



Process Control for CGI Series Production

Series Production Experience

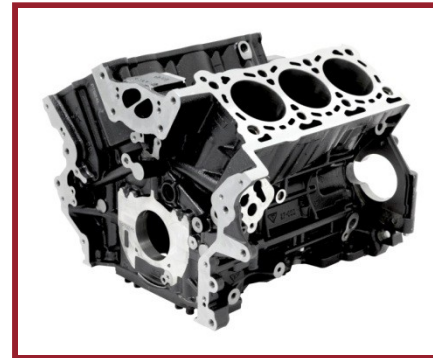
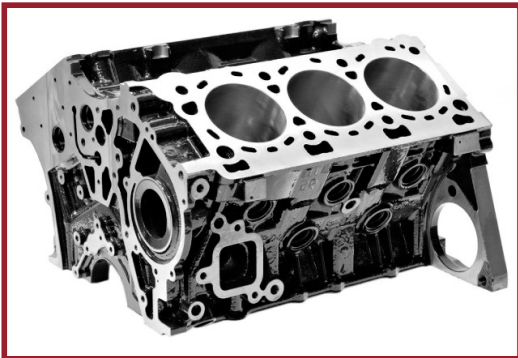
Production Experience and Technical Support

- Current Production Rate:
 - Current Annualised Production: 120,000 tonnes shipped castings
 - Number of Castings Produced: >2 million
 - Number of ladles controlled: >150,000 (~300,000 tonnes liquid iron)
- Current Production Support:
 - >65 CGI components in series production
 - 100,000 cylinder blocks per month
 - 2.7 kg to 9,000 kg per piece
 - 22 different installations
 - 11 countries and 10 languages
- Total Installations (44)
 - 24 System 3000 and System 3000 *Plus*
 - 20 Mini-System 3000
 - 13 countries and 10 languages

Series Production Experience

Passenger Vehicles

- >100,000 cylinder blocks per month
- Cummins, FCA, Ford, Hyundai-Kia, VW-Audi
- 2.7L to 6.7L displacement
- Diesel and petrol
- SinterCast-CGI engines in 53 vehicles and 18 car brands
- 14 of the last 15 V-diesels have been approved in CGI
 - One in Aluminium; none in Grey Iron

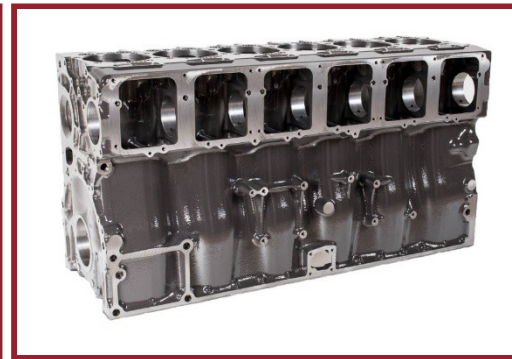
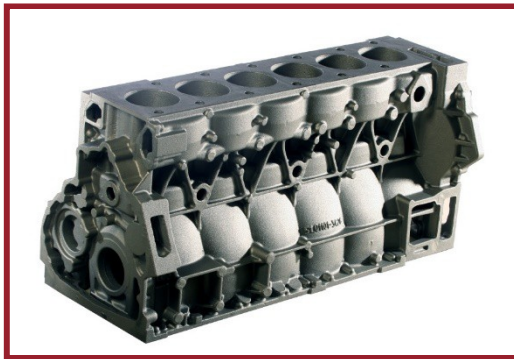
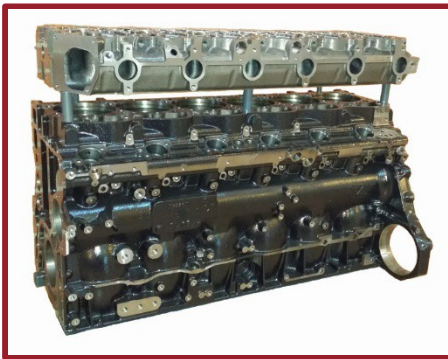


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— Supermetal CGI —

Series Production Experience

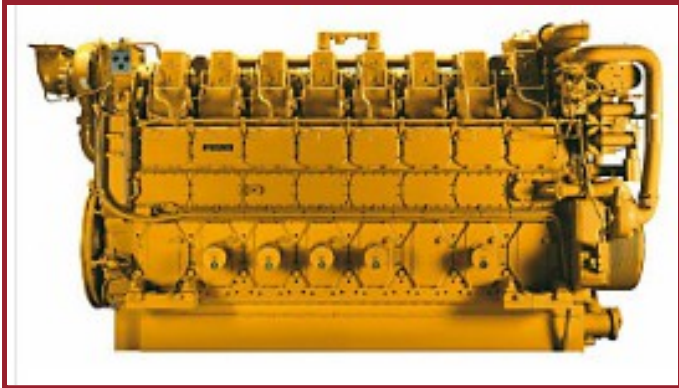
Commercial Vehicles and Heavy-Duty Engines

- DAF 10.8L and 12.9L (blocks and heads)
- Ford Otosan 7.3L and 9.0L (block and head)
- Hyundai 3.9L, 5.9L and 6.3L (blocks)
- Hyundai 6.3L, 10.0L and 12.7L (heads)
- JMC 9.0L block and head; 13L head
- Navistar 6.4L, 10.5L and 12.4L 'MaxxForce' (blocks)
- MAN 10.5L (D20) and 12.4L (D26) engines (blocks)
- Scania 13L & 16L (blocks)



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Series Production Experience



Industrial Power

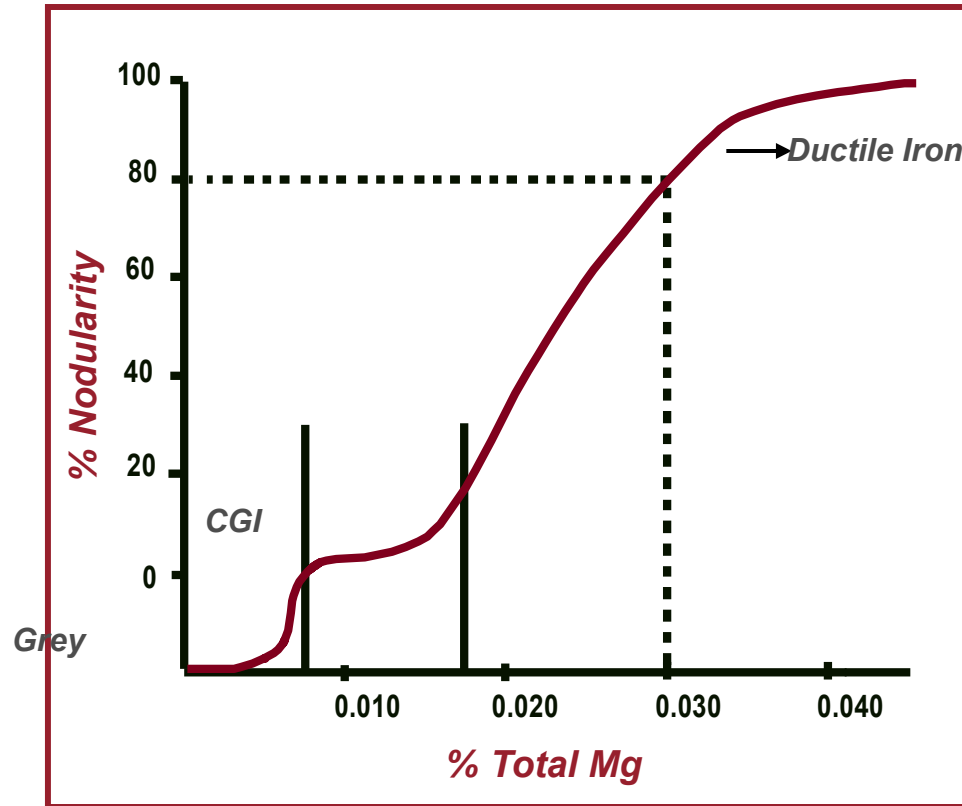
- Allen Diesels:
 - 550 kg cylinder heads
 - 9-17 tonne engine frames
- Cameron Compression:
 - 150-500 kg heads & turbos
- CAT cylinder heads: 3500, 3600, C175 engines
- Cummins QSK95 95L cylinder head
- Deutz 7.8L 6-cylinder head for tractors
- Doosan 27L V12 engine cylinder block
- Federal Mogul: 200-900 mm Dia. piston rings
- General Electric:
 - 165 kg cylinder heads for locomotives
 - Strongback support for locomotives
- Jenbacher heads for natural gas engines
- Liebherr V8 & V12 blocks
- MTU Series 2000 heads

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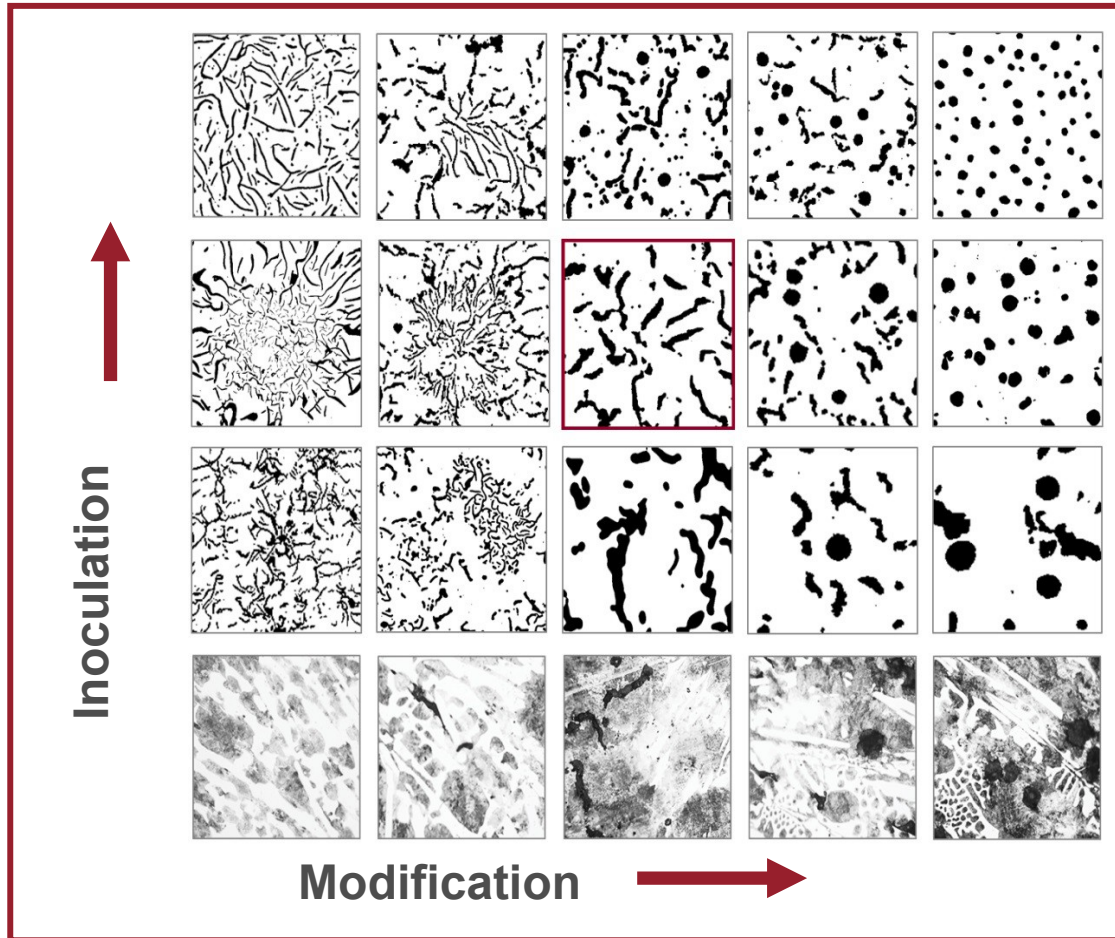
CGI Process Control

The Stable CGI Range



CGI Process Control

The SinterCast 'Chessboard'



CGI Process Control



Consistent Sampling

- Dimensional precision
 - Rapid heat-up
- Immersion Sampling
 - no oxidation
 - constant volume
 - thermal equilibrium
- Uniform heat loss
- Re-usable thermocouples
 - Up to 250 cycles
- Mg-fade simulation

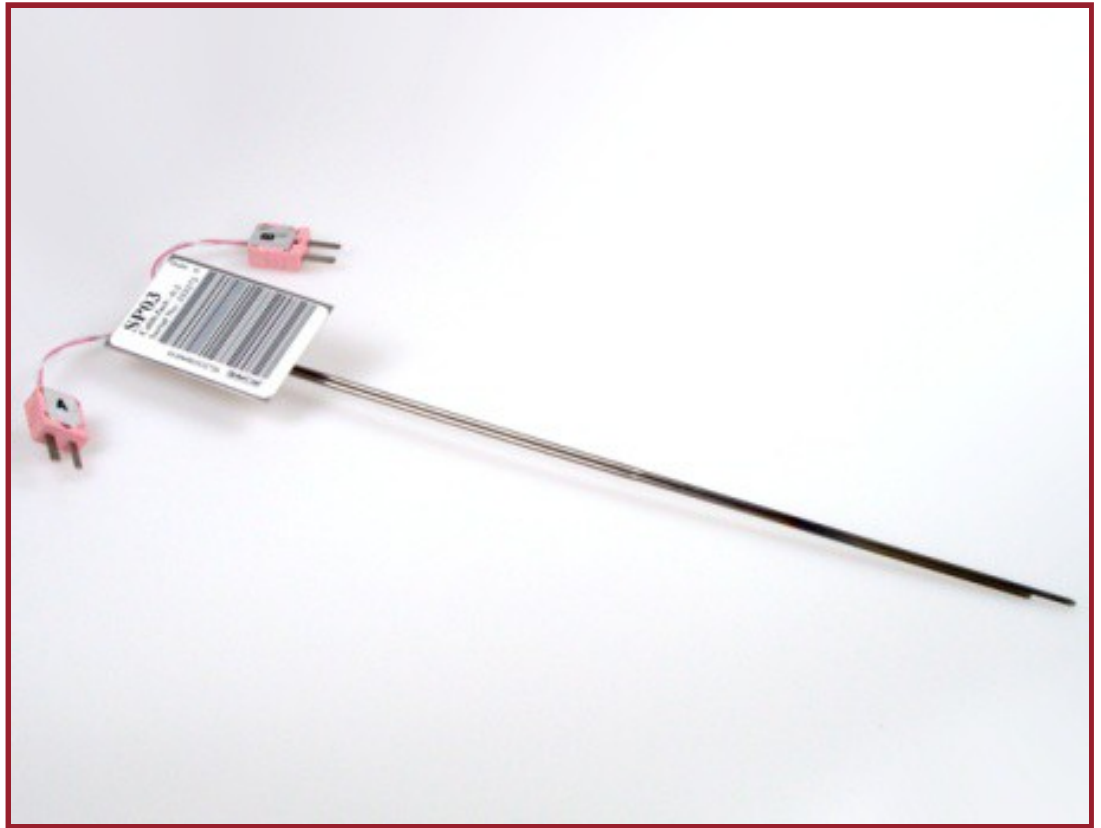
CGI Process Control



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CGI Process Control

Sampling Cup



CGI Process Control

Reusable Thermocouple Pair



CGI Process Control



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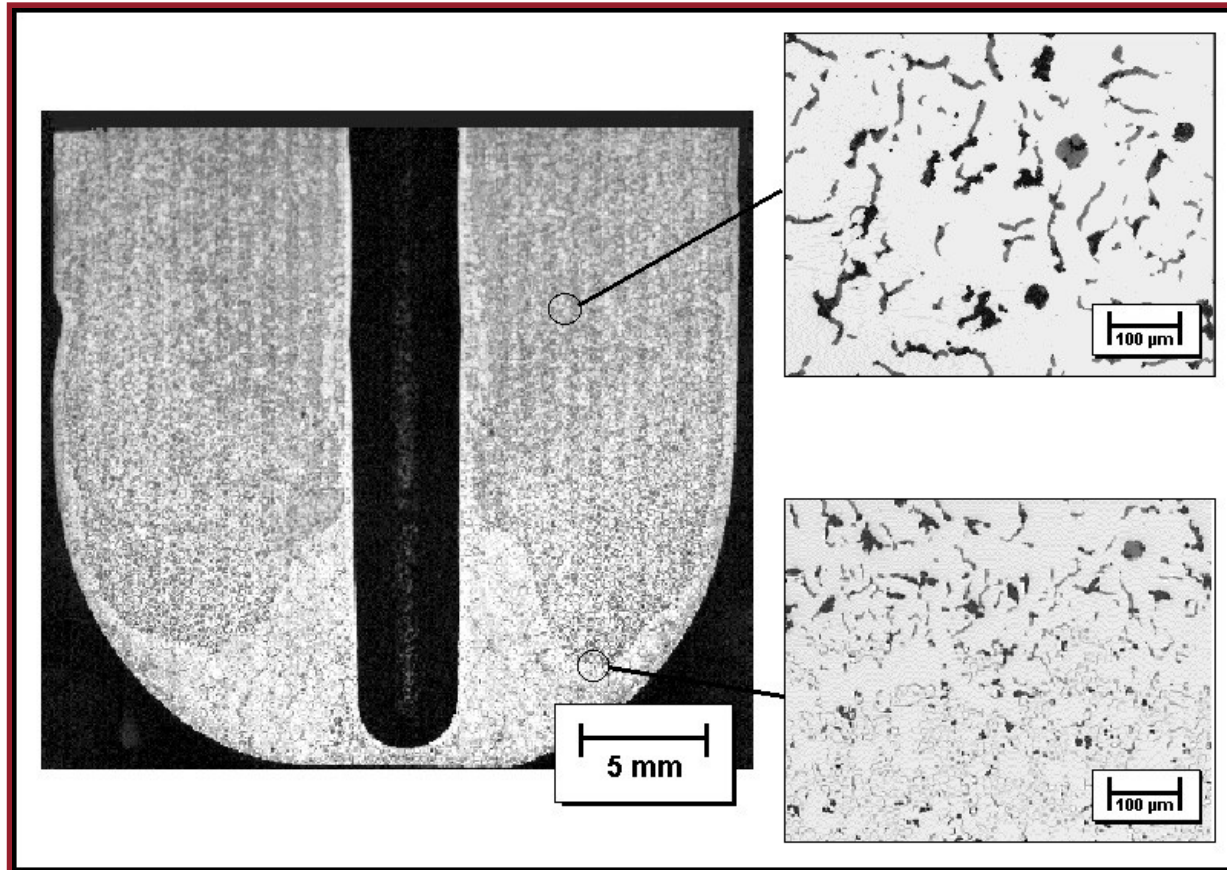
CGI Process Control

Mg-Fade Simulation



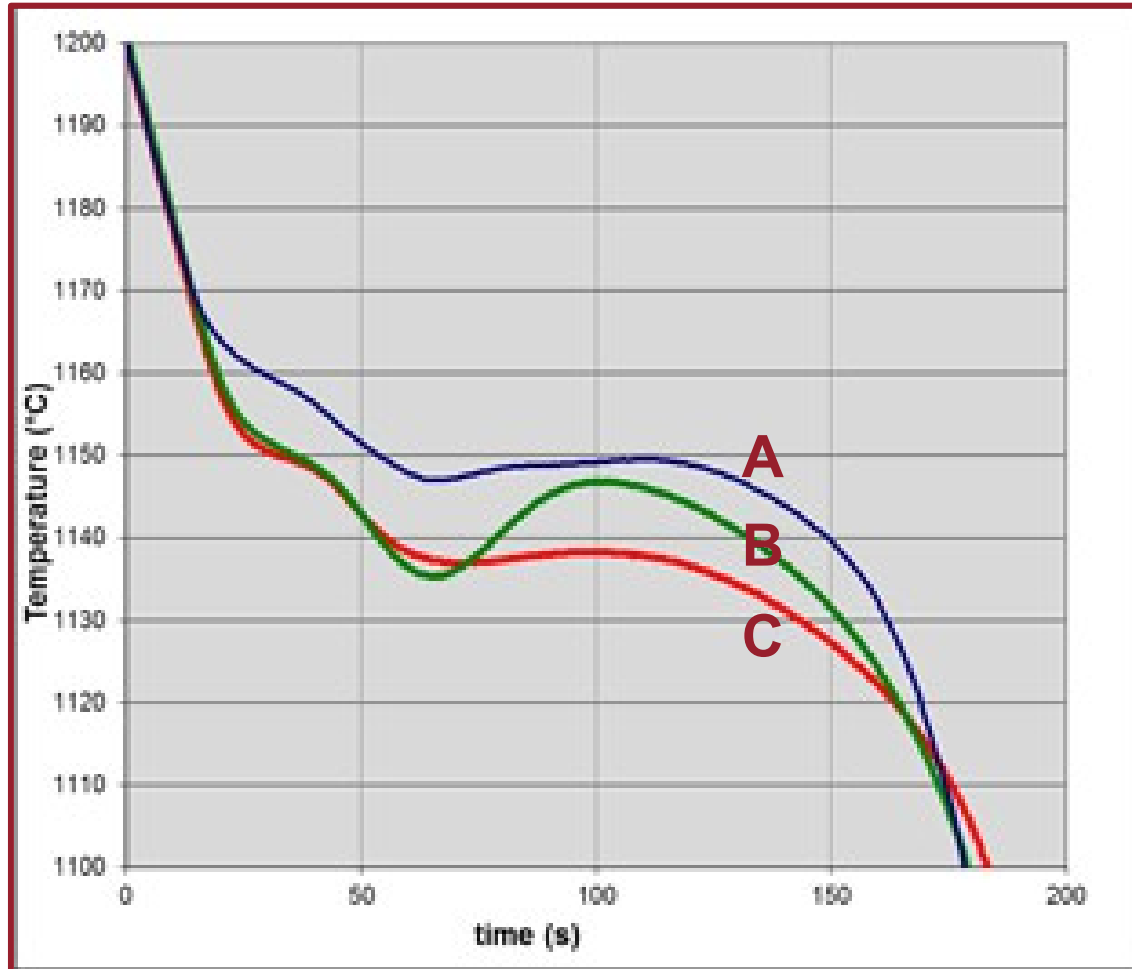
CGI Process Control

Mg-Fade Simulation



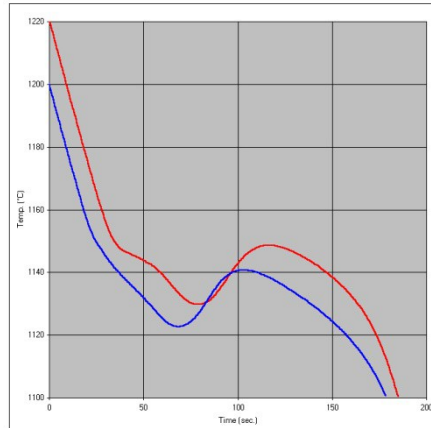
CGI Process Control

Mg-Fade Simulation

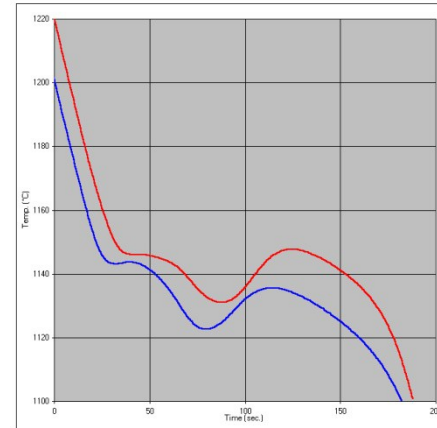


CGI Process Control

Mg-Fade Simulation



Without Wall Reaction



With Wall Reaction

CGI Process Control

Two Critical Components:

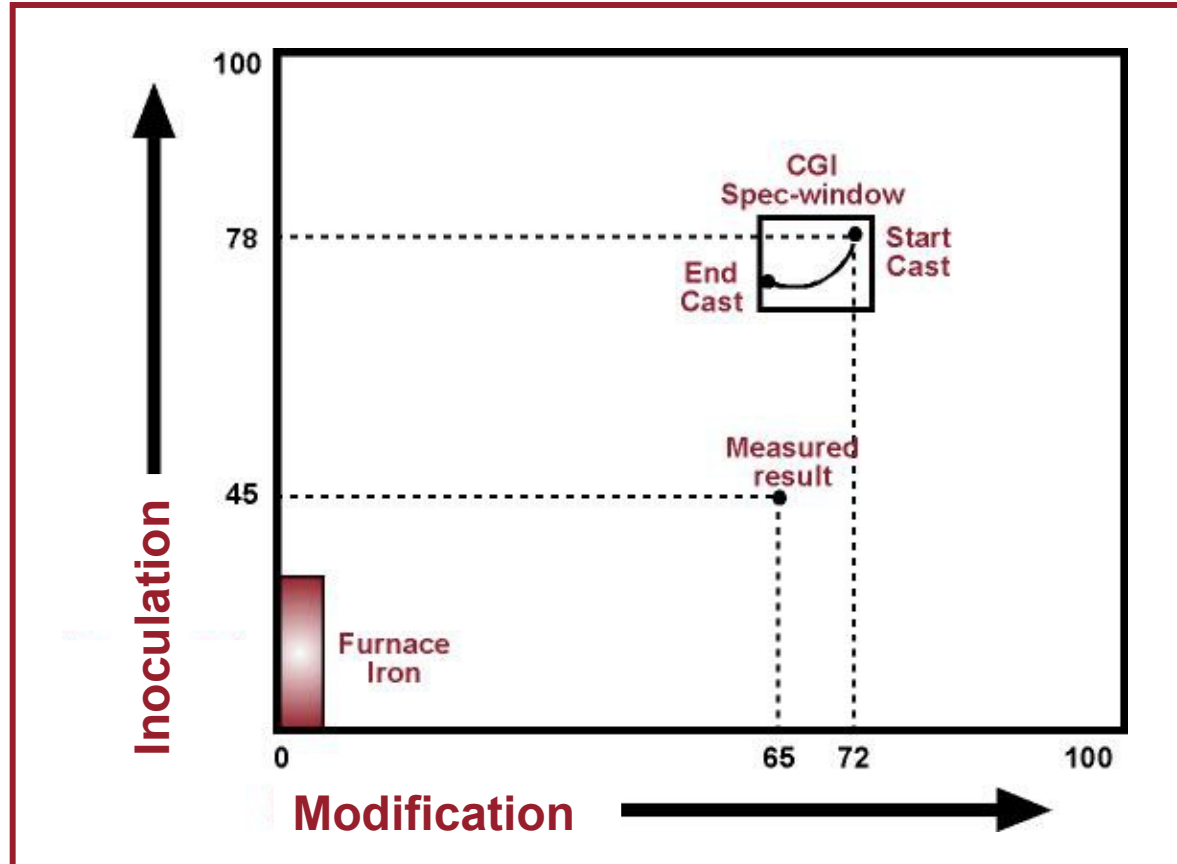
1. An accurate measurement of the treated iron
2. A control strategy that eliminates variation
 - Measurement location
 - Response action before casting



The SinterCast Process: Ladle Production

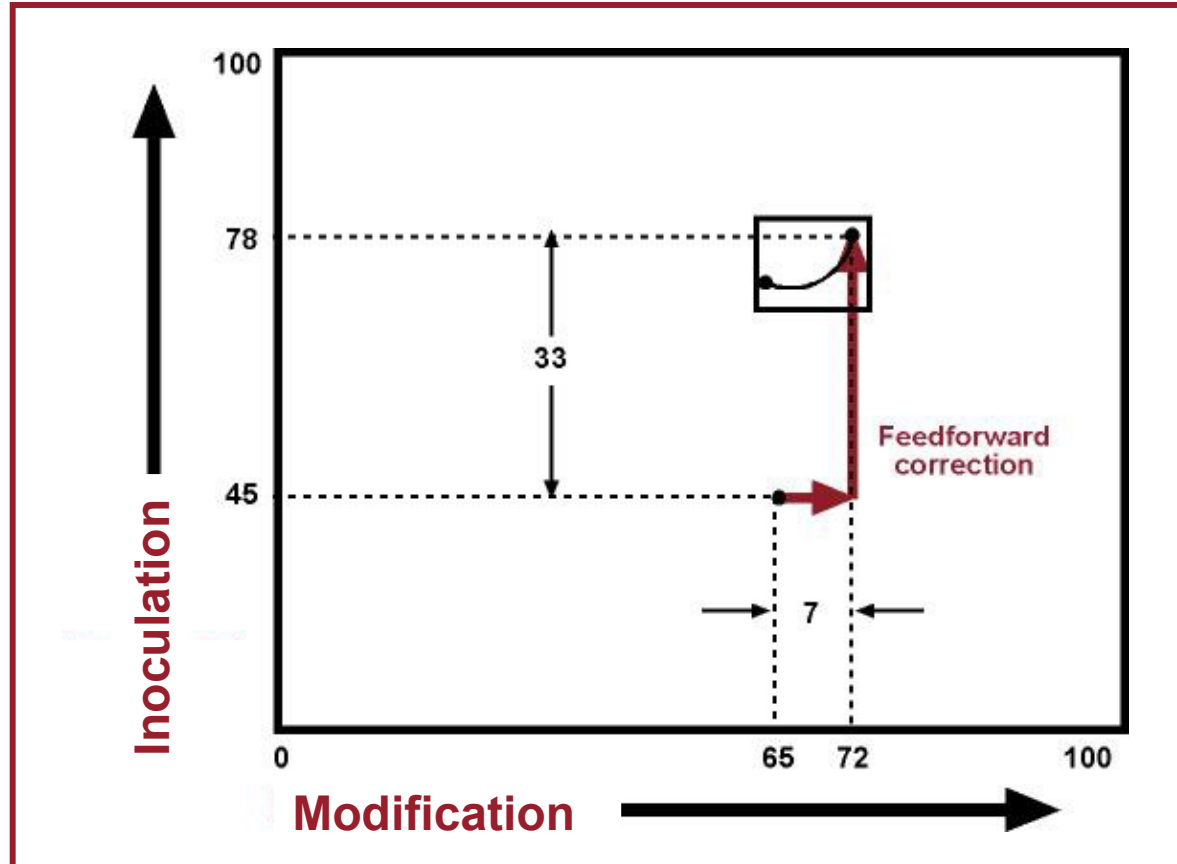
The SinterCast Process: Ladle Production

Base Treatment – Sandwich or Wire



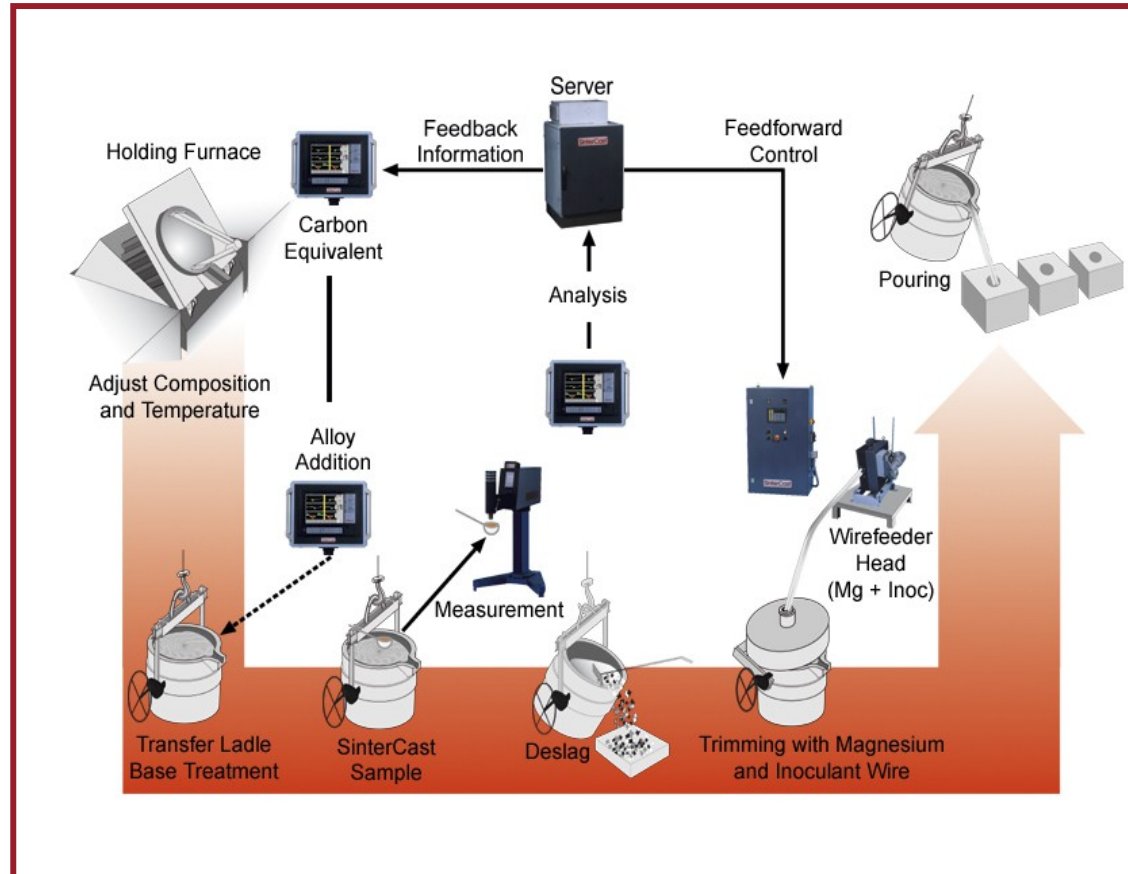
The SinterCast Process: Ladle Production

Wire Correction



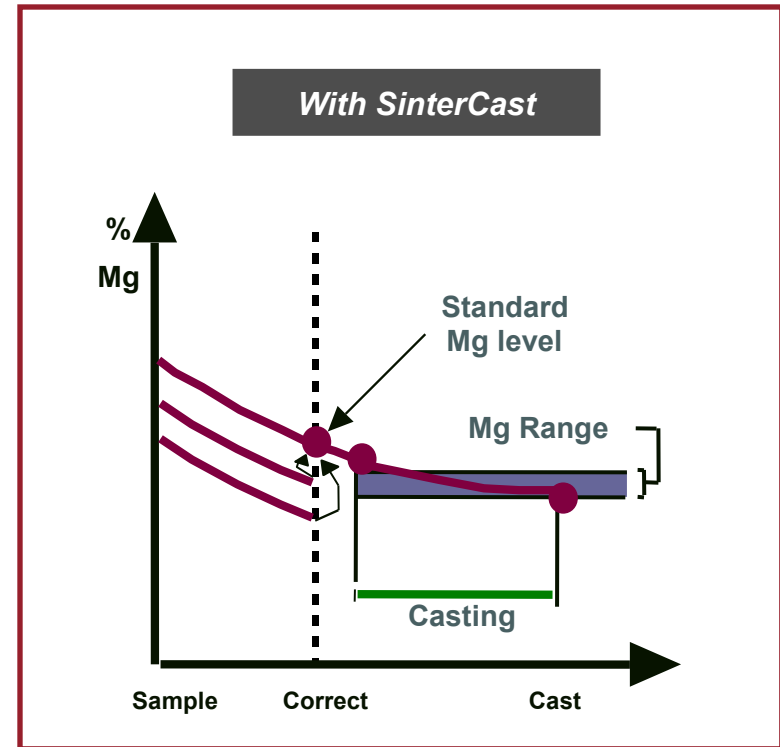
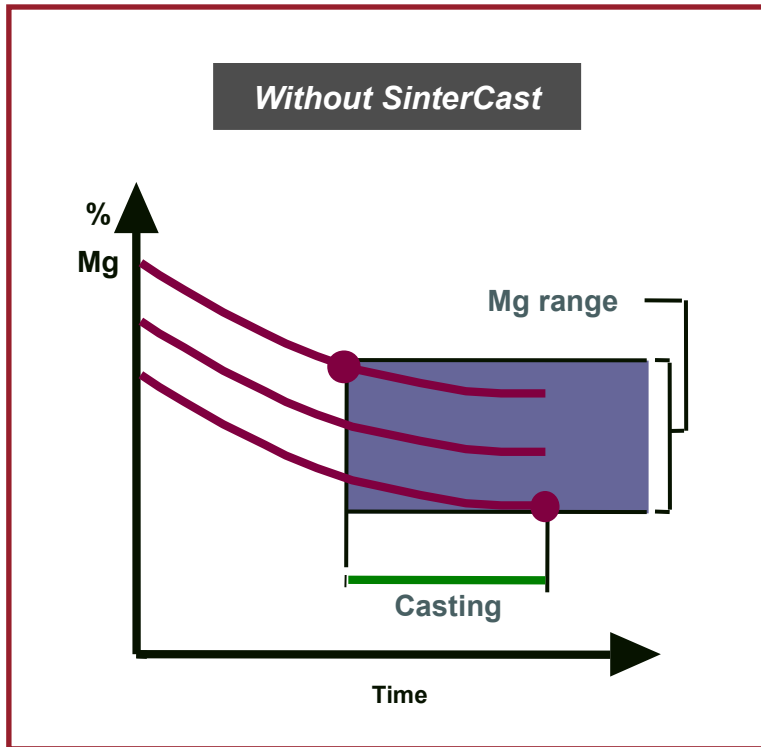
The SinterCast Process: Ladle Production

Measure-and-Correct



The SinterCast Process: Ladle Production

Magnesium Control

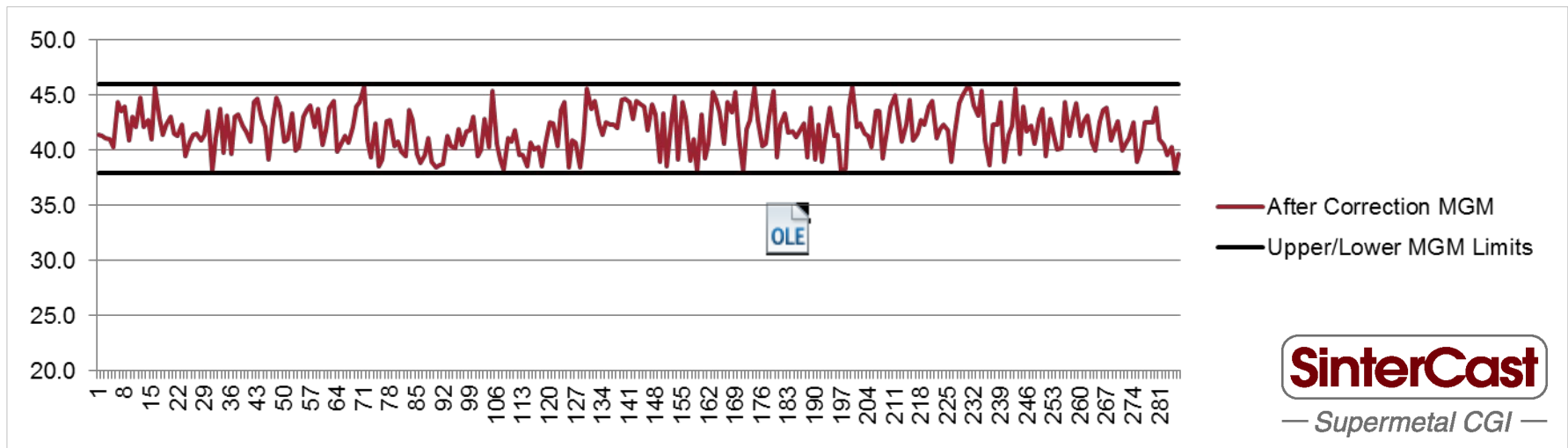


The SinterCast Process: Ladle Production

Base Treatment Modification - MGM



After Correction Modification - MGM





System 3000

System 3000



System 3000 Features

- Proven robustness and reliability
- Operator friendly
- Configurable touch screen OCM
- Open software access
- Network linked Wirefeeder
- Remote technical support
- One sample every 4 minutes
- Ladle-by-Ladle production records
- ISO 9001 certified

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System 3000 Plus



System 3000 Plus Features

- Automatic feed-forward correction
- *'Plus'* automatic feedback control of base treatment
 - Automated input of temperature, weight, and historical SinterCast results
 - Optimal amount of magnesium and inoculant cored wire for each base treatment
 - Reduced base treatment variability
 - Separate network-linked Wirefeeders for base treatment and correction



Mini-System 3000



Mini-System 3000 Features

- Designed for product development and prototyping
- System 3000 sampling technology & analysis software
- Simplified hardware platform
- All product calibrations directly transferable to full System 3000
- Optional manually operated Wirefeeder
- Installed in 12 foundries in 6 countries

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