 - Billions of fatigue cycles plus force breaking
 - Performance correlation criteria met
 - Quasar predicted those rocker arms that would fail early
 - Hundreds of laboratory correlations for grain structure
 - Critically reviewed by top GM metallurgists, quality statisticians, engine designers, production process engineers and purchasing execs
- Greatest percent testing cost savings
 - Previous NDT: 50% film X-ray, Mag Particle, 5 visuals
- Most valuable warranty cost reduction results
- Greatest reduction of scrap loss
 - >6% to 0.5%% scrap

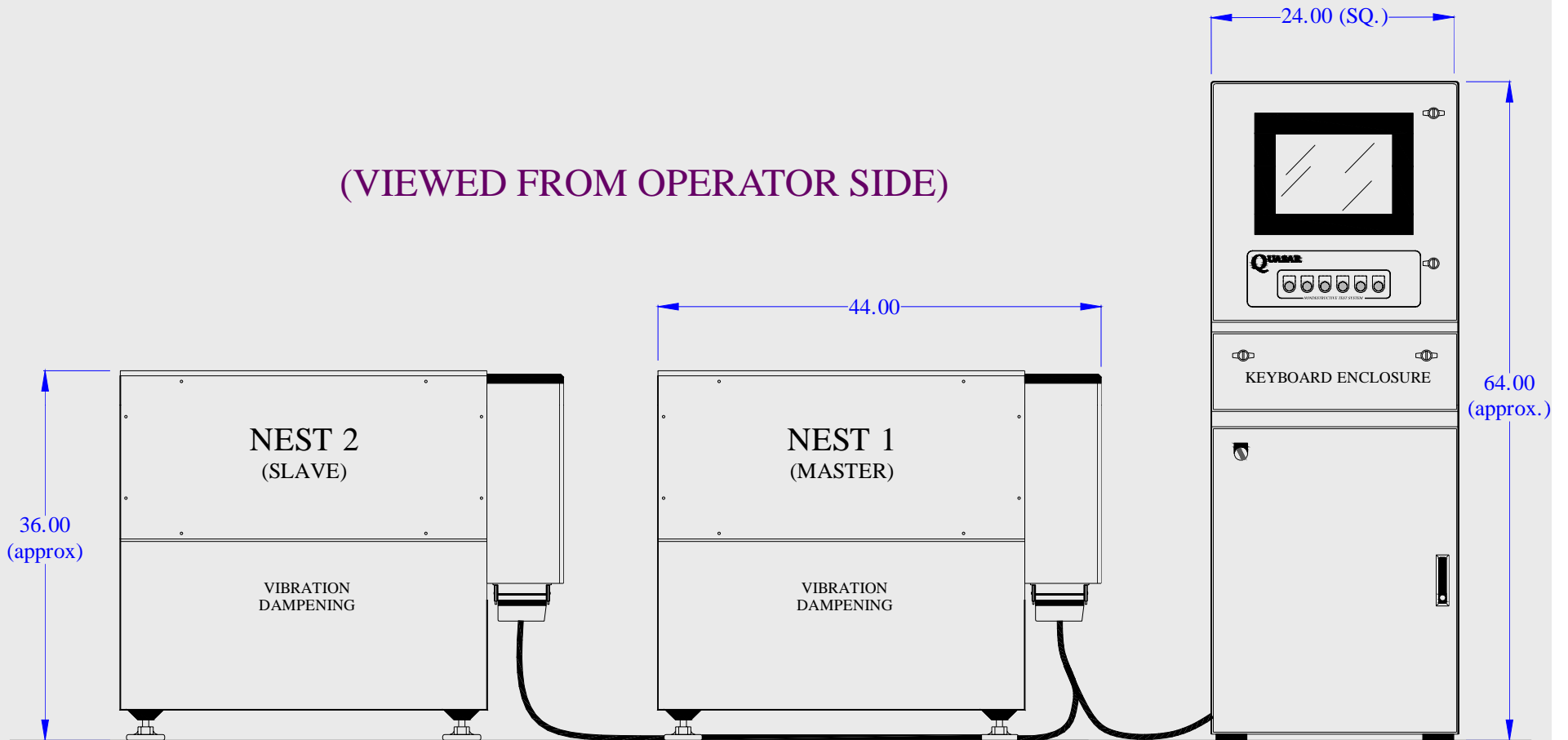
Immediate Benefits

- NDT that rejects parts based on probability of failure in operation, rather than “indications”
 - Better performance than conventional NDT
 - Eliminates wasted processing & machining
- Significant reduction in NDT & visual inspection cost.
- Lower Risk
 - *Proper use has eliminated containment for Magnaflux Quasar users*
 - *Part return is virtually ZERO!*
- Process easily automated
 - Computer decision & control
 - Inherent Error Proofing

Magnaflux Quasar NDT System

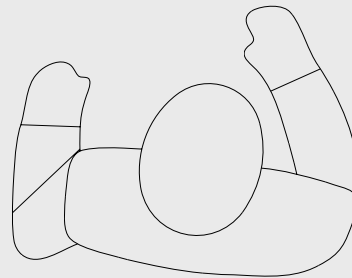
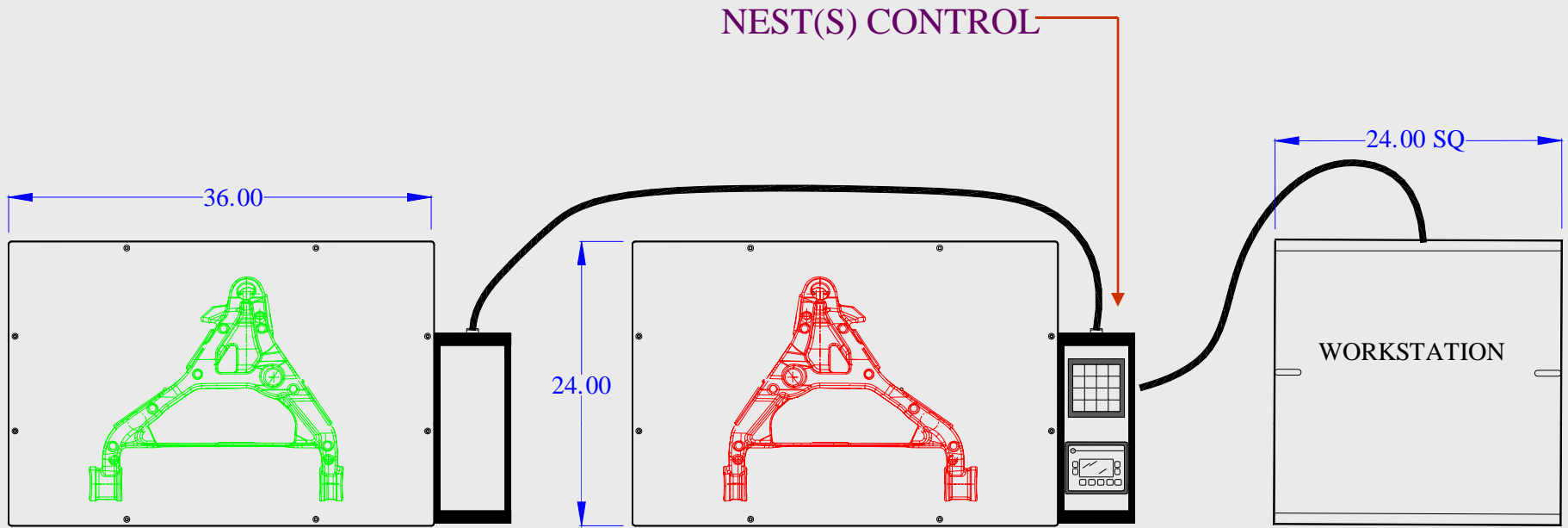


(VIEWED FROM OPERATOR SIDE)



QUASAR DUAL-NEST INSPECTION SYSTEM

(ELEVATION)



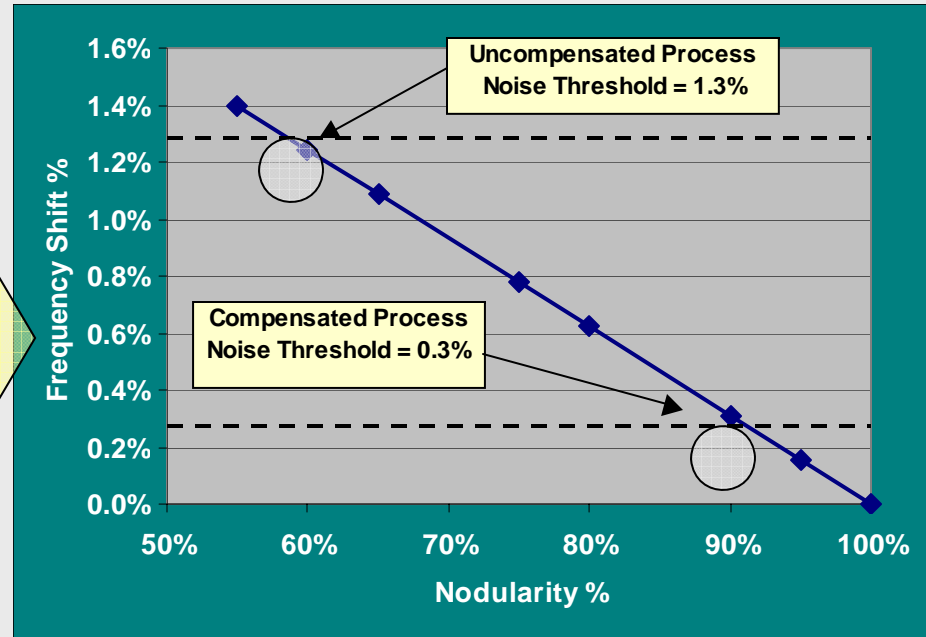
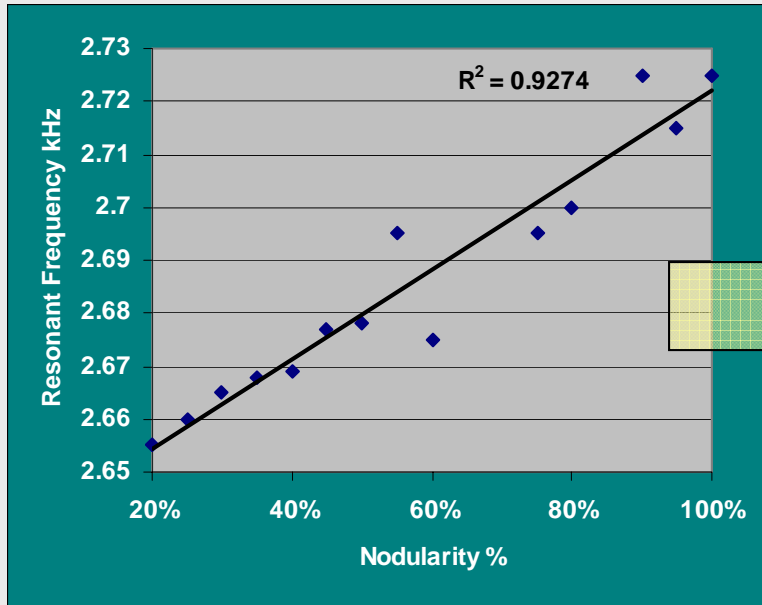
QUASAR DUAL-NEST INSPECTION SYSTEM

(PLAN VIEW)

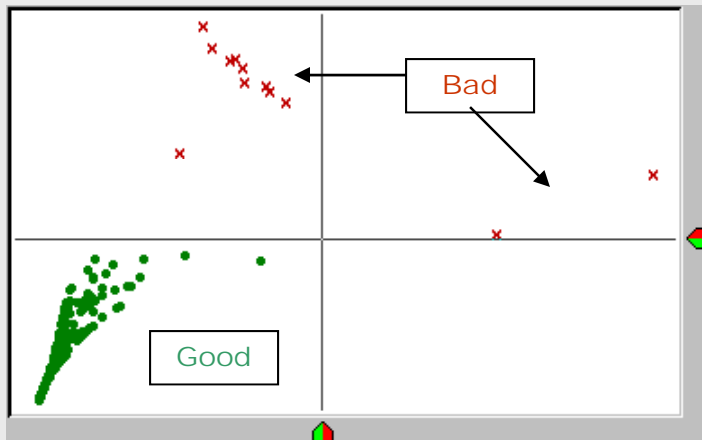
Sources of Errors

- Human error in process control and NDT
- Visual estimate of % nodularity is human dependent particularly below 90% nodularity
- NDT methods are too easily “adjusted to accept”
- Velocity measurements not sensitive to carbide
- Velocity measurements should be compensated for Section dimensions and temperature
- 40 degrees F changes velocity about 0.30% or about 10% difference in nodularity

Application Example - Nodularity



Data Source: Emerson - British Cast Iron Research Assoc. - 1974

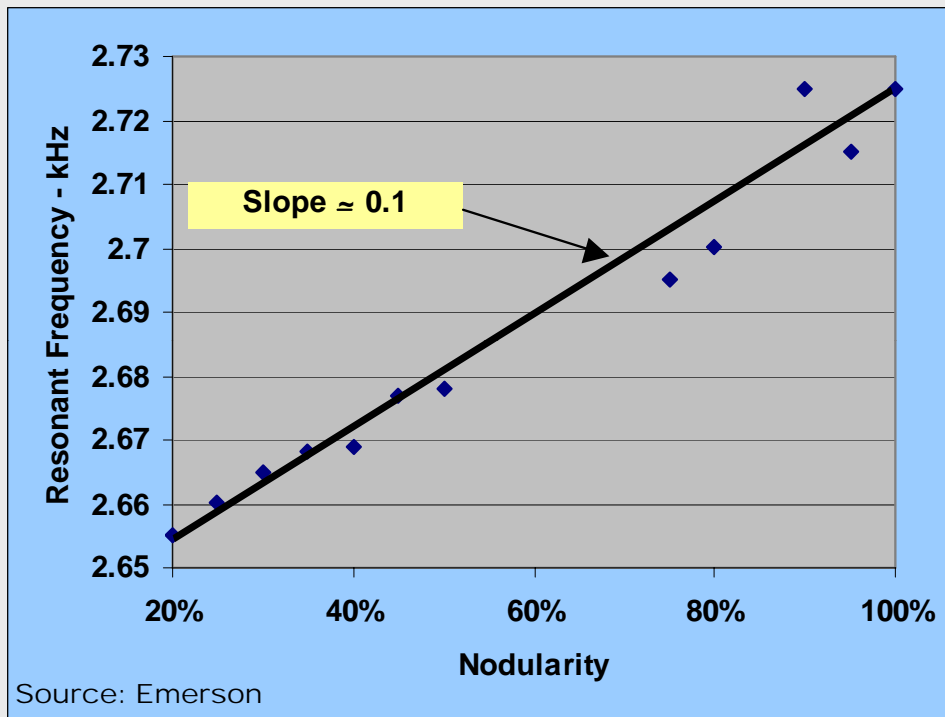


Ductile Iron Brake Anchors
Defective = Average nodularity 70%

Sensitivity: Frequency shift vs. Nodularity

	Nodularity Detection Threshold
Uncompensated	< 60%
Compensated	< 90%

Application Example - Nodularity



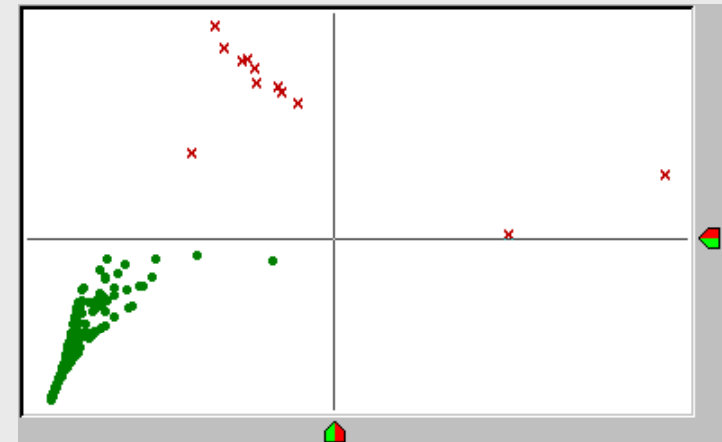
Sensitivity example:

Change in Nodularity = 5%

Change in Frequency = 0.5%

Uncompensated sensitivity ~ 1.5%

Compensated sensitivity ~ 0.3%



VIPR Sort - 2 bands

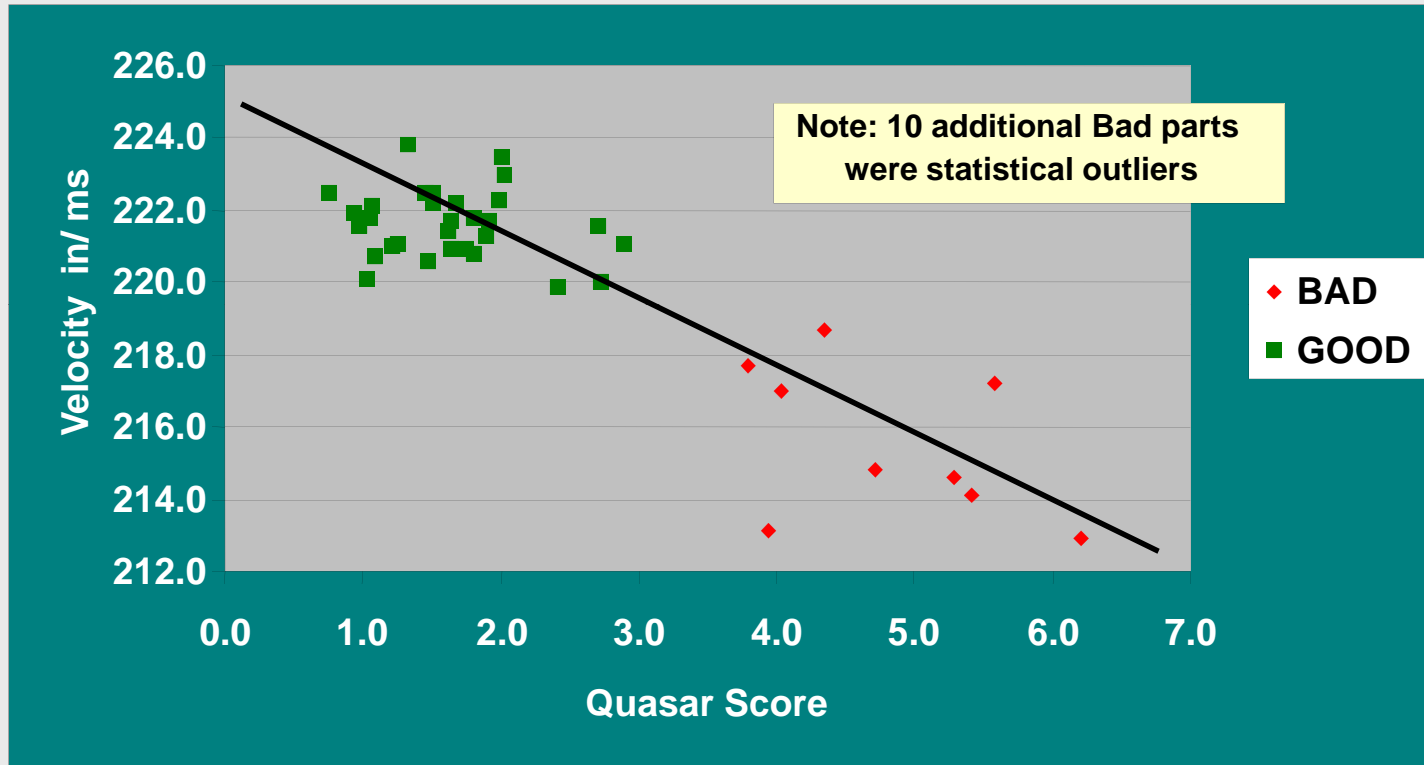
166 Brake Anchors

Defect - Average Nodularity of "bad" anchors is 70%

Because Nodularity of all "bad" anchors is so low, <70%, all bad parts fail MTS

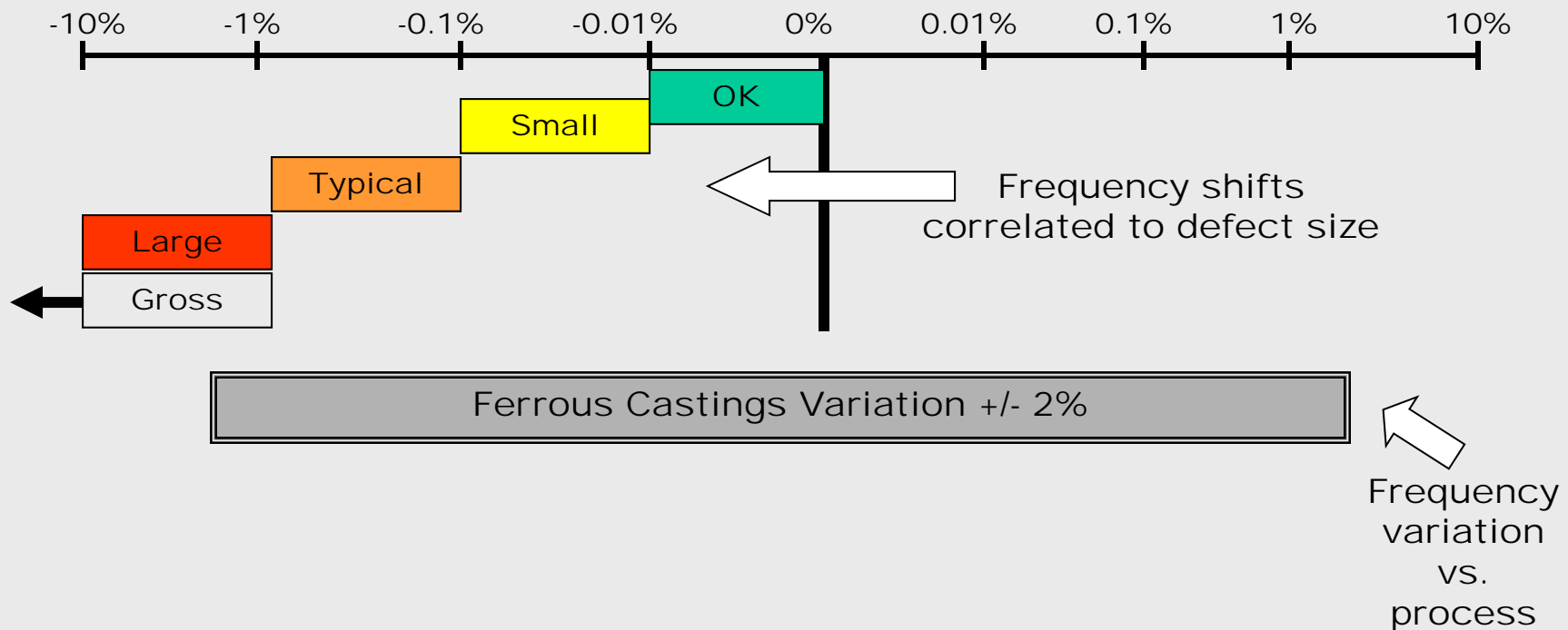
Rejecting higher % nodularity, say below 80% requires Bias test and more bands to compensate

Quasar Score vs. Velocity



RI Masking Effect

- Acceptable Production Variations in dimensions and material properties produce frequency shifts that mask defects – the batch problem



Result – Uncompensated Resonant Inspection limited to detecting large defects or requires “batch adjustment”

