PROCESS AUTOMATION IN ACTION

AUSTRALIAN DIE CASTING ASSOCIATION

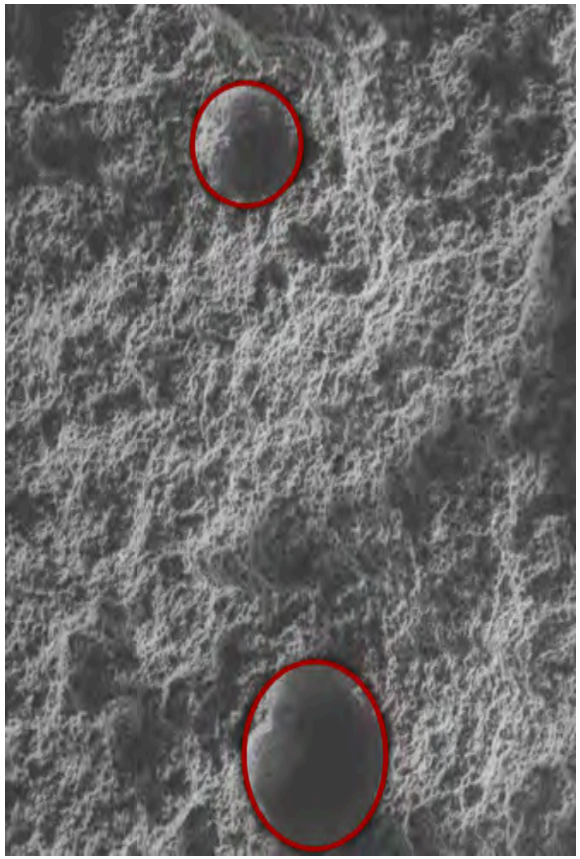
Visi-Trak®
SENSE, MONITOR, CONTROL

Process Automation In Action!

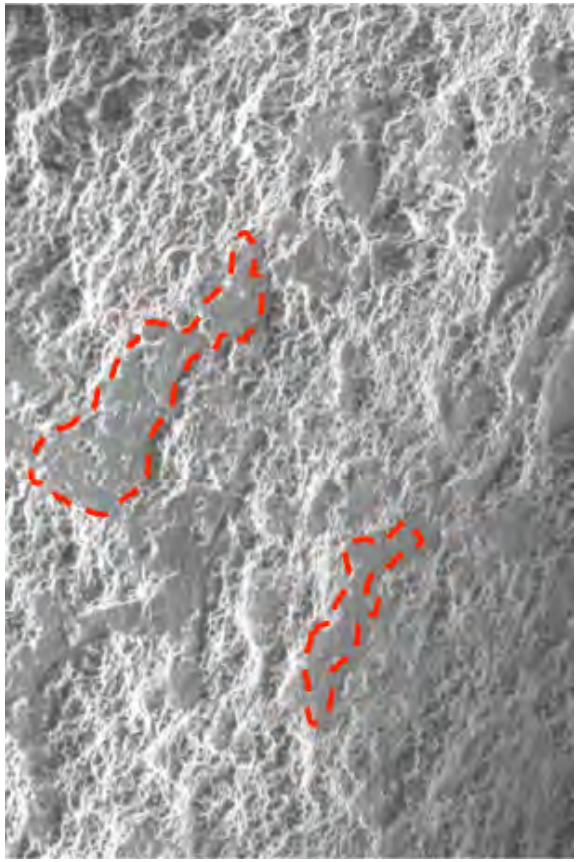
Defect Prevention

less scrap
reduced metal & energy costs
greater OEE

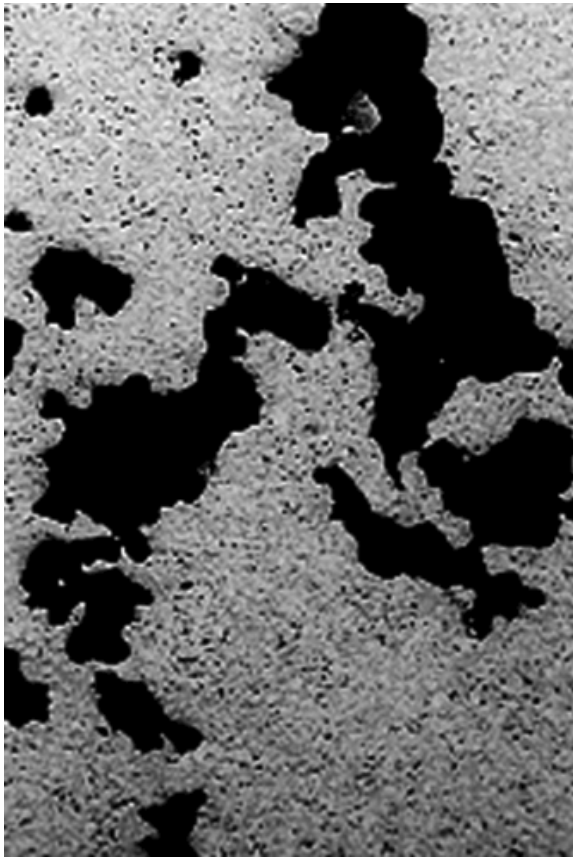
The Porosity Problem



Trapped Gases



Material Separation



Shrinkage Porosity

The Porosity Problem

- Excessive porosity creates unexpected mechanical properties in the finished casting:
  - Creates blistering in parts requiring heat treatment.
  - Reduce ductility leading to cracks during deformation.
  - Reduce conductivity in applications like electrical rotors
  - Leads to leakage in pressure-tight castings

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Sleeve Fill Phase

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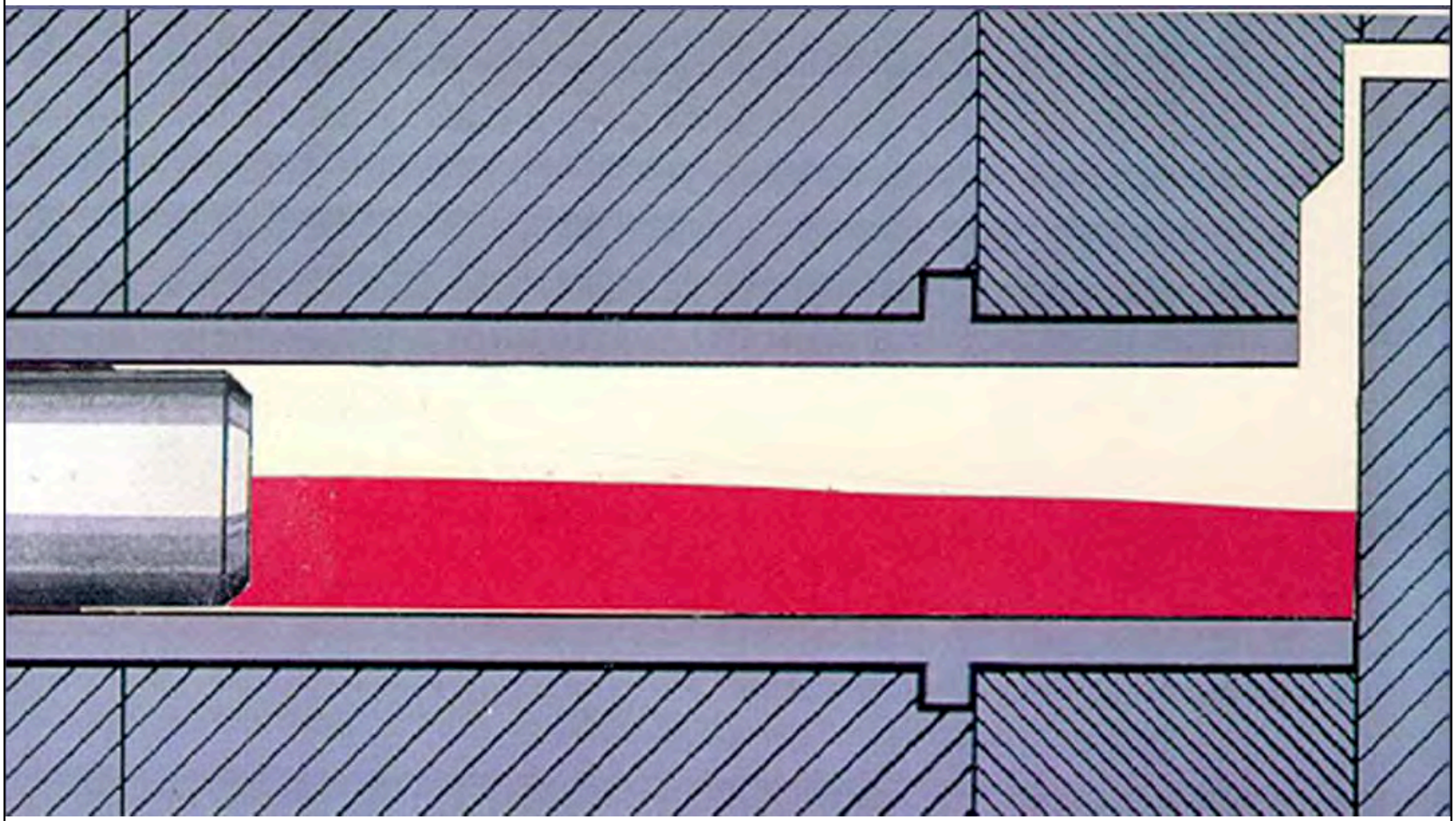

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Sleeve Fill Phase – Too Slow?

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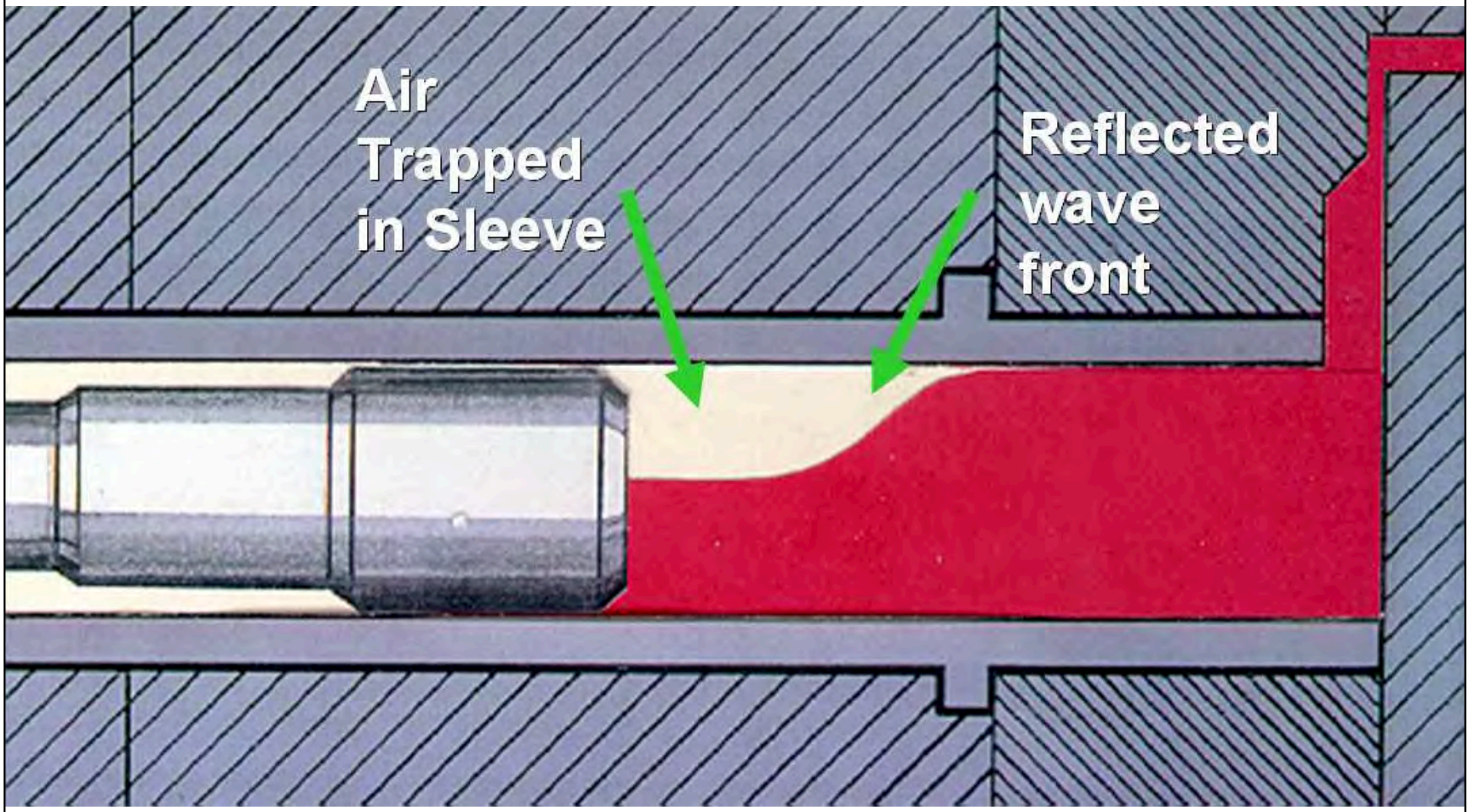

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Sleeve Fill Phase – Too Fast?

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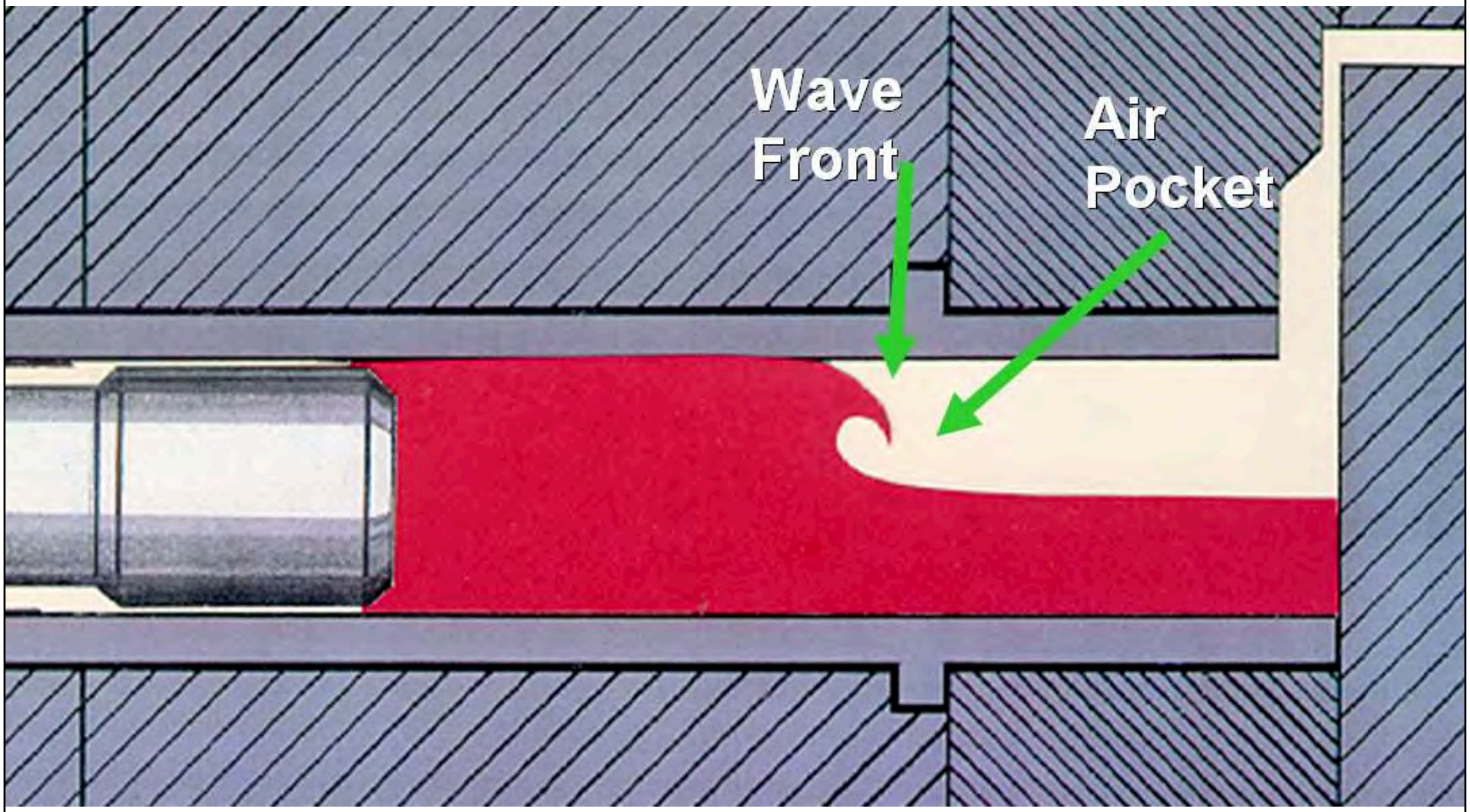
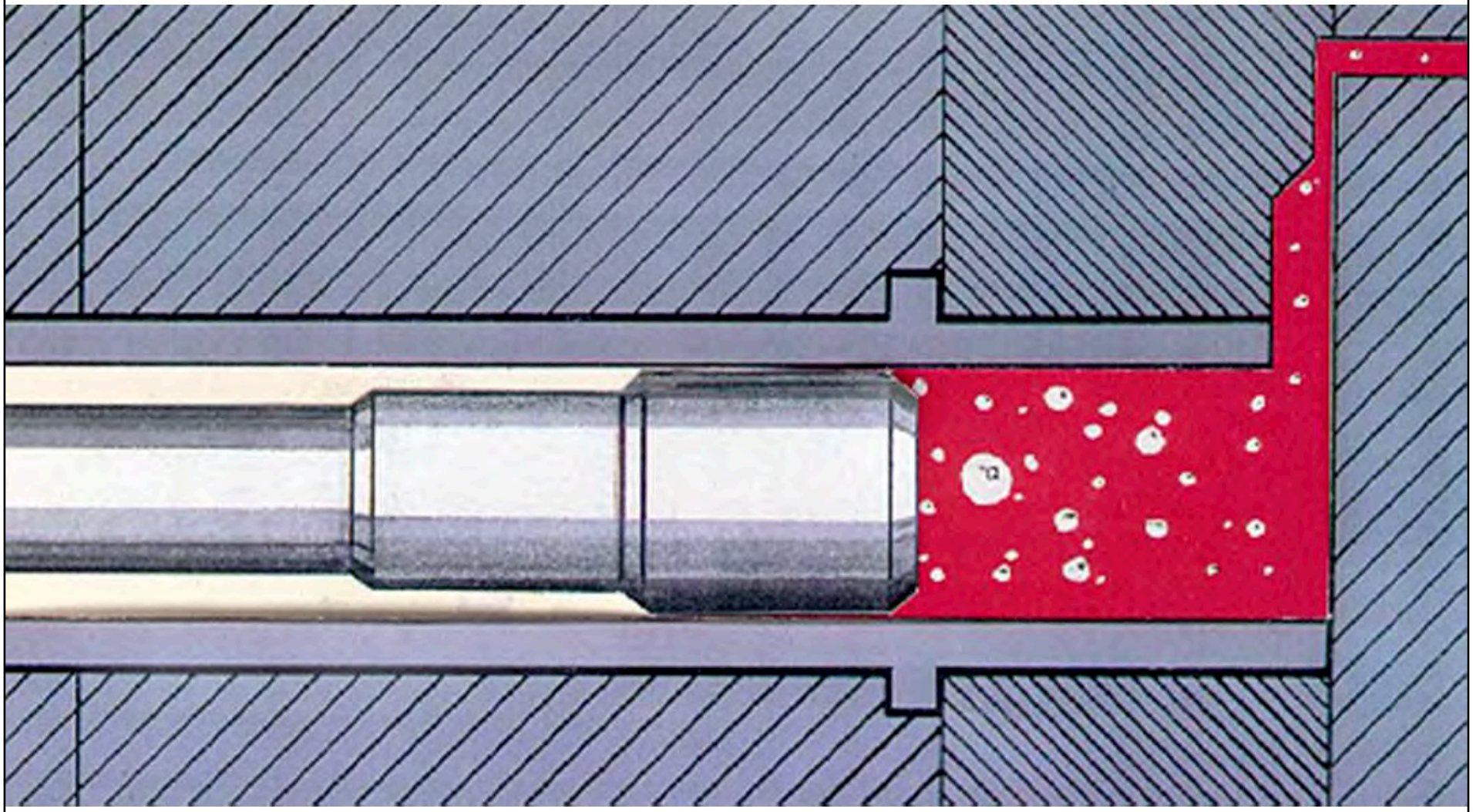
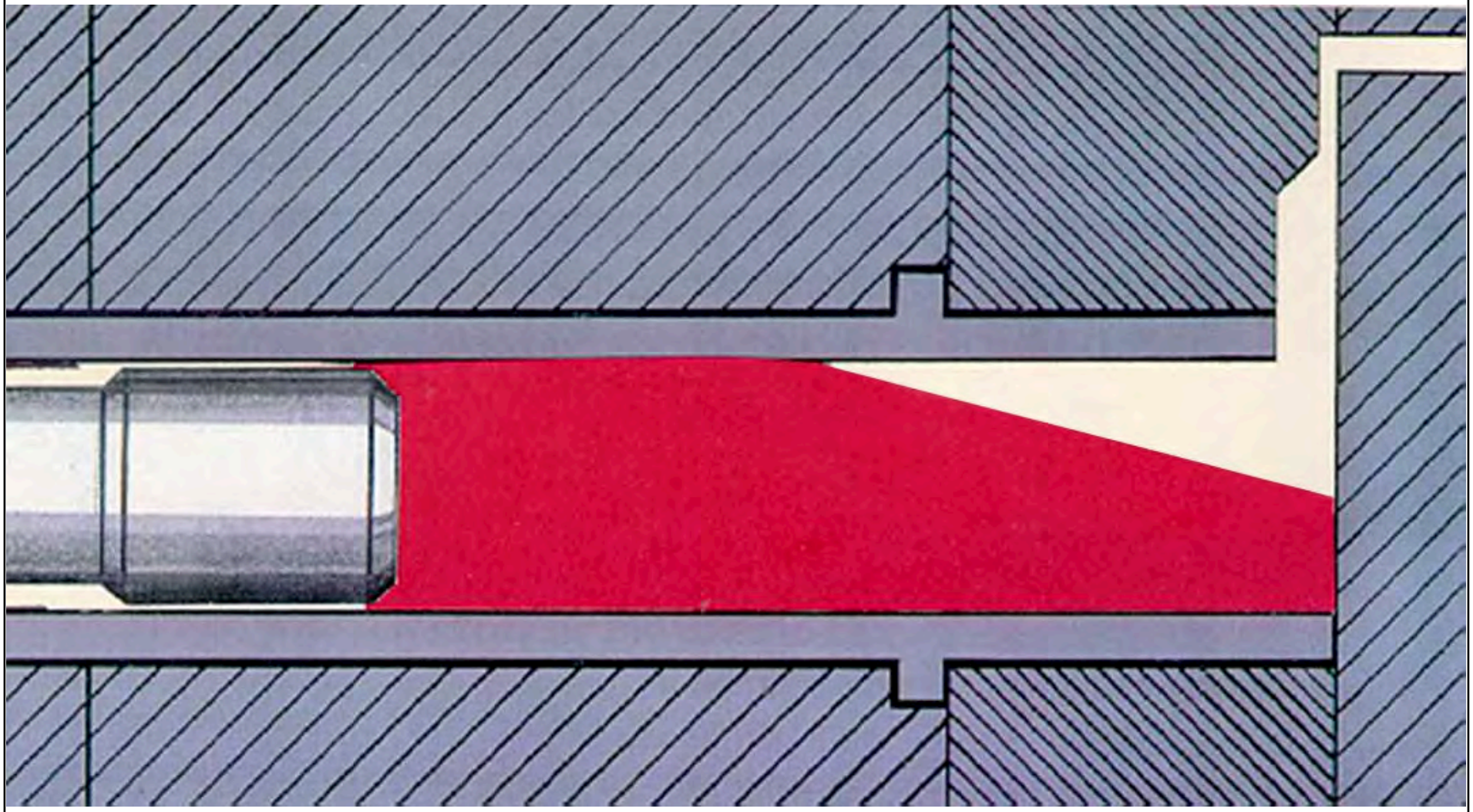


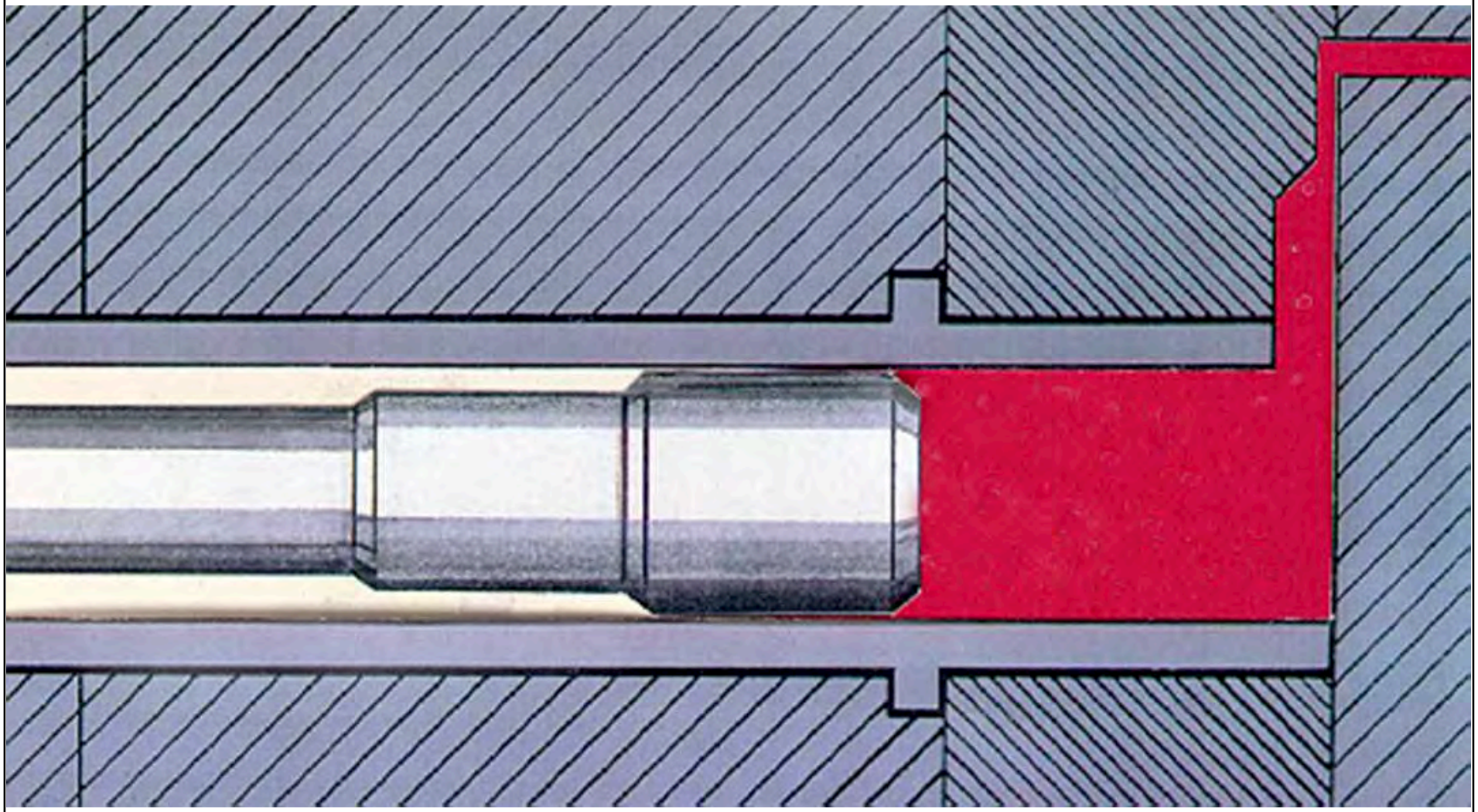
Sleeve Fill Phase – Porosity



Cavity Fill Phase – Critical Slow Shot Velocity

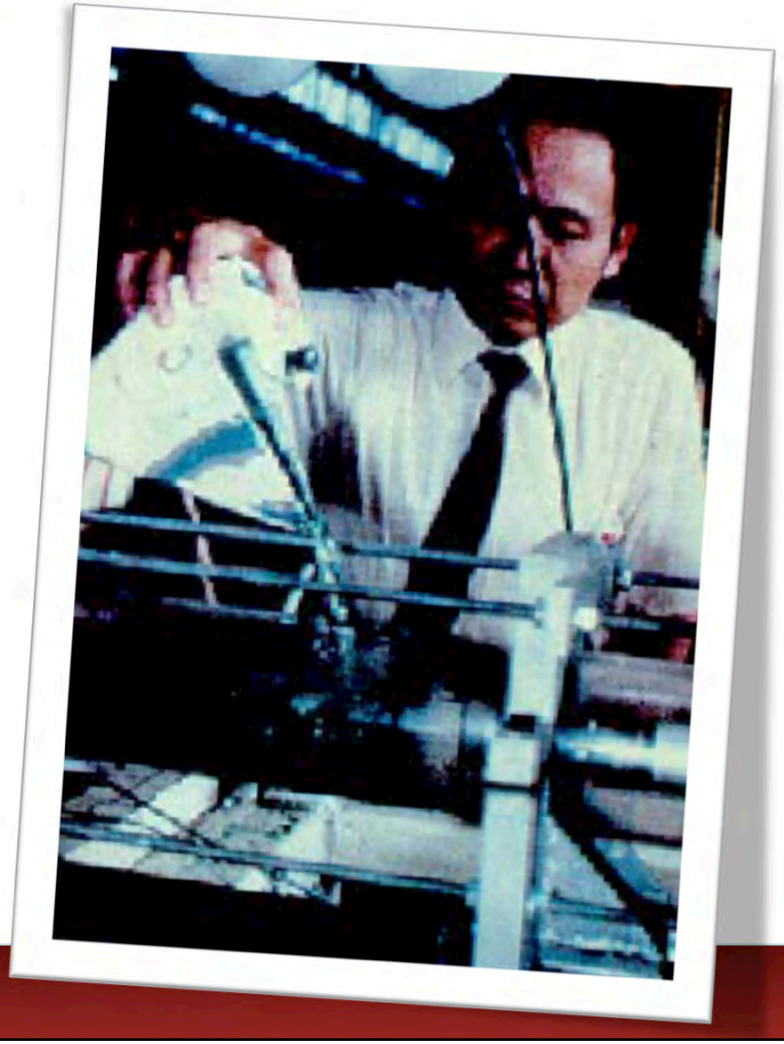


Cavity Fill Phase
Consistent Results

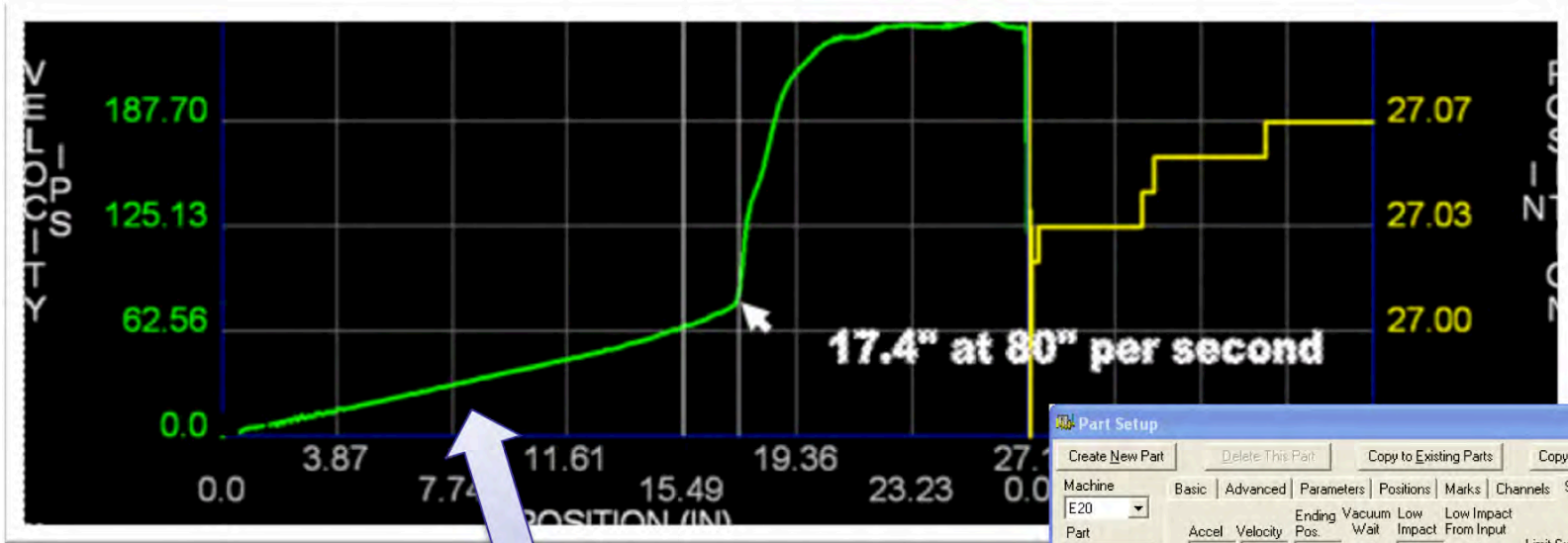


Ohio State Water Analog Simulation

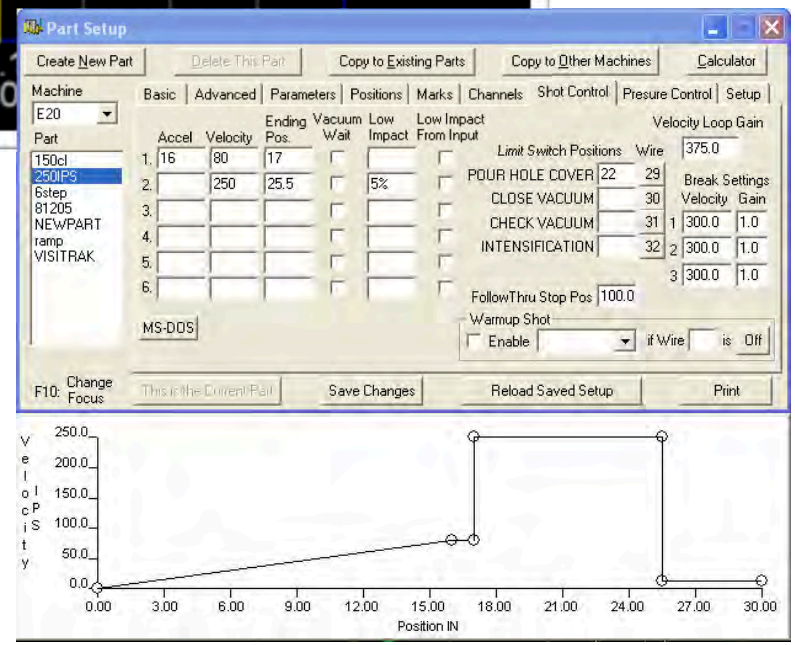
- Discovered **importance of acceleration control** to critical slow shot velocity



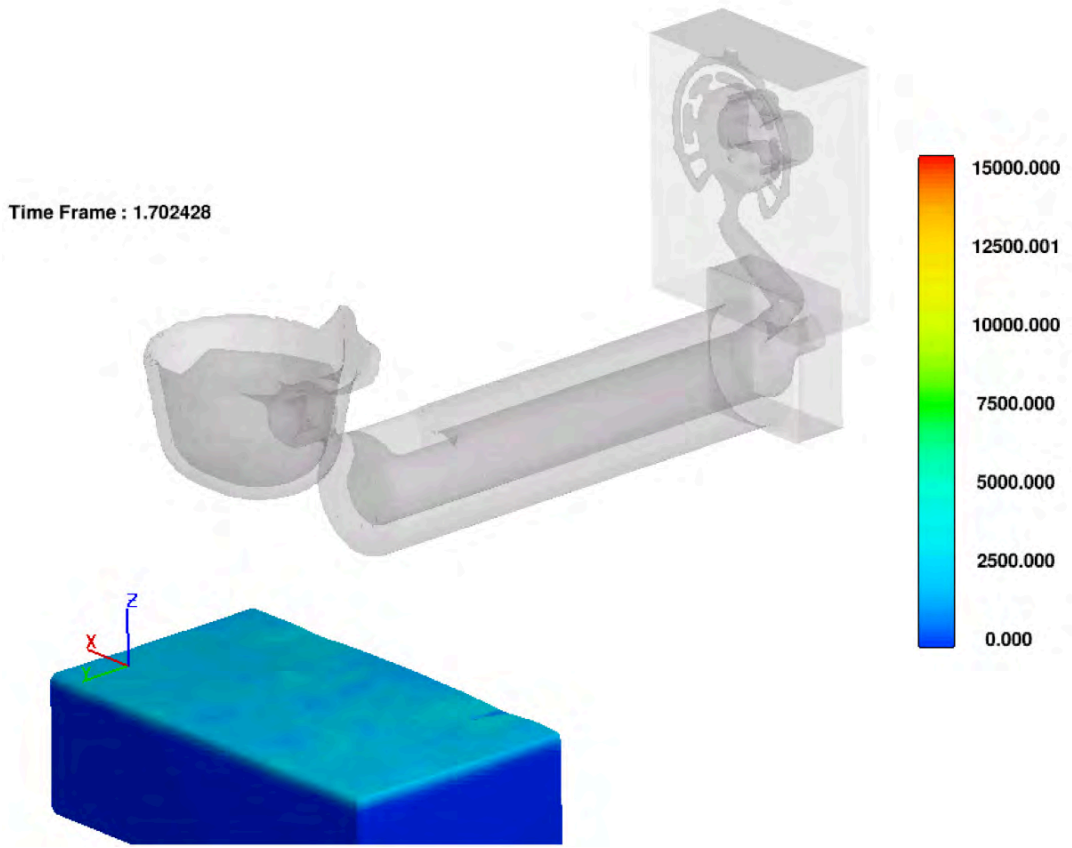
Programmable Velocity



Constant Acceleration

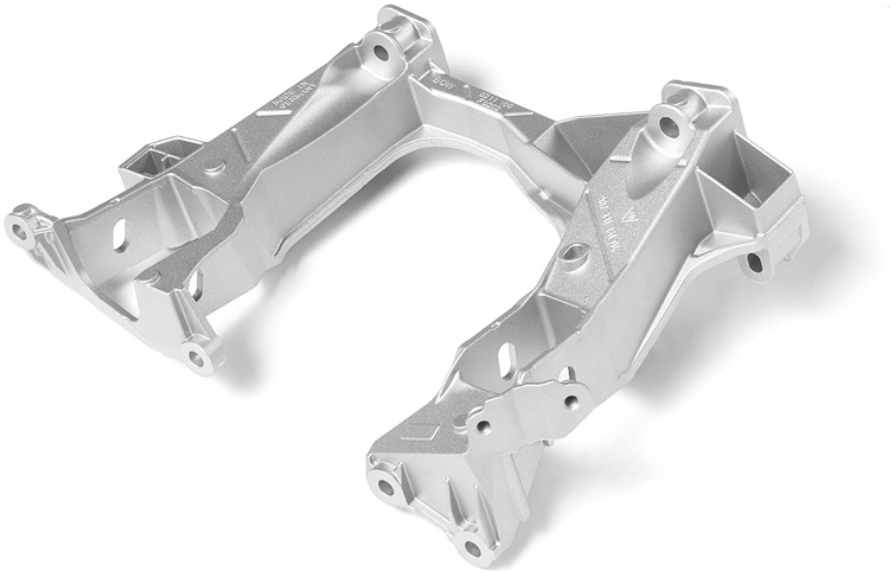


Real-time Computer Simulation



Customer BDW Technologies

- **Problem**: 10% fallout due to material separation porosity
- All other critical parameters within limits
- **Why the defect?**



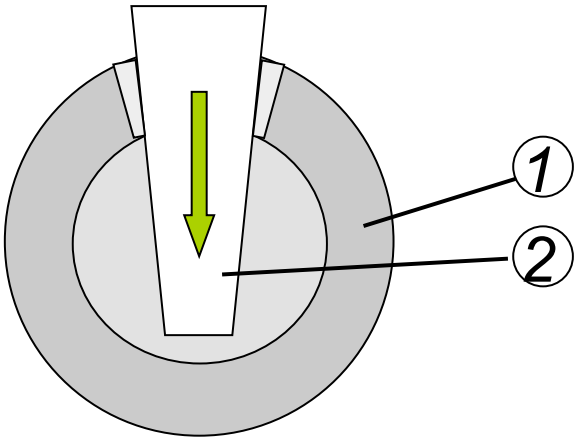
Porsche Suspension Part

Swivel Launder

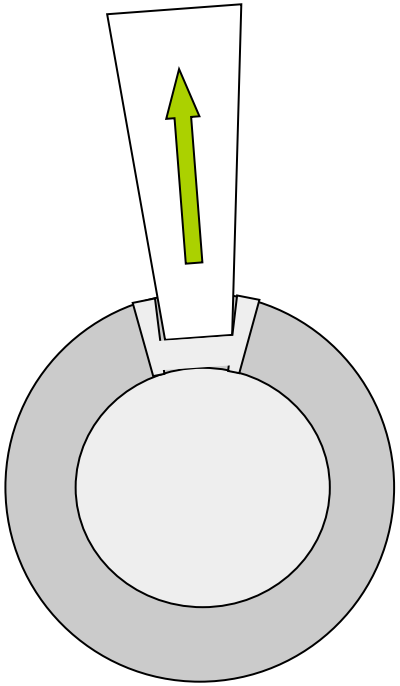
SUSPECT: Turbulence during dosing
SOLUTION: custom swivel launder developed to provide laminar flow during metal delivery

Swivel Launder

Shot sleeve (1)
Launder spout (2)



Fill position



Home position

Swivel Launder

Description:

- The swivel launder allows a laminar metal flow into the shot sleeve. Thus will assure an excellent metal quality in the shot sleeve.
- The reduced drop height and lower flow rate of the melt during the metering sequence will extend the life time of the shot sleeve - in some cases by factor 10 or more.
- The condition of the shot sleeve is essential when applying a powerful vacuum (< 0.7 PSI) to the cavity. Any significant leakage between the shot sleeve and the shot tip will cause a prefilling of melt into the cavity prior to fast shot!
- BDW technologies has developed the design of the launder and the swivel jig in order to achieve a high melt quality level for weldable and heat treatable diecastings.

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Determine Cause of Part Variation

less scrap
happy customers
greater OEE

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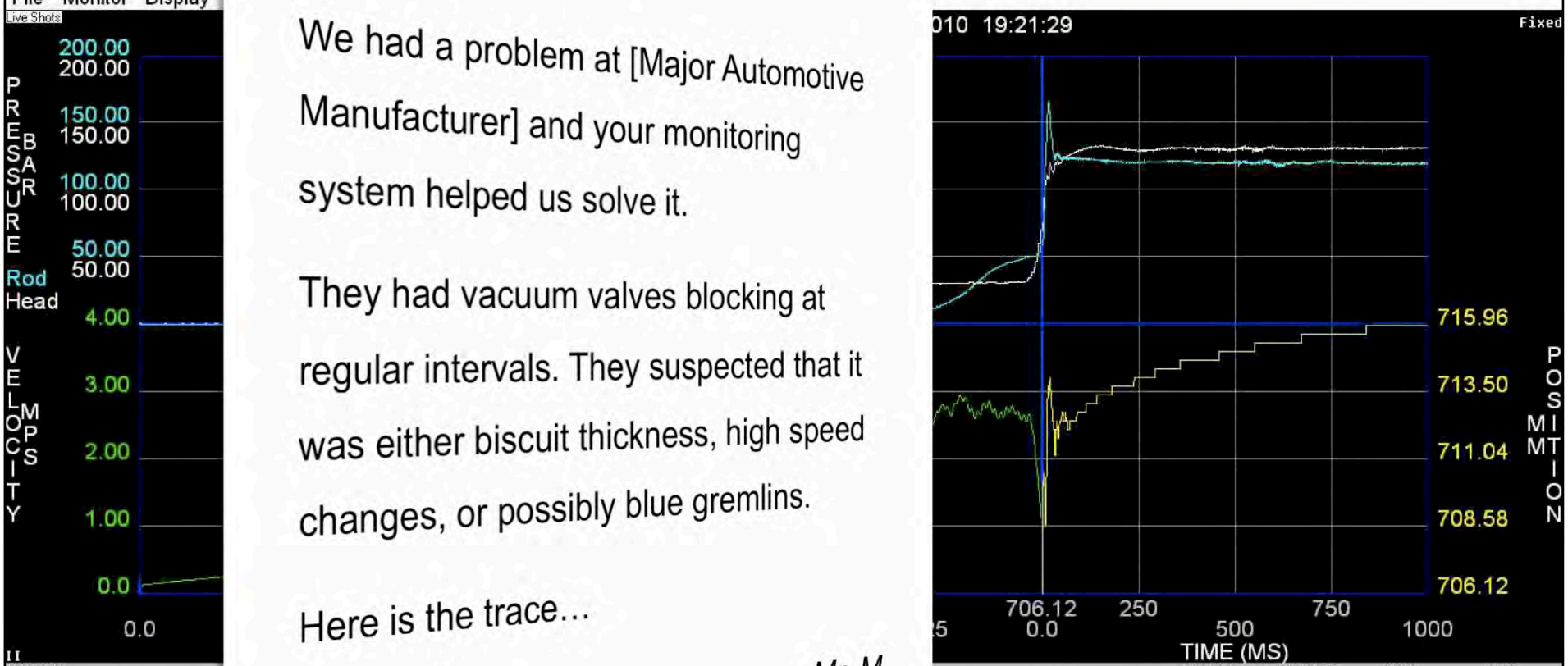
Jack,

We had a problem at [Major Automotive Manufacturer] and your monitoring system helped us solve it.

They had vacuum valves blocking at regular intervals. They suspected that it was either biscuit thickness, high speed changes, or possibly blue gremlins.

Here is the trace…

- Mr. M



Parameter	Low Alarm	High Alarm	Value	Units
Biscuit Size	0.0	0.0	3.4303	MPS
Cycle Time	0.0	0.0	2.7248	MPS
Calc Start Fast Shot	0.0	0.0	70.213	KG/CM^2
Sleeve Full Velocity	0.0	0.0	68.59	MS

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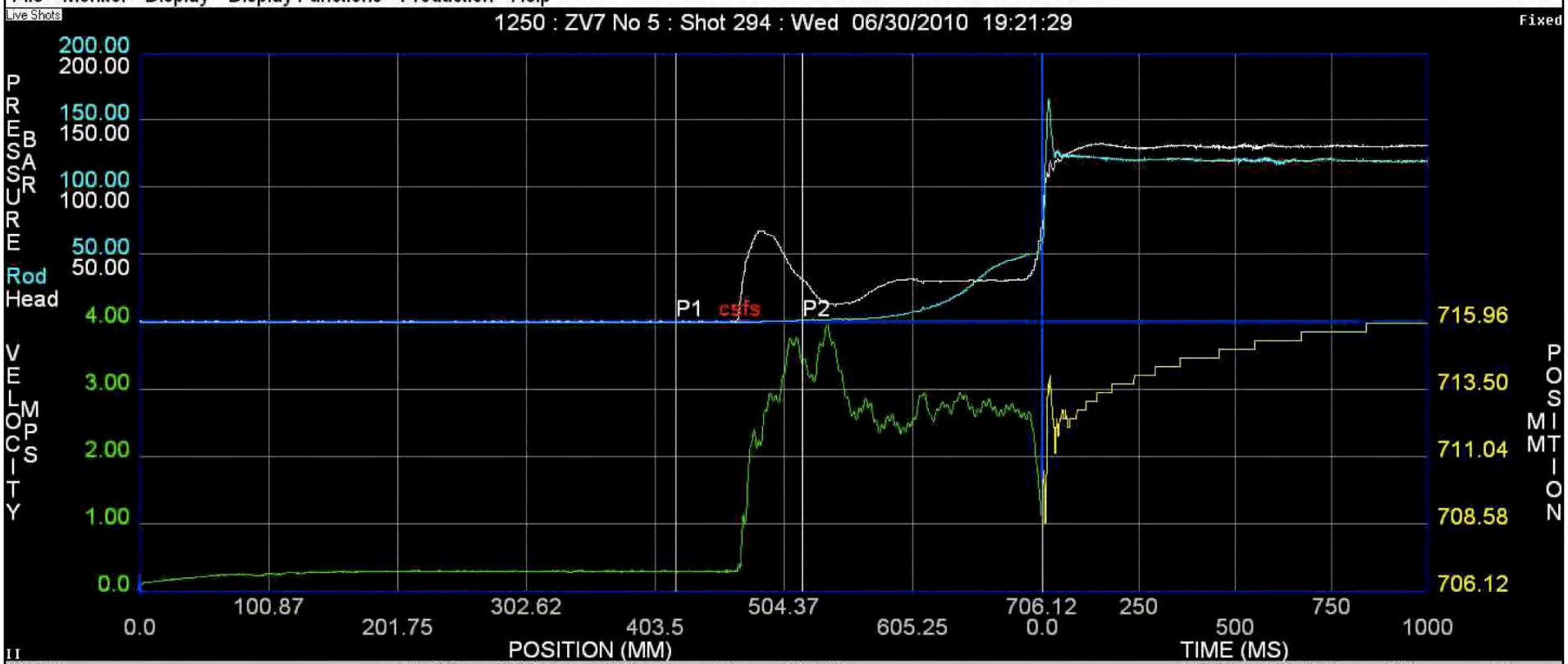
File Monitor Display Display Functions Production Help



Parameter	Low Alarm	High Alarm	Value	Units	Parameter	Low Alarm	High Alarm	Value	Units
Biscuit Size	0.0	0.0	84.036	MM	Runner Full Velocity	0.0	0.0	3.4303	MPS
Cycle Time	0.0	0.0	89.184	SEC	Avg Fill Velocity	0.0	0.0	2.7248	MPS
Calc Start Fast Shot	0.0	0.0	470.84	MM	Intens Pressure	0.0	0.0	70.213	KG/CM^2
Sleeve Full Velocity	0.0	0.0	0.29813	MPS	Fill Time	0.0	0.0	68.59	MS

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… We right clicked on the screen and chose "Trends". I checked the usual suspects – the slow and high speed shot… as you can see we were getting sudden jumps.

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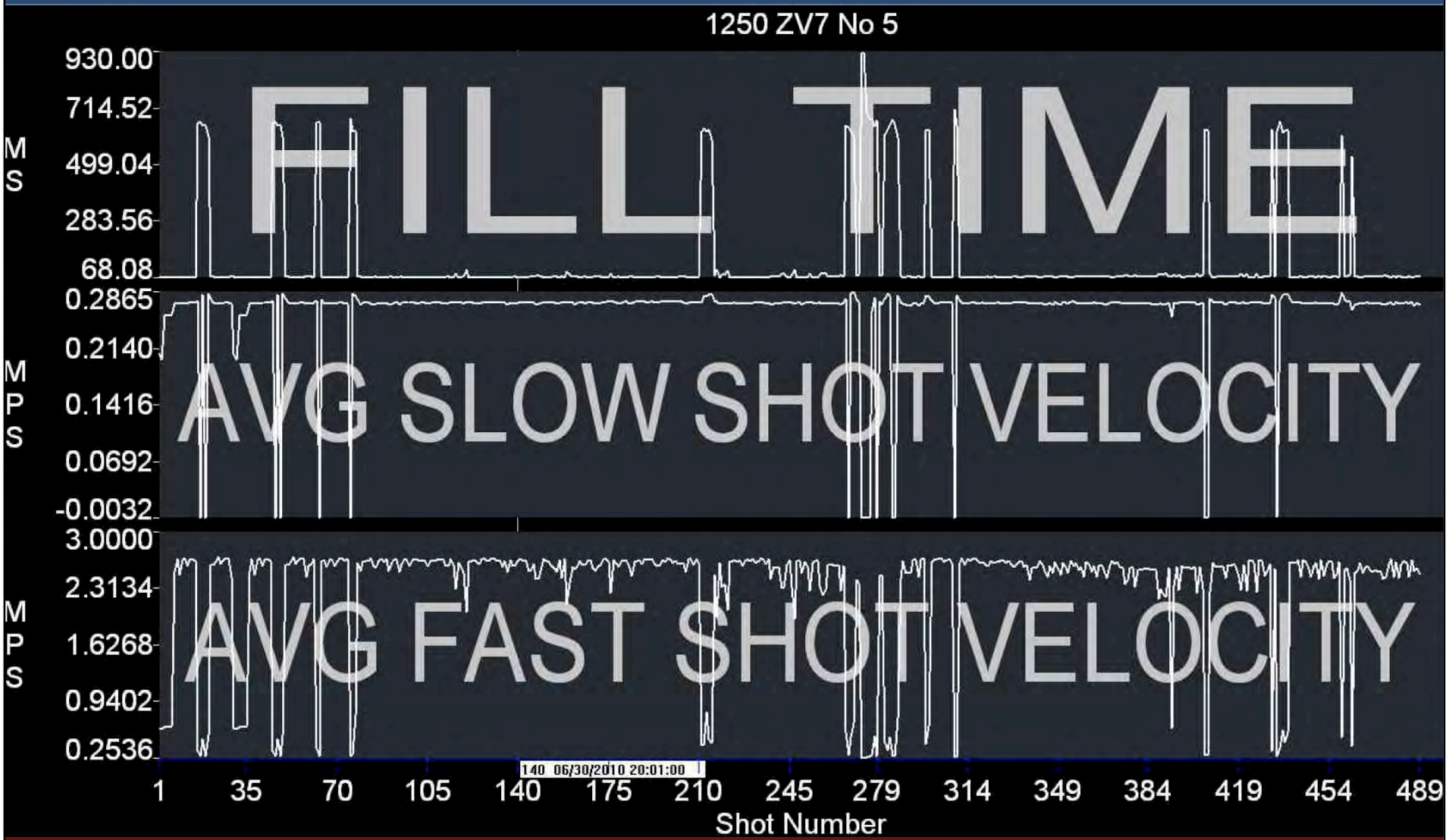

… by comparing this to the cycle time record we were able to determine that they they had a breakdown at the same time they had the jumps.

These were determined to be times they had to clean the die and filled vacuum valves.

The intensification data proved very telling…


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File Monitor Display Display Functions Production Help
1250 ZV7 No 5
CYCLE TIME
BISCUIT SIZE
INTENS SQUEEZE DISTANCE
SEC
MM
MM
5200.0
3920.8
2641.5
1362.3
83.1
89.569
170.00
109.85
49.71
-10.44
-70.59
78.639
20.000
15.000
10.000
5.000
0.000
13.653
94 06/30/2010 18:52:16
1 35 70 105 140 175 210 245 279 314 349 384 419 454 489
Shot Number

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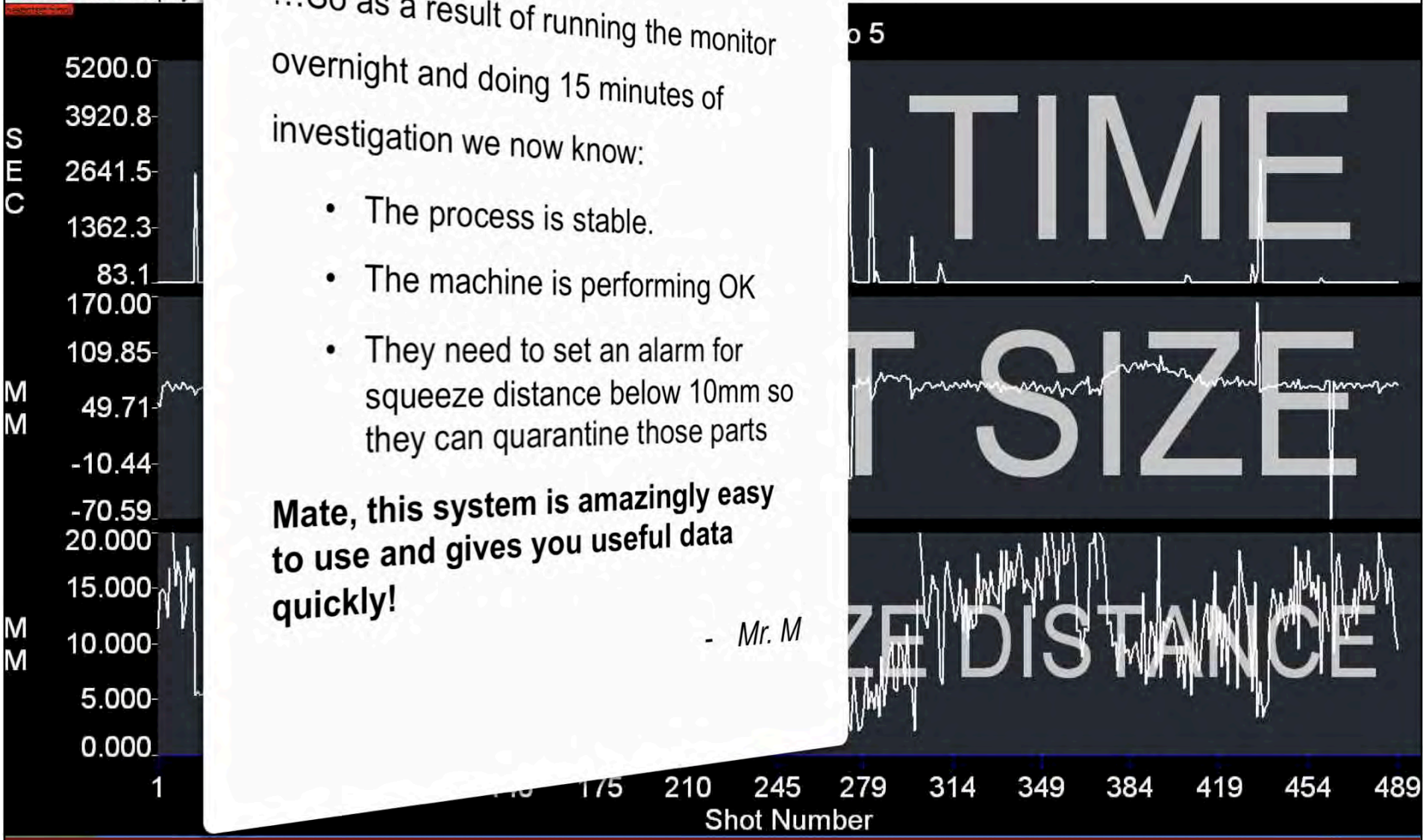
File Monitor Display

…So as a result of running the monitor overnight and doing 15 minutes of investigation we now know:

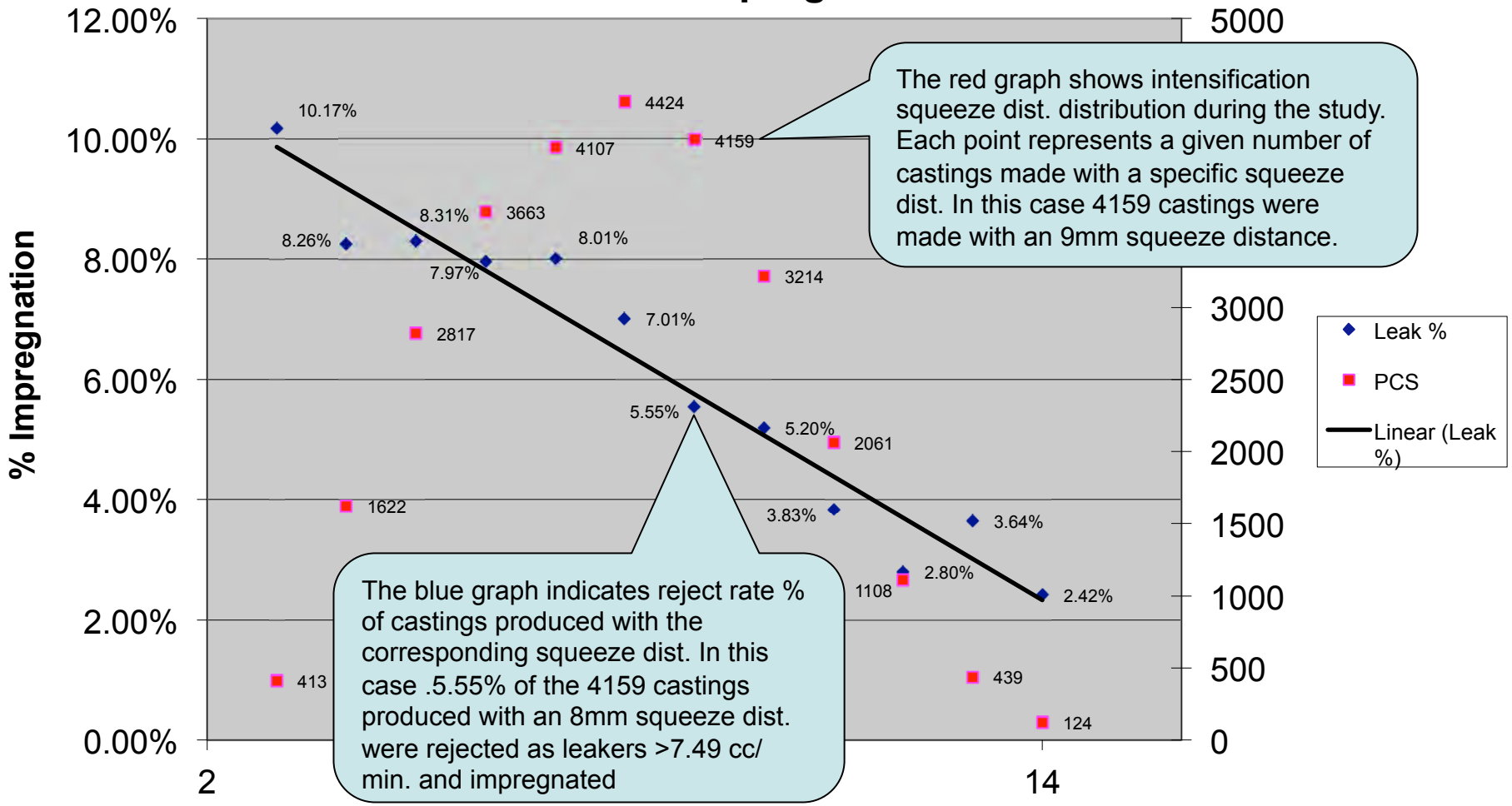
- The process is stable.
- The machine is performing OK
- They need to set an alarm for squeeze distance below 10mm so they can quarantine those parts

Mate, this system is amazingly easy to use and gives you useful data quickly!

- Mr. M



Intensification Squeeze Dist. VS Impregnation level Leak % (>7.49 cc/min) before C/M activity (28222 Data Points) 6.64% Overall impregnation rate



Intensification squeeze distance (X-Axis) Is the distance the shot piston moves during the high pressure phase of the casting injection cycle (post impact). This data shows the larger our squeeze dist. reading the lower our leak rate tends to be.

Results after counter measures

- $10k per year savings in impregnation costs
- + 6700 less scrapped parts
- Greater detail coming in case studies section

The preferred intensifier profile

- **Solidification begins** as soon as the metals stops moving.
- **Intensification must initiate** just prior to or as soon as the plunger stops.
- The effect of intensification is reported as "**Plunger squeeze distance**".
- To be effective, **the gate must remain open while the intensification pressure is applied**.
- This can only be assured when it is properly displayed. **A numerical total of plunger squeeze does not tell the whole story** such as when the die blows and all the plunger squeeze occurs instantly.
- **Plunger squeeze can be calculated**. See the following slide.

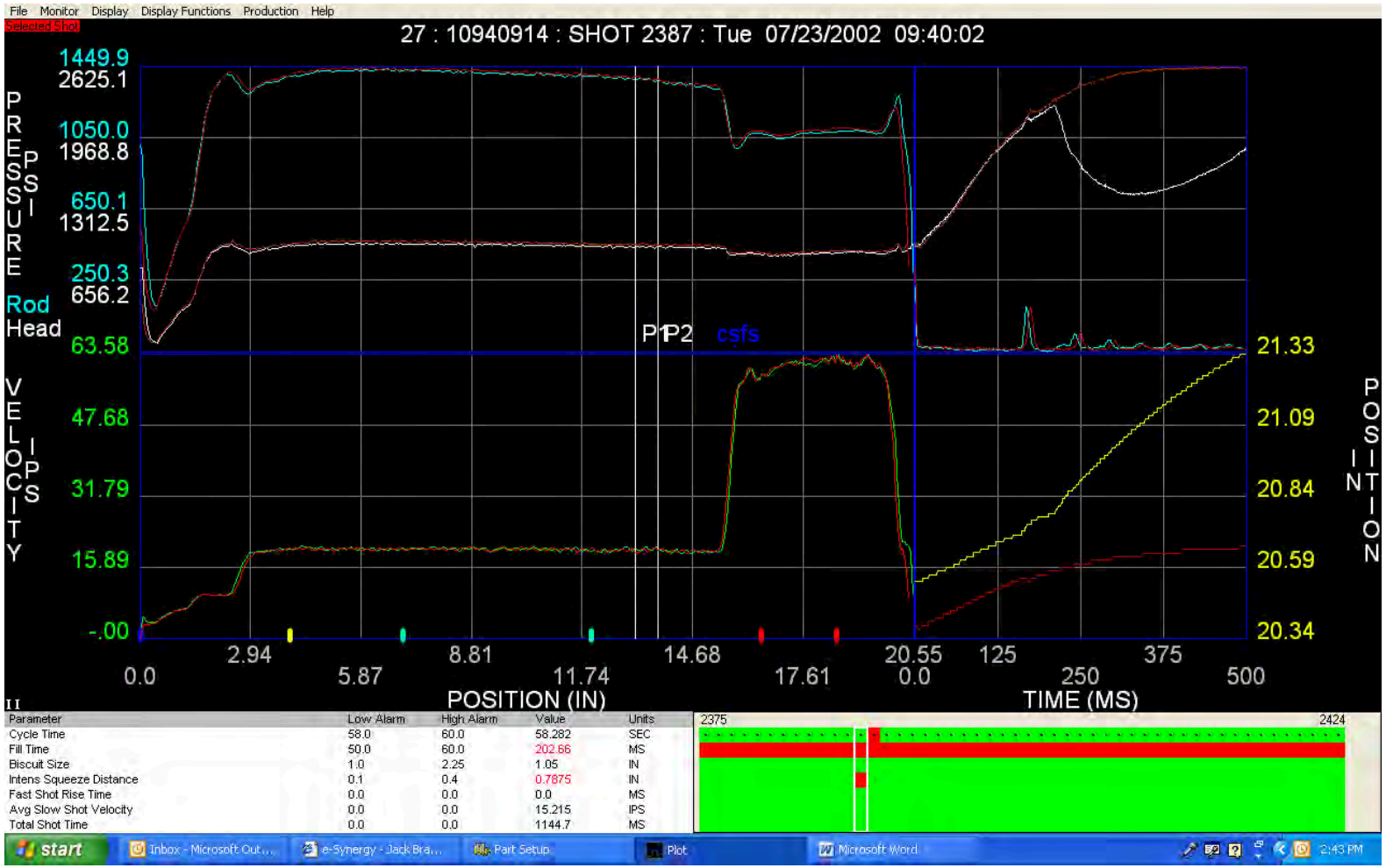
Calculating Plunger Squeeze

Shot wt.	19.260	Lbs.
Shot volume	192.6	cubic inches
Tip dia.	3.750	inches
Tip area	11.04	Sq. in.

0.3139 inches, plunger travel

Plunger travel during intensification to 100% eliminate porosity.
(Generally, the actual measured value will only be about 30 to 40% of the calculated maximum.)

Flashing


File Monitor Display Display Functions Production Help
Selected Shot
27 : 10940914 : SHOT 2387 : Tue 07/23/2002 09:40:02
PRESSURE PSI
1449.9
2625.1
1050.0
1968.8
650.1
1312.5
250.3
656.2
Rod Head
63.58
P1 P2 csfs
VELOCITY IPS
47.68
31.79
15.89
-.00
POSITION
21.33
21.09
20.84
20.59
20.34
0.0 2.94 5.87 8.81 11.74 14.68 17.61 20.55
POSITION (IN)
0.0 125 250 375 500
TIME (MS)
Parameter Low Alarm High Alarm Value Units
Cycle Time 58.0 60.0 58.282 SEC
Fill Time 50.0 60.0 202.66 MS
Biscuit Size 1.0 2.25 1.05 IN
Intens Squeeze Distance 0.1 0.4 0.7875 IN
Fast Shot Rise Time 0.0 0.0 0.0 MS
Avg Slow Shot Velocity 0.0 0.0 15.215 IPS
Total Shot Time 0.0 0.0 1144.7 MS
2375
2424
start
Inbox - Microsoft Out...
e-Synergy - Jack Bra...
Part Setup
Plot
Microsoft Word
2:43 PM

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Reduced Set-up Time

turn around jobs more quickly
less downtime
less start-up waste
greater consistency

Define shot in engineering units

Part Setup

Create New Part | Delete This Part | Copy to Existing Parts | Copy to Other Machines | Calculator

Machine: E20

Part: 150cl, 250IPS, 6step, 81205, NEWPART, ramp, VISITRAK

Basic | Advanced | Parameters | Positions | Marks | Channels | Shot Control | Presure Control | Setup

	Accel	Velocity	Ending Pos.	Vacuum Wait	Low Impact	Low Impact From Input
1.	16	80	17			
2.		250	25.5		5%	
3.						
4.						
5.						
6.						

Velocity Loop Gain: 375.0

Limit Switch Positions		Wire
POUR HOLE COVER	22	29
CLOSE VACUUM		30
CHECK VACUUM		31
INTENSIFICATION		32

Break Settings

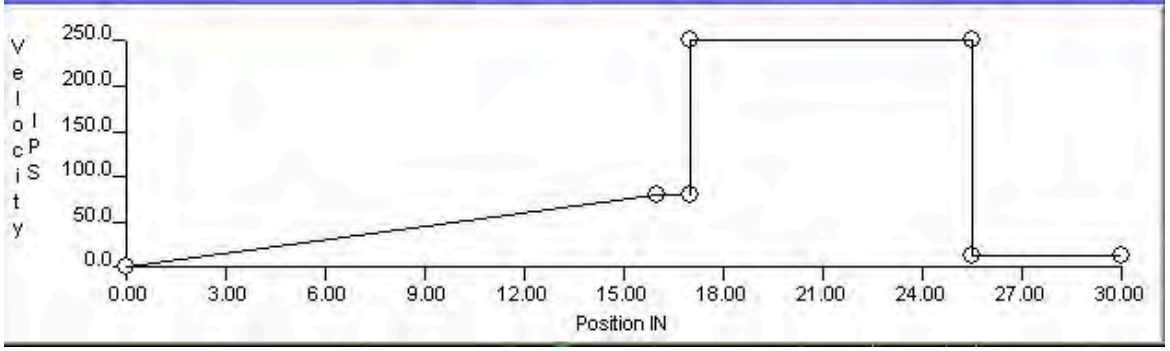
	Velocity	Gain
1	300.0	1.0
2	300.0	1.0
3	300.0	1.0

FollowThru Stop Pos: 100.0

Warmup Shot: Enable | if Wire | is | Off

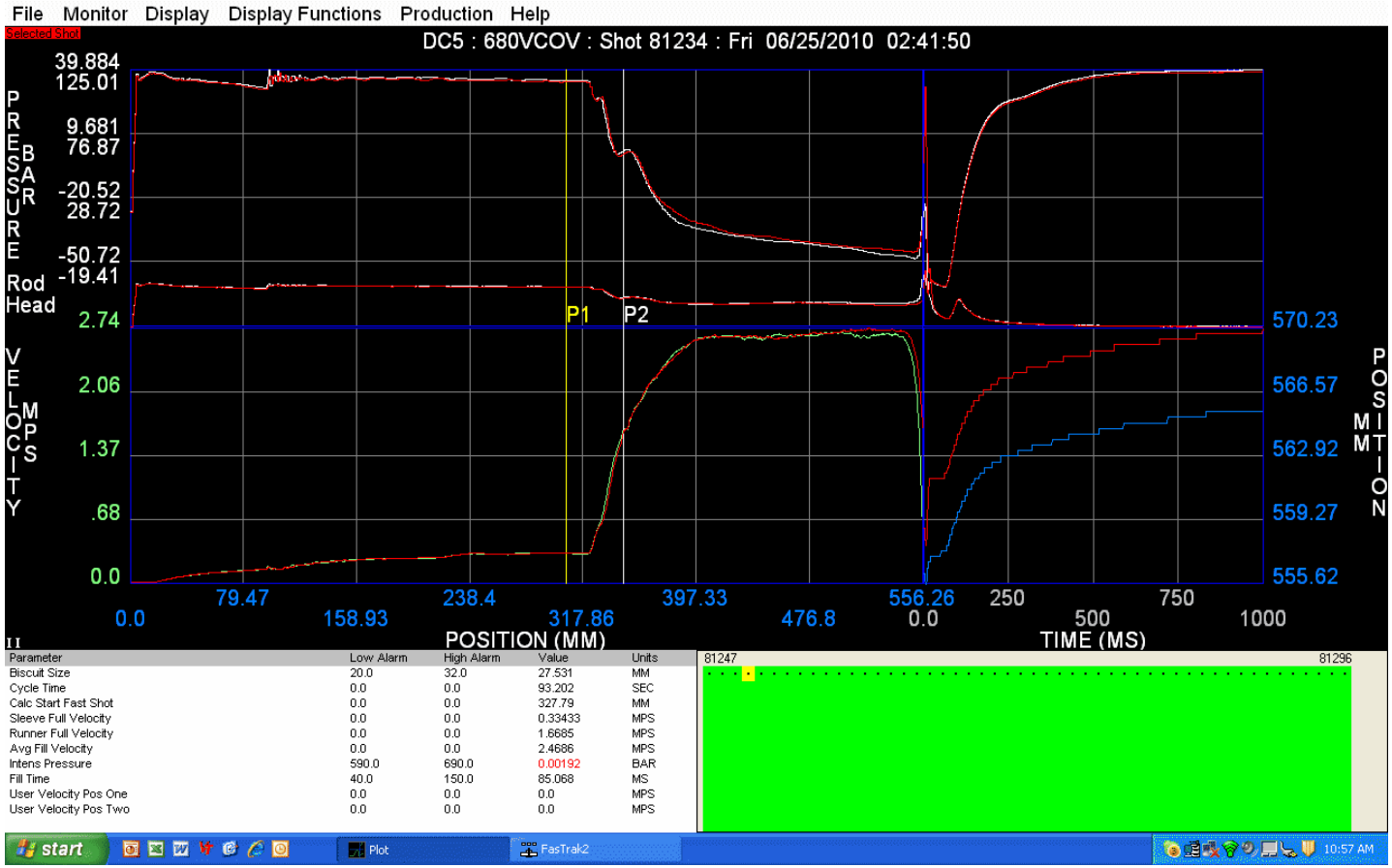
MS-DOS

F10: Change Focus | This is the Current Part | Save Changes | Reload Saved Setup | Print



Precision shot control and recall for future set-ups

Master Profile Overlay



Monitor and compare shots to master profile

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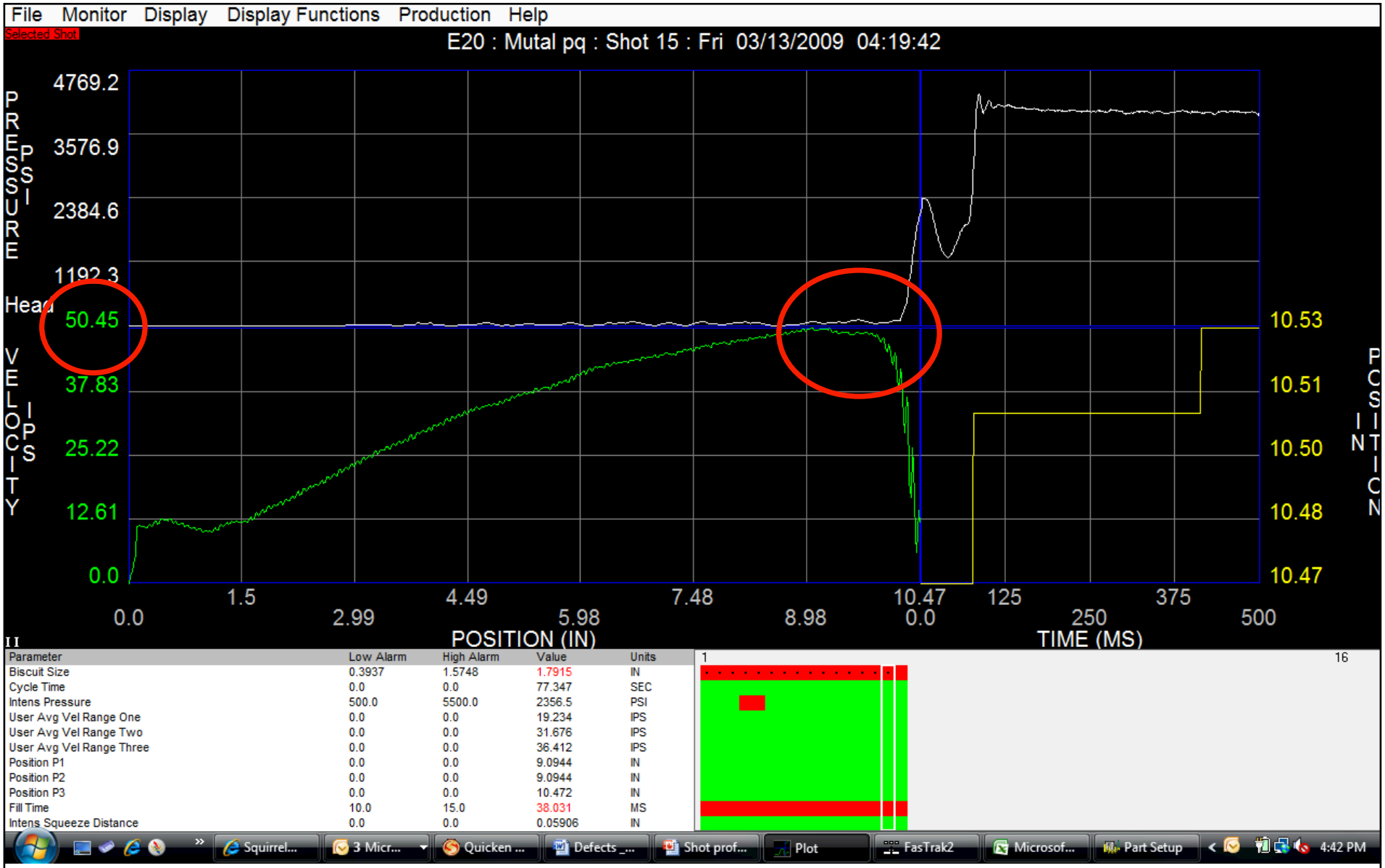
Document Machine Capabilities

run the right part on the right machine
less scrap
greater OEE

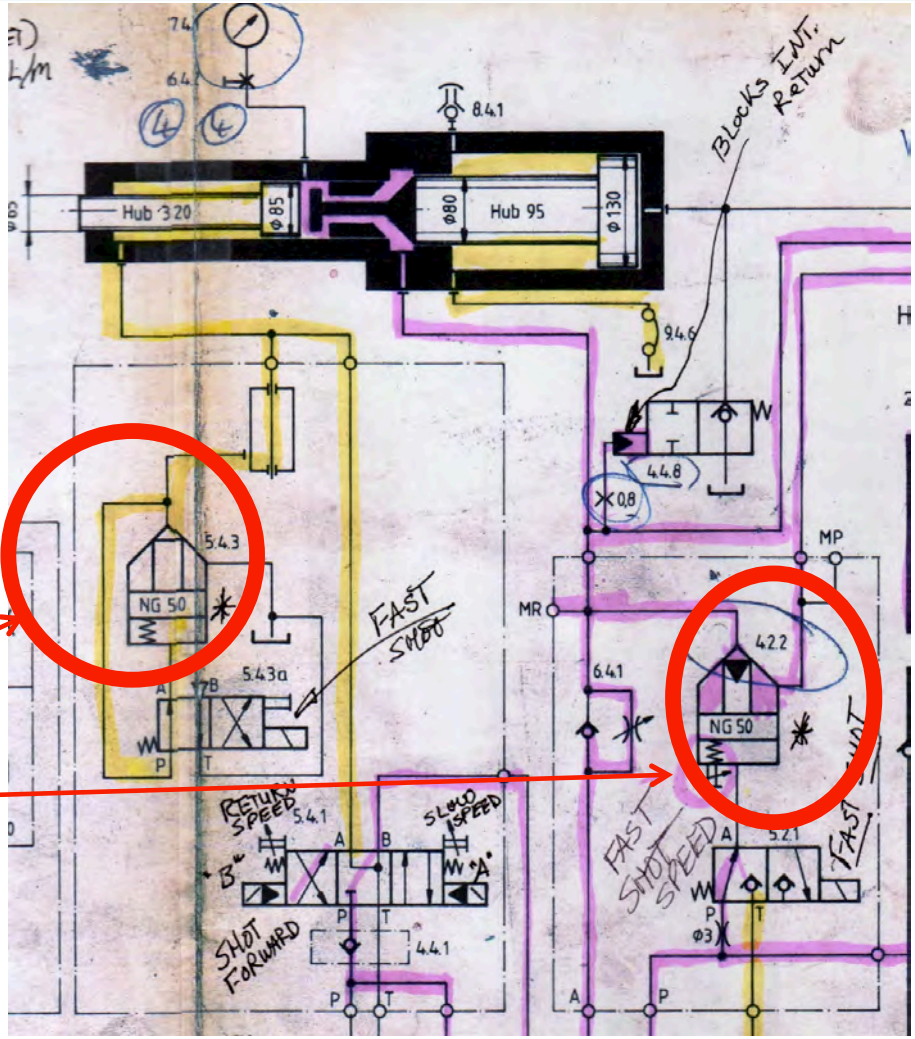
Document Machine Capabilities - Before

- 160-ton cold chamber machine.
- As delivered maximum capability was only **50 IPS, (1.27 MPS)**, **not 196 IPS (5 MPS)** as specified.
- Head side pressure is low until impact.
  - This confirms no back pressure on the rod side.
  - Restriction is on the head side.



Before, Fast Shot valve 5 turns open Maximum capability.

160-ton Cold Chamber



No orifices are shown in either cartridge valve.

Tests

- No orifice is shown in the schematic.
- Disassembled the head side fast shot cartridge valve cover to inspect for restriction.
  - Found a 0.8mm orifice in valve #4.22.
  - Removed and retested the maximum fast shot.

5.3 MPS After, Orifice Removed: Fast Shot valve 5 turns open

After

- Maximum Fast Shot is **now 215 IPS, (5.5 MPS)**
- Slight pressure build up during the peak of the fast shot indicates some back pressure is beginning to develop on the rod side.

PQ^2 explained

PQ^2 EA™

MACHINE PROCESS SETTINGS

Job Title:	Frech 580
Hydraulic Pressure (psi):	2320
Back Pressure (psi):	0
Cylinder Diameter (in):	4.133858268
Plunger Diameter (in):	2.362204724
Tailrod Diameter (in.):	0
Plungerod Diameter (in.):	0
Shot Speed (%):	100
Machine Description:	580

BASIC MACHINE DATA

Dry Shot Velocity (in/s):	393
Hyd. Pres. @ dry shot (psi):	2320

METAL AND DIE DATA

ALLOY	MAGNESIU
# of cavities:	1
Total Weight (lbs):	1.23
cd value:	0.55
Minimum Gate area (in^2.):	0.403
Gate area incrament size (in):	0.403

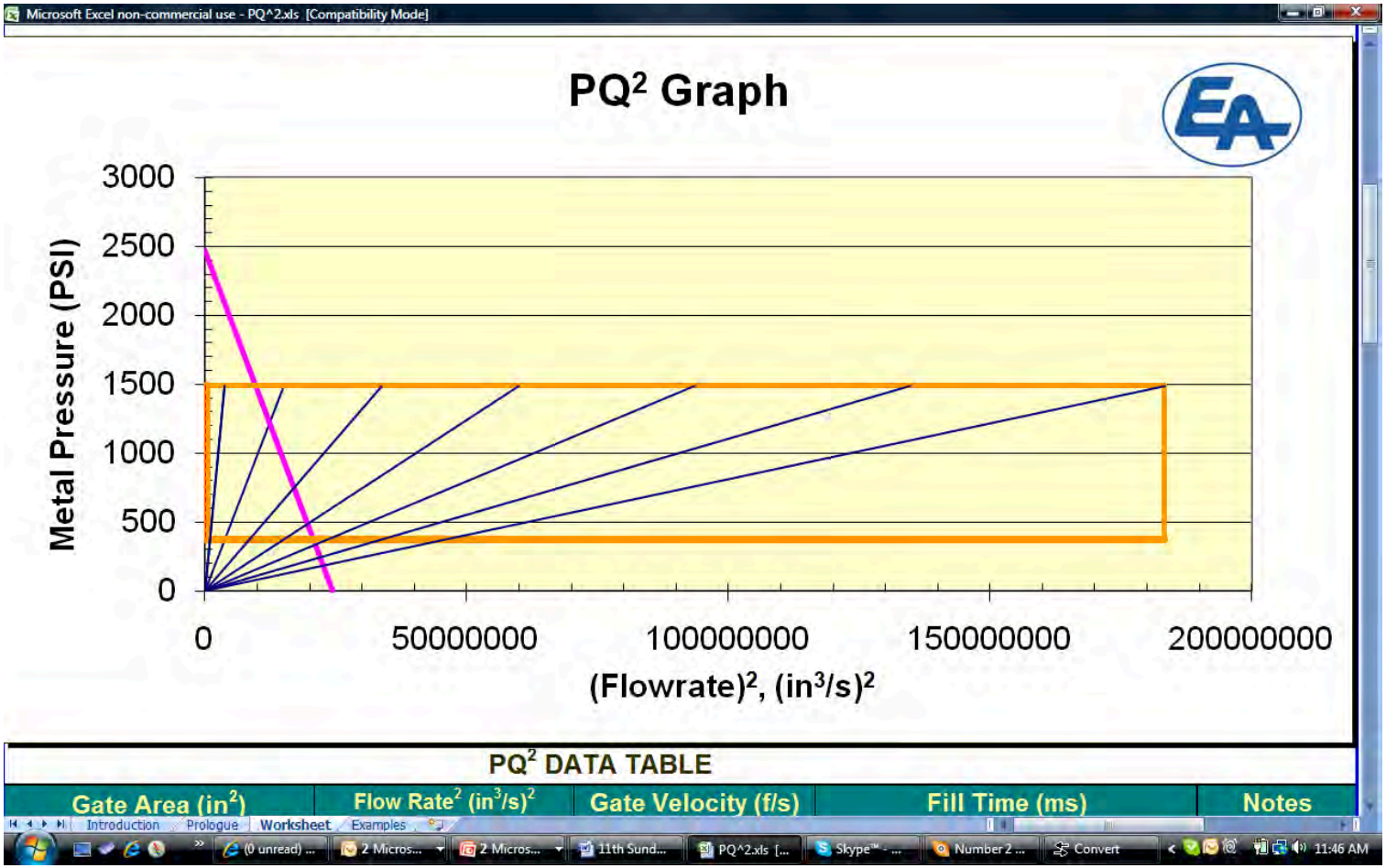
DATA OUTPUT

Max Metal Pressure (psi):	7105.00
Max Flow Rate (in^3/s):	1722.3
Max Flow Rate^2 (in^3/s)^2:	2966436.1
Act. Hydraulic Press. (psi):	2320
Density (lbs/in^3):	0.06

Table 1.

Compliments of Eastern Alloys. www.ea.com

PQ^2 explained



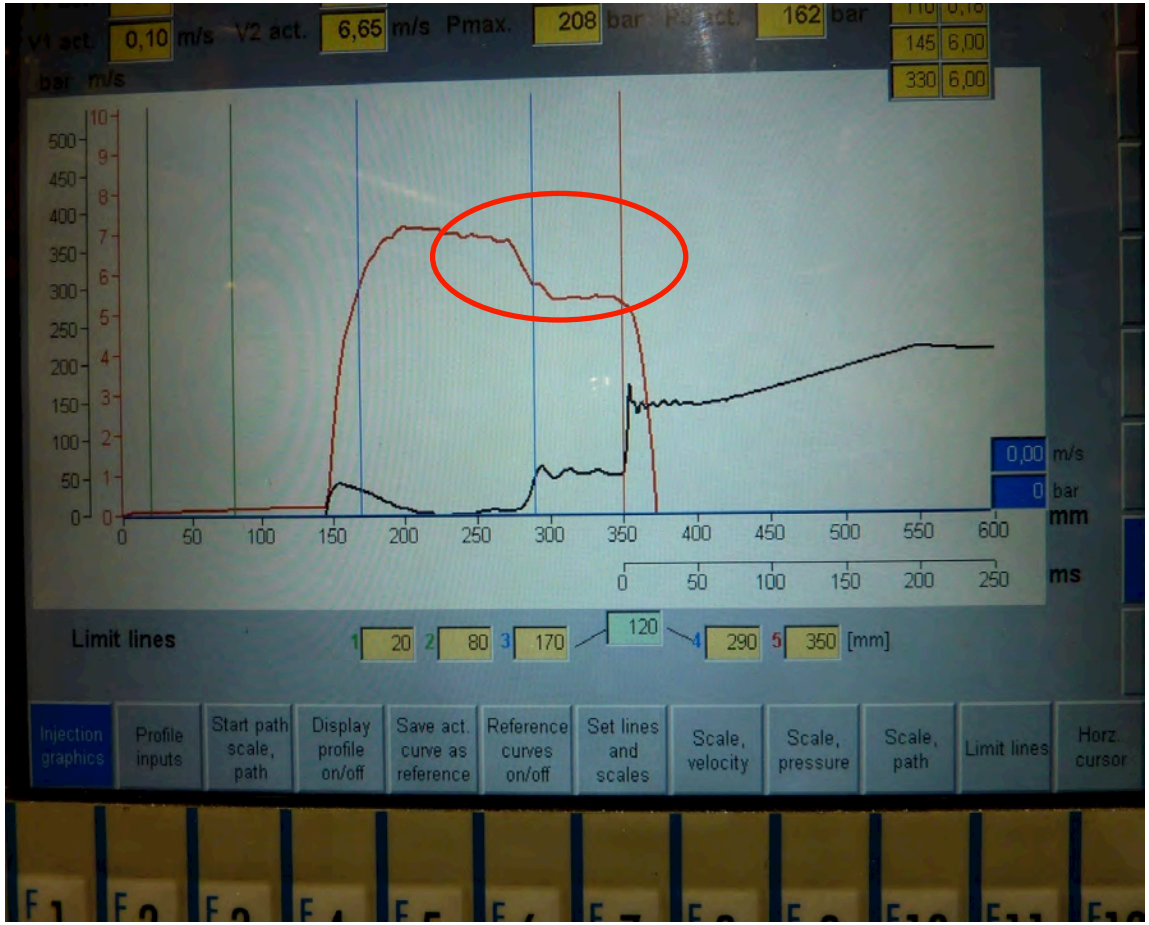
Graph 1:

Compliments of Eastern Alloys. www.ea.com

PQ^2 Explanation

- The above examples illustrate the maximum capability calculated for the shot profile for machine in the following slide.
- It correctly calculated that the fast shot would stabilize at 5.0 MPS due to the restriction of the gate.

PQ^2 at work


V1 act. 0,10 m/s V2 act. 6,65 m/s Pmax. 208 bar 162 bar
145 6,00
330 6,00
bar m/s
0,00 m/s
0 bar
mm
ms
Limit lines
1 20 2 80 3 170 120 4 290 5 350 [mm]
Injection graphics
Profile inputs
Start path scale, path
Display profile on/off
Save act. curve as reference
Reference curves on/off
Set lines and scales
Scale, velocity
Scale, pressure
Scale, path
Limit lines
Horz. cursor

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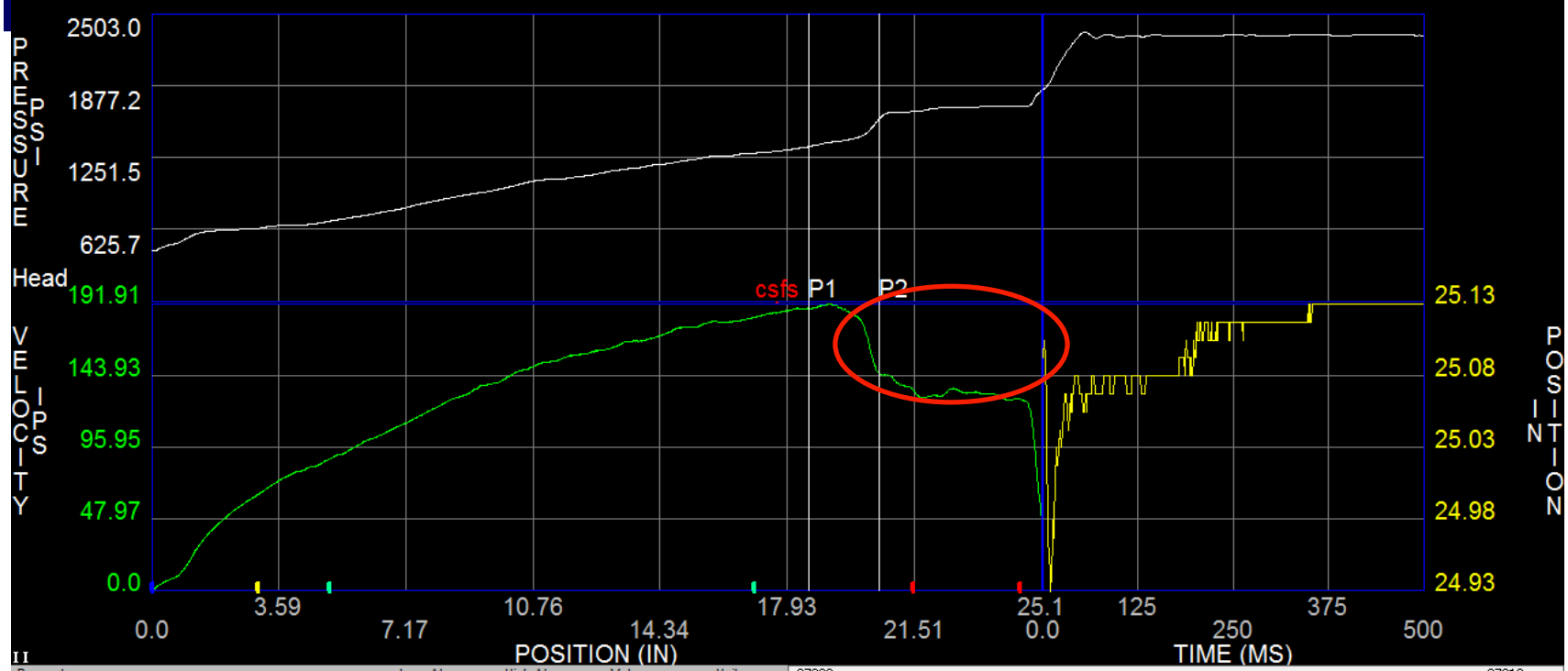
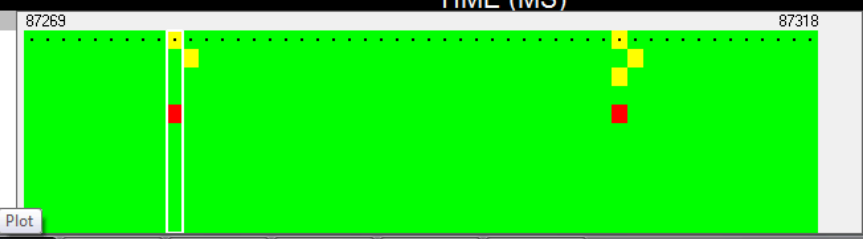
File Monitor Display Display Functions Production Help

Selected Shot

7 : 51015TIP : Shot 87278 : Thr 06/26/2008 07:45:08



Parameter	Low Alarm	High Alarm	Value	Units
Biscuit Size	0.7	1.4	1.2625	IN
Cycle Time	52.5	57.0	54.867	SEC
Intens Pressure	2200.0	2500.0	2317.5	PSI
User Avg Vel Range One	0.0	13.0	11.754	IPS
User Avg Vel Range Two	24.0	30.0	139.38	IPS
User Avg Vel Range Three	126.0	155.0	131.06	IPS
Position P1	0.0	0.0	18.552	IN
Position P2	0.0	0.0	20.542	IN
Position P3	0.0	0.0	25.112	IN
Fill Time	20.0	45.0	35.722	MS
Intens Squeeze Distance	0.0	0.0	0.025	IN



Squir... Cont... Quic... Defe... Shot ... Plot FasT... Micr... Part ... Con... Fan ... 12:34 PM

PQ^2 (Continued)

- Both of the previous slides are examples of the gate limiting the fast shot velocity.
- **When the metal reaches the gate, the fast shot decelerates to "equilibrium".** That is when the force and resistance are balanced.

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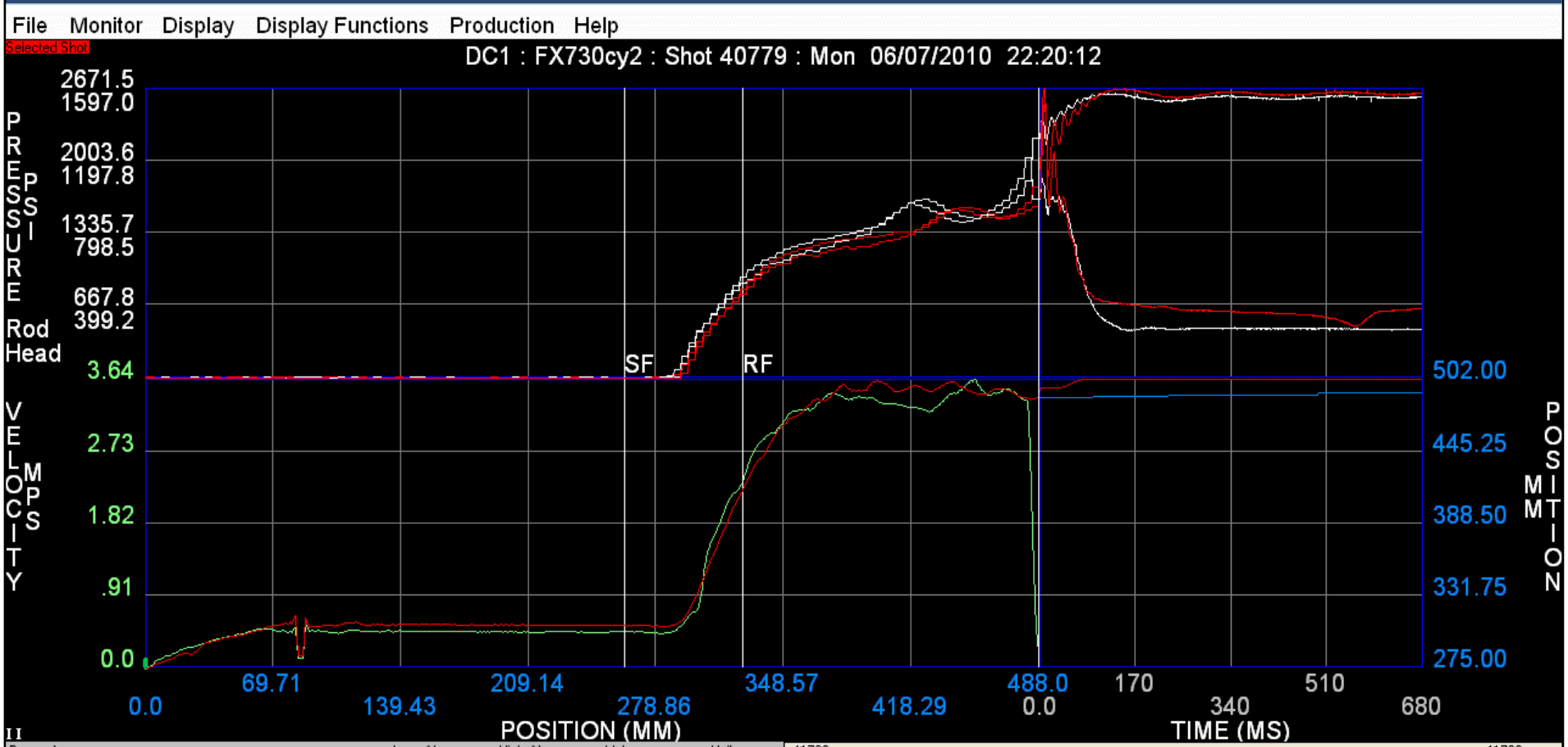
Evaluate Process Repeatability

less scrap
happy customers
greater OEE

BEFORE

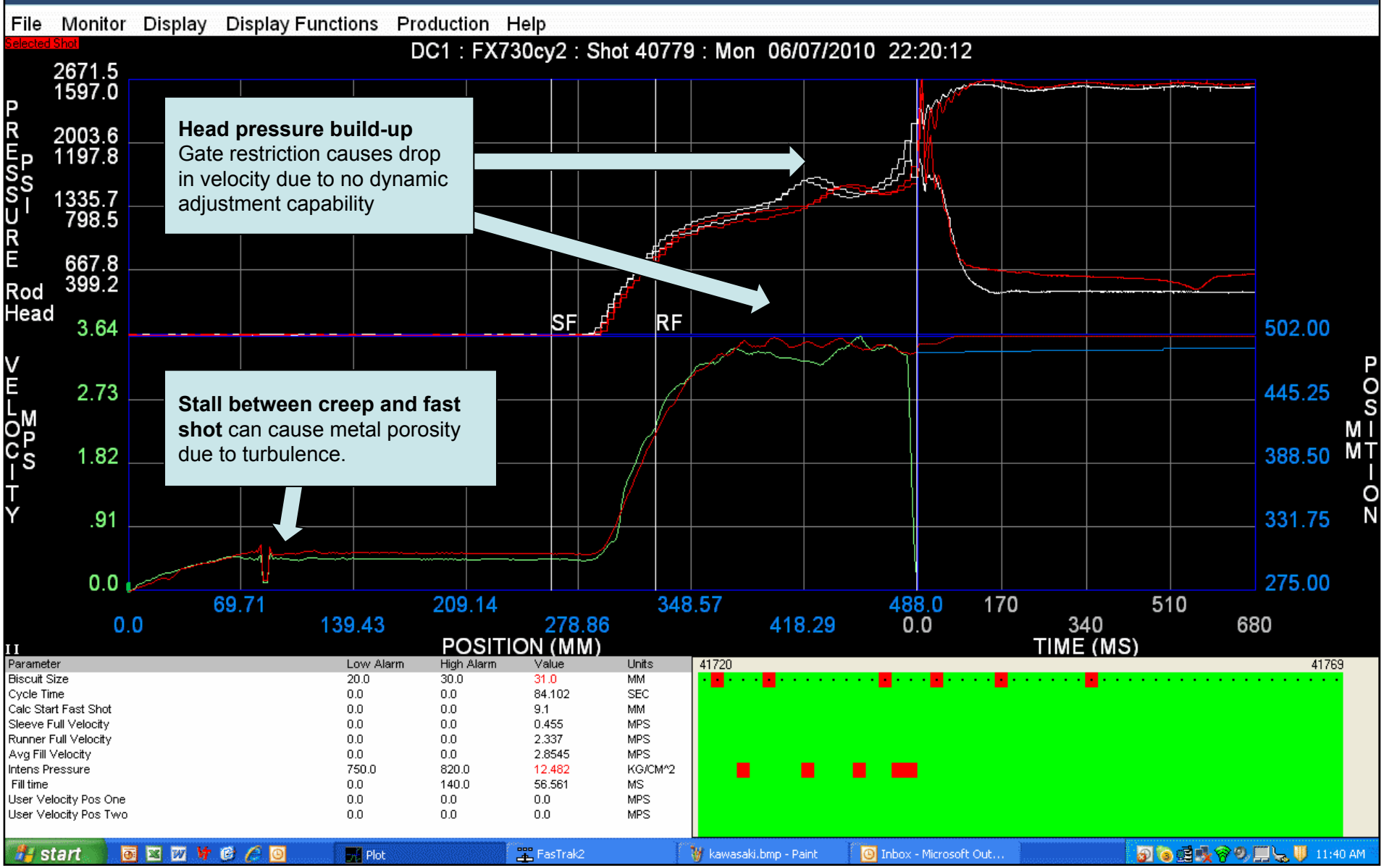
UBE Shot-end and
Conventional UBE controls
on 800-ton machine

UBE Shot-end + Conventional Control - Single Shot



Parameter	Low Alarm	High Alarm	Value	Units
Biscuit Size	20.0	30.0	31.0	MM
Cycle Time	0.0	0.0	84.102	SEC
Calc Start Fast Shot	0.0	0.0	9.1	MM
Sleeve Full Velocity	0.0	0.0	0.455	MPS
Runner Full Velocity	0.0	0.0	2.337	MPS
Avg Fill Velocity	0.0	0.0	2.8545	MPS
Intens Pressure	750.0	820.0	12.482	KG/CM^2
Fill time	0.0	140.0	56.561	MS
User Velocity Pos One	0.0	0.0	0.0	MPS
User Velocity Pos Two	0.0	0.0	0.0	MPS

UBE Shot-end + Conventional Control - Single Shot



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Biscuit Size	20.0	30.0	31.0	MM
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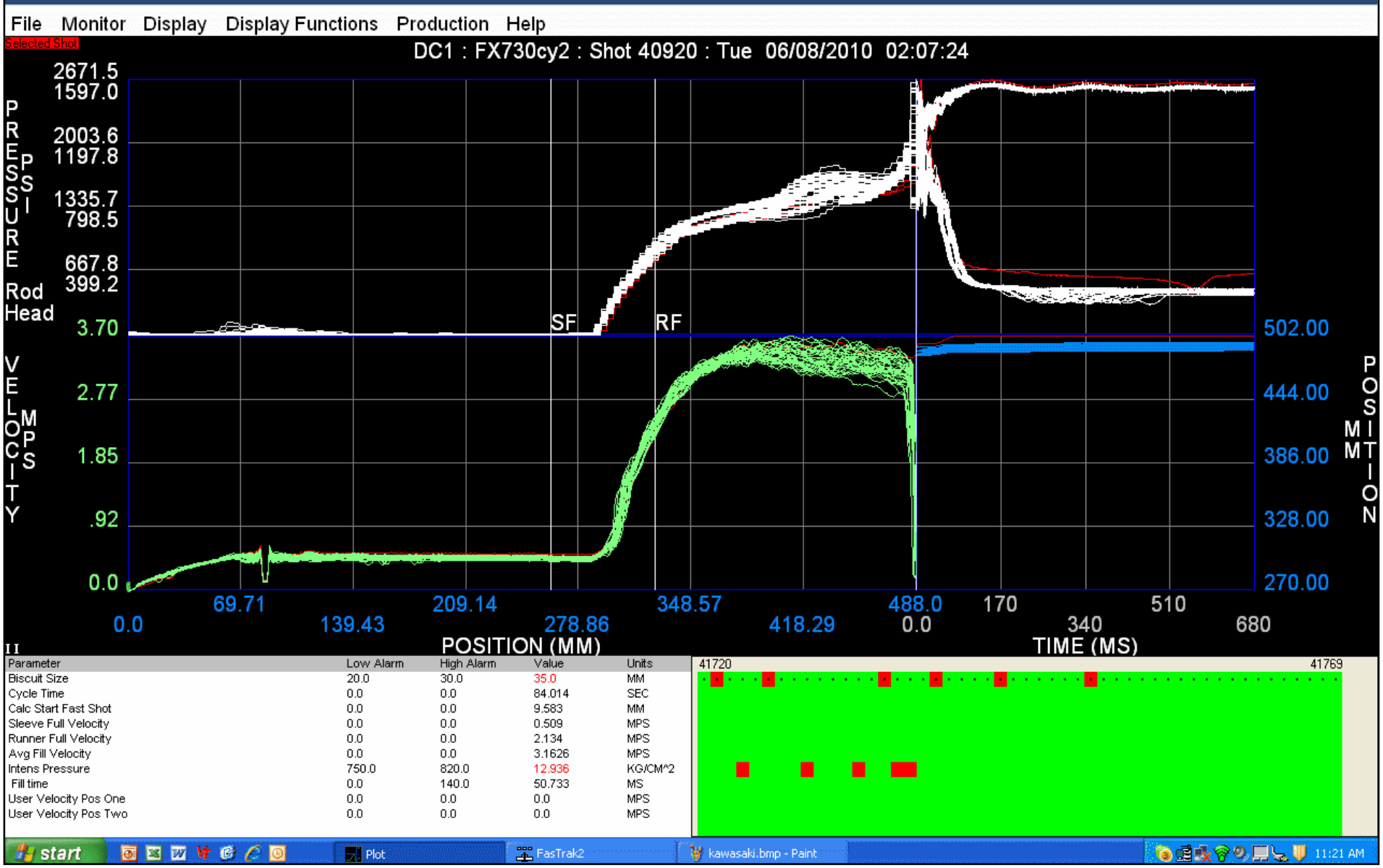
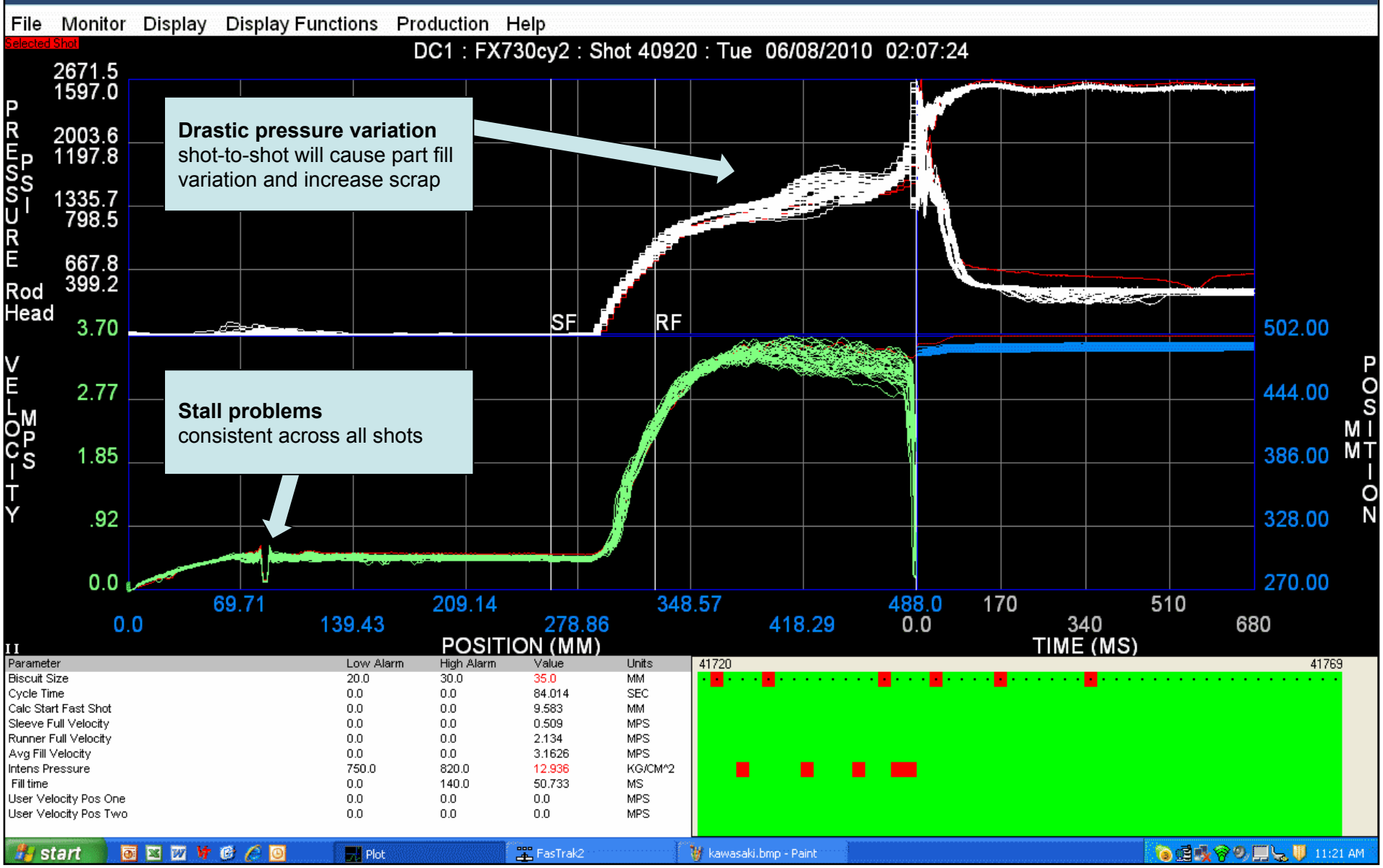
User Velocity Pos Two	0.0	0.0	0.0	MPS

UBE Shot-end + Conventional Control – Multi-Shot Overlay



UBE Shot-end + Conventional Control – Multi-Shot Overlay



AFTER

New retro-fit shot-end
and integrated controls
on same model 800-ton machine

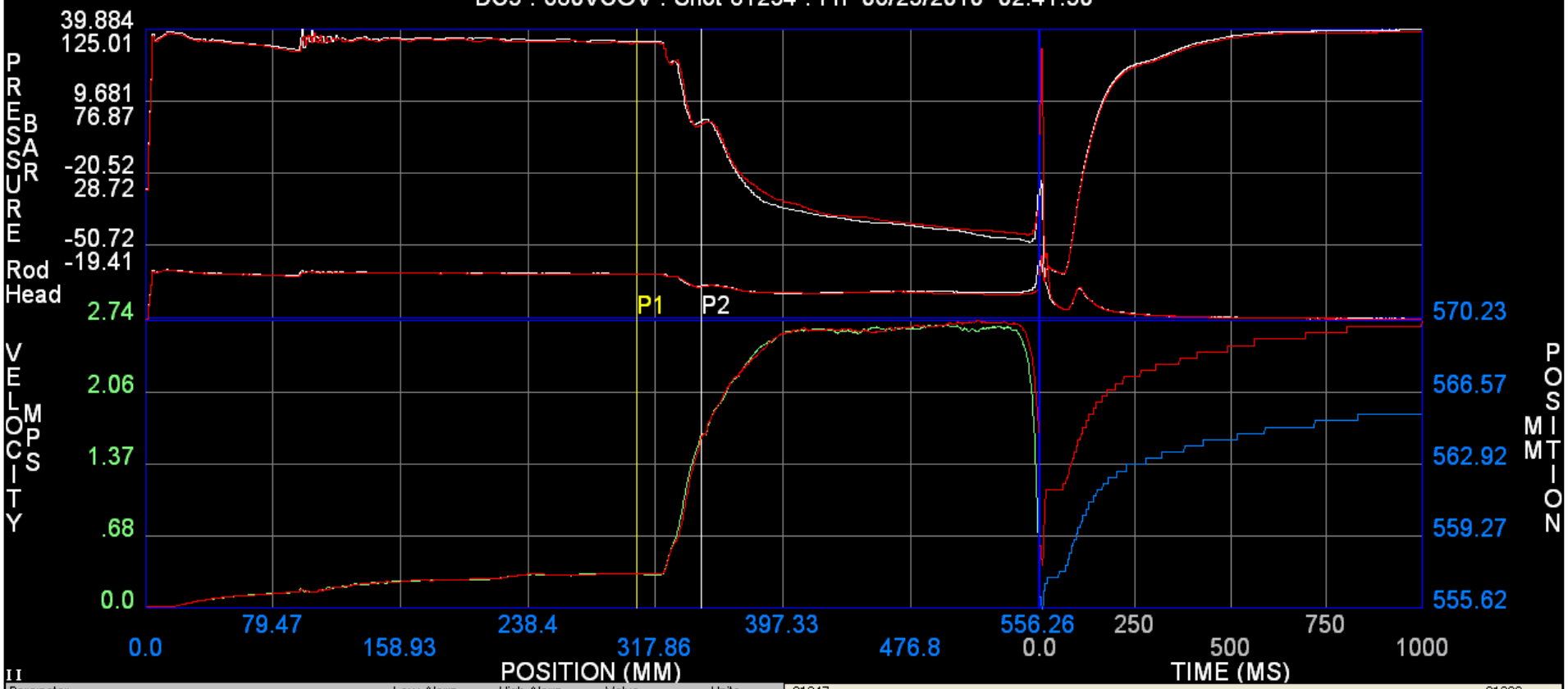
DCP Shot-end + Sure-Trak2 - Single Shot

Visi-Trak®
SENSE, MONITOR, CONTROL

File Monitor Display Display Functions Production Help

Selected Shot

DC5 : 680VCOV : Shot 81234 : Fri 06/25/2010 02:41:50

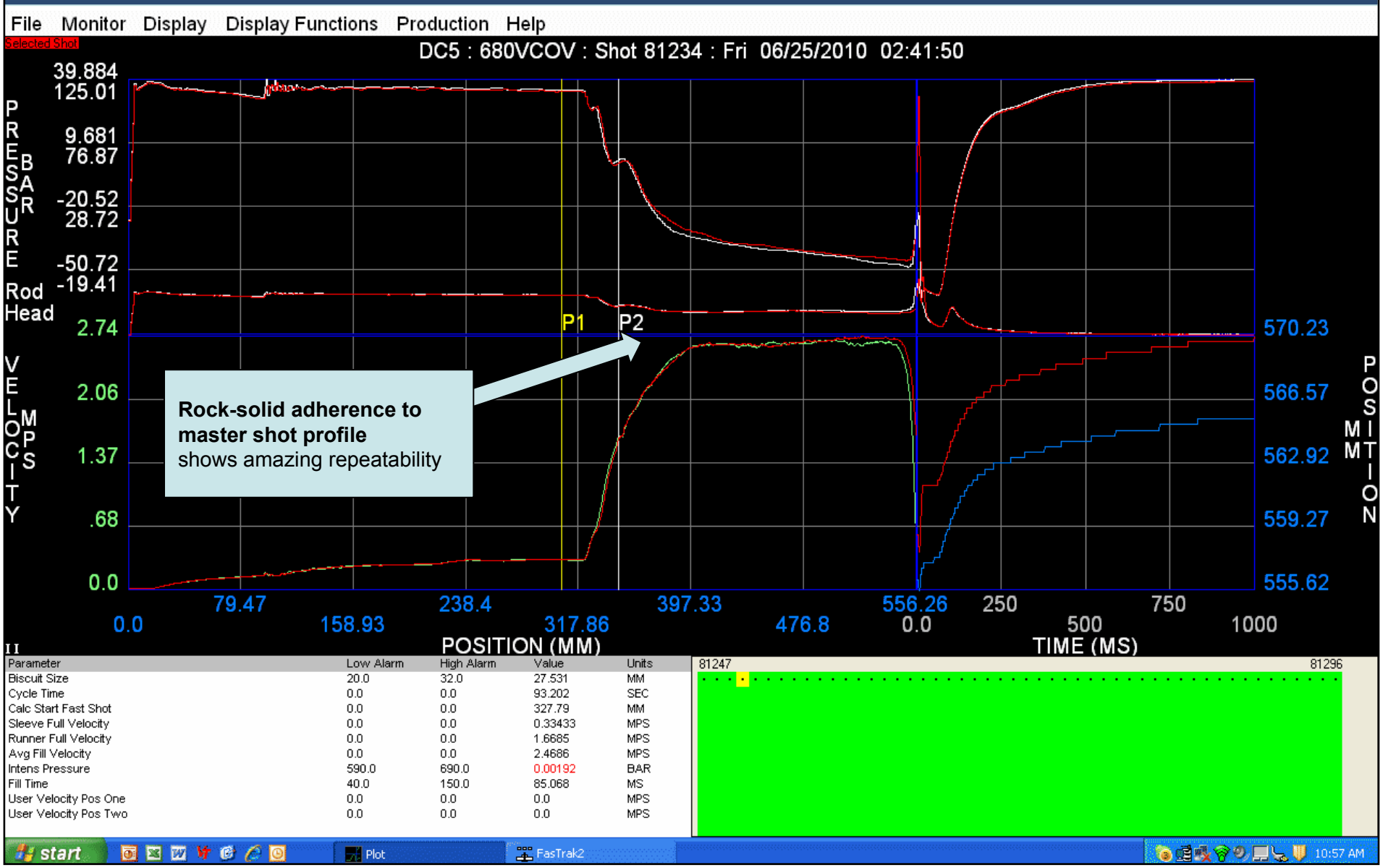


Parameter	Low Alarm	High Alarm	Value	Units
Biscuit Size	20.0	32.0	27.531	MM
Cycle Time	0.0	0.0	93.202	SEC
Calc Start Fast Shot	0.0	0.0	327.79	MM
Sleeve Full Velocity	0.0	0.0	0.33433	MPS
Runner Full Velocity	0.0	0.0	1.6685	MPS
Avg Fill Velocity	0.0	0.0	2.4686	MPS
Intens Pressure	590.0	690.0	0.00192	BAR
Fill Time	40.0	150.0	85.068	MS
User Velocity Pos One	0.0	0.0	0.0	MPS
User Velocity Pos Two	0.0	0.0	0.0	MPS

81247 81296

start Plot FasTrak2 10:57 AM

DCP Shot-end + Sure-Trak2 - Single Shot



DCP Shot-end + Sure-Trak2 Multi-Shot Overlay

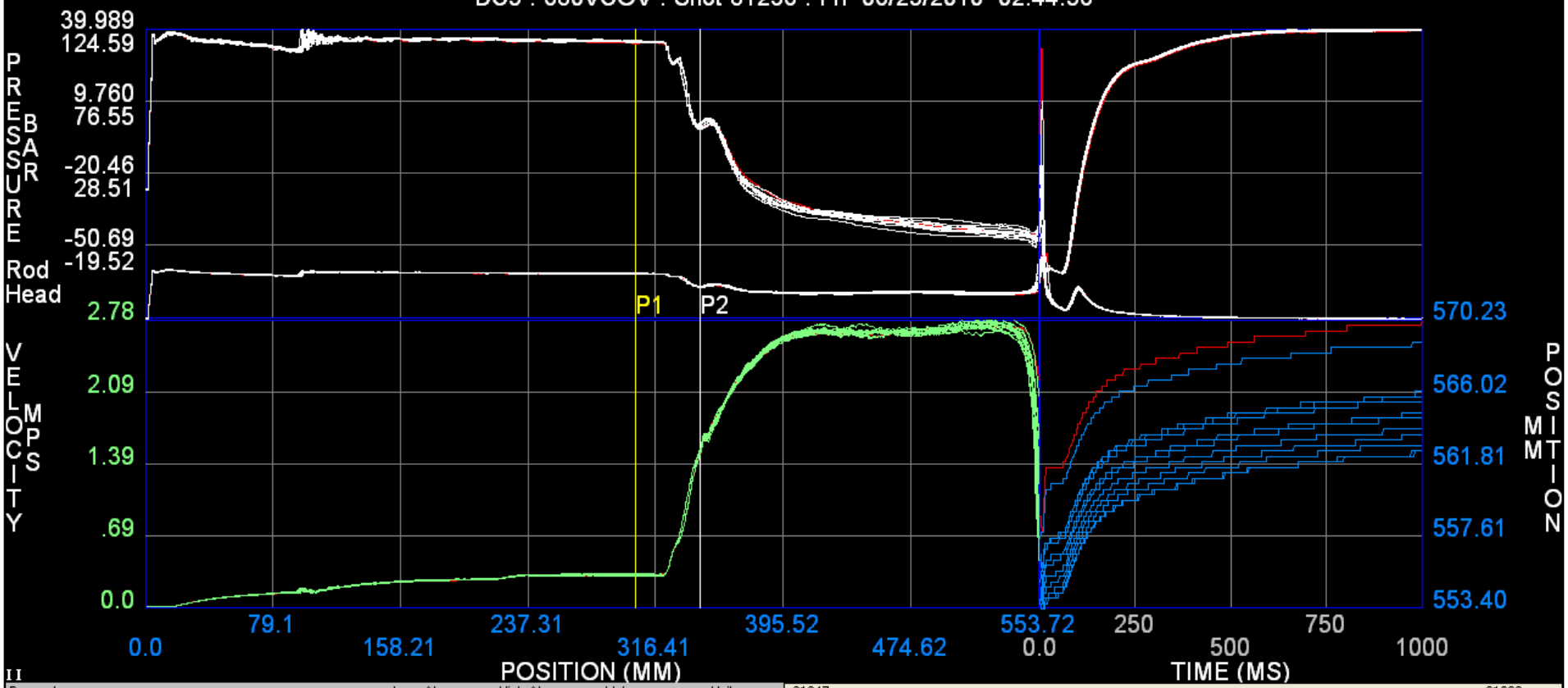
AUSTRALIAN DIE CASTING ASSOCIATION

Visi-Trak®
SENSE, MONITOR, CONTROL

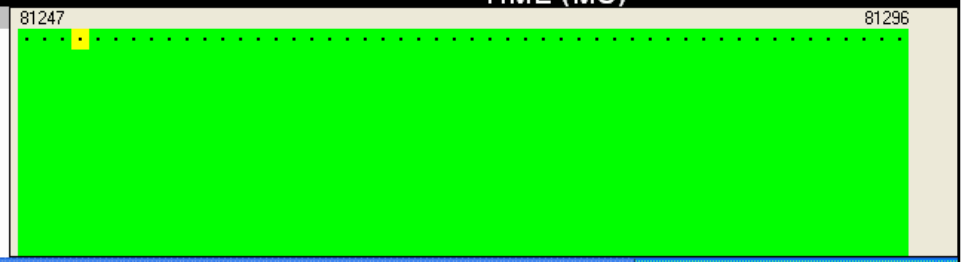
File Monitor Display Display Functions Production Help

Selected Shot

DC5 : 680VCOV : Shot 81236 : Fri 06/25/2010 02:44:56



Parameter	Low Alarm	High Alarm	Value	Units
Biscuit Size	20.0	32.0	24.039	MM
Cycle Time	0.0	0.0	93.387	SEC
Calc Start Fast Shot	0.0	0.0	327.65	MM
Sleeve Full Velocity	0.0	0.0	0.32353	MPS
Runner Full Velocity	0.0	0.0	1.6434	MPS
Avg Fill Velocity	0.0	0.0	2.5133	MPS
Intens Pressure	590.0	690.0	0.00188	BAR
Fill Time	40.0	150.0	83.431	MS
User Velocity Pos One	0.0	0.0	0.0	MPS
User Velocity Pos Two	0.0	0.0	0.0	MPS



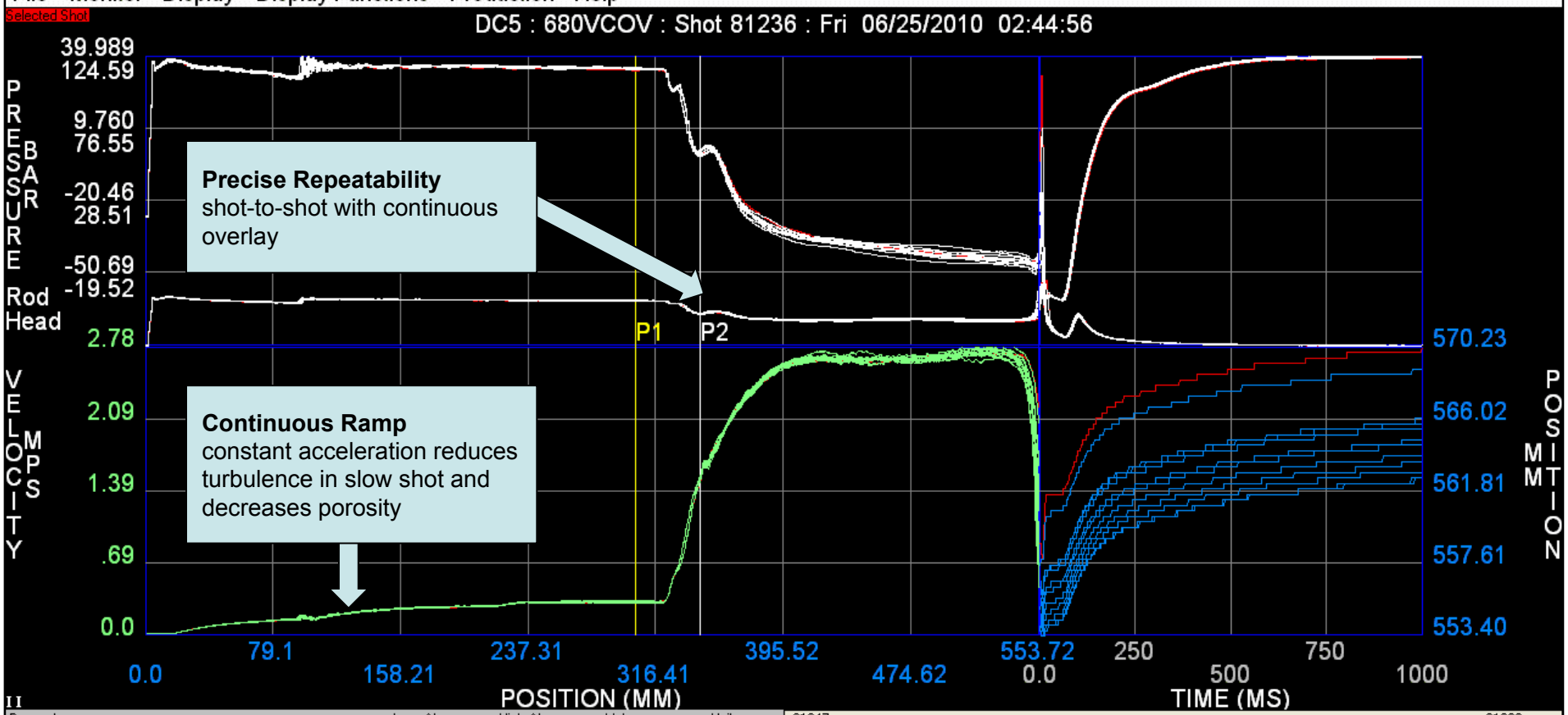
start Plot FasTrak2 kawasaki.bmp - Paint 11:30 AM

DCP Shot-end + Sure-Trak2 Multi-Shot Overlay

AUSTRALIAN DIE CASTING ASSOCIATION

Visi-Trak® SENSE, MONITOR, CONTROL

File Monitor Display Display Functions Production Help



Parameter	Low Alarm	High Alarm	Value	Units
Biscuit Size	20.0	32.0	24.039	MM
Cycle Time	0.0	0.0	93.387	SEC
Calc Start Fast Shot	0.0	0.0	327.65	MM
Sleeve Full Velocity	0.0	0.0	0.32353	MPS
Runner Full Velocity	0.0	0.0	1.6434	MPS
Avg Fill Velocity	0.0	0.0	2.5133	MPS
Intens Pressure	590.0	690.0	0.00188	BAR
Fill Time	40.0	150.0	83.431	MS
User Velocity Pos One	0.0	0.0	0.0	MPS
User Velocity Pos Two	0.0	0.0	0.0	MPS

81247 81296

start Plot FasTrak2 kawasaki.bmp - Paint 11:30 AM

AUSTRALIAN DIE CASTING ASSOCIATION

Visi-Trak®
SENSE, MONITOR, CONTROL

Process Automation In Action!

Squash Machine Problems

less downtime
less waste
longer tool life
greater OEE

Slow Intensifier Response

A delay in the intensifier rise time as shown in Figure 1. will often result in excessive porosity.

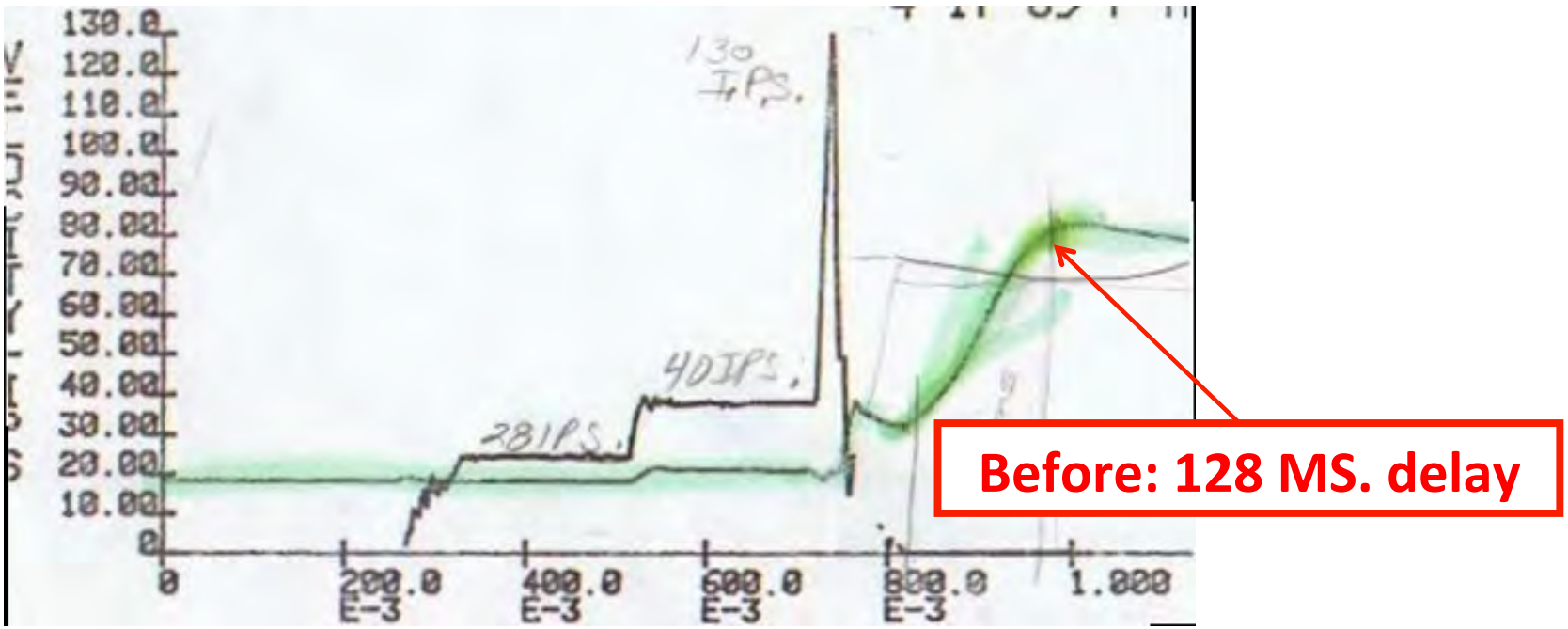
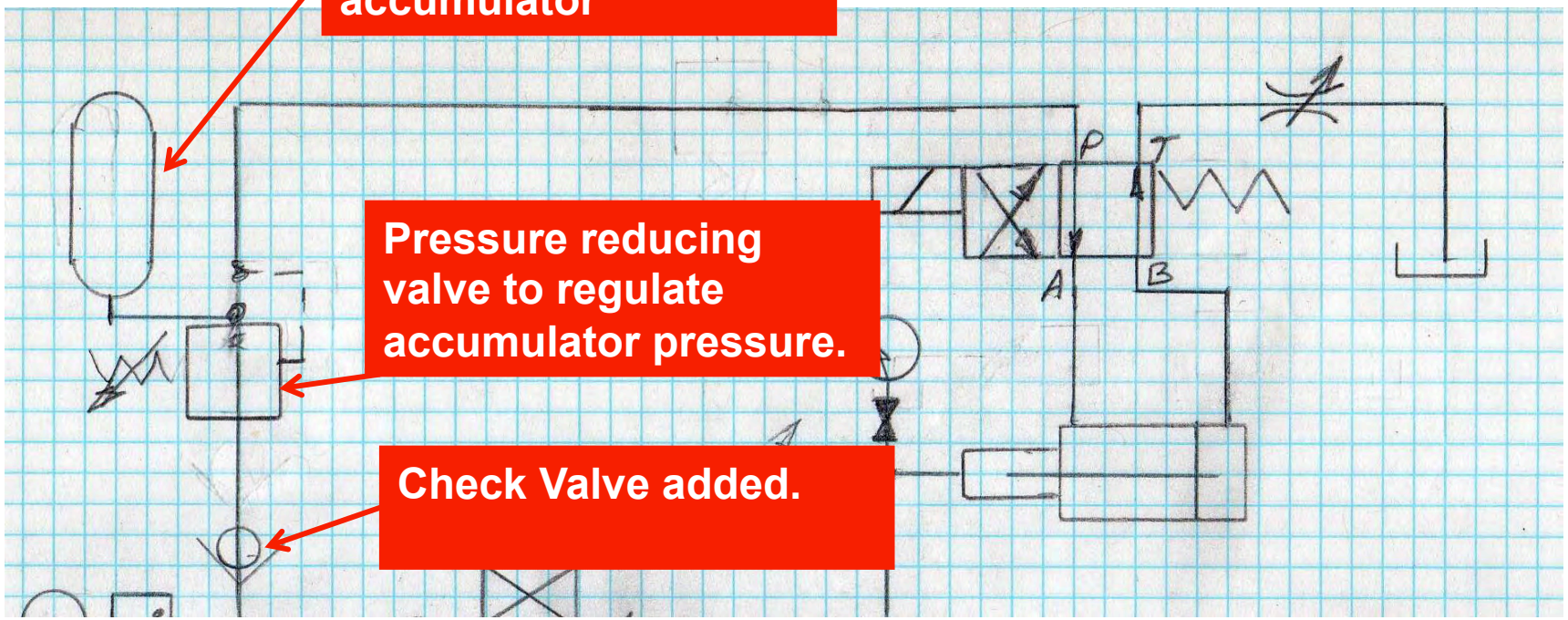


Figure 1.

Multiplier/Intensifier, as supplied

- The shot profiles on the previous slide were taken from a Wolniak rebuild.
- Originally, the hydraulic supply for the multiplier/intensifier was from the main shot accumulator.
- The supply pressure was metered through a Vickers Pressure Reducing Valve.

Economical Multiplier/Intensifier Modification



A common problem in die casting

Before: 128 MS. delay

Figure 1.

After: Immediate response

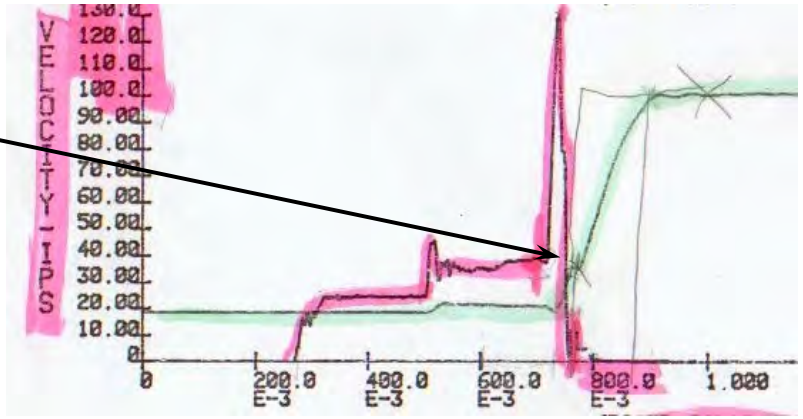


Figure 2.

AUSTRALIAN DIE CASTING ASSOCIATION

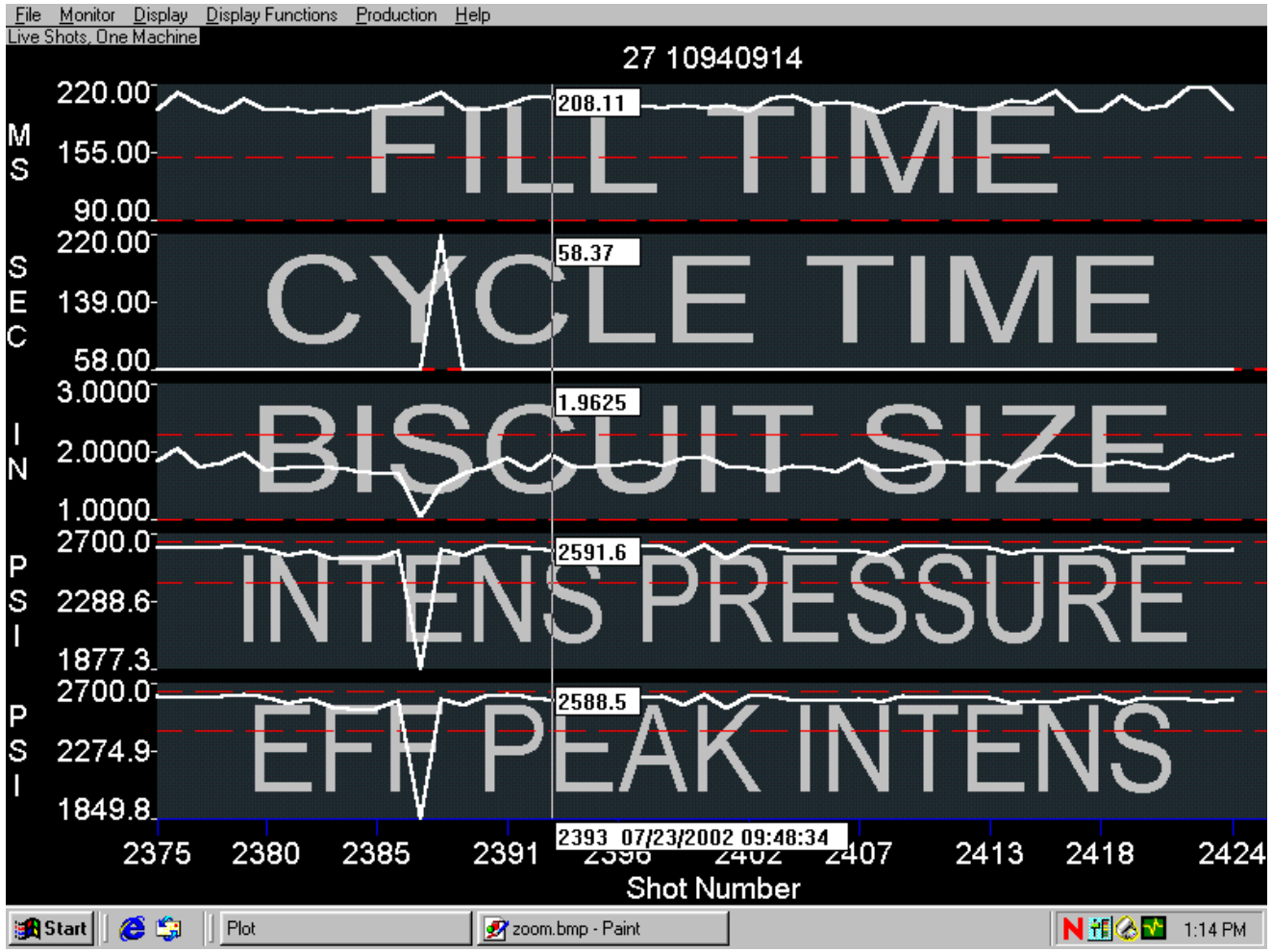
Visi-Trak®
SENSE, MONITOR, CONTROL

Process Automation in Action

Implementing SPC

Improve quality
greater OEE

Implementing SPC



AUSTRALIAN DIE CASTING ASSOCIATION

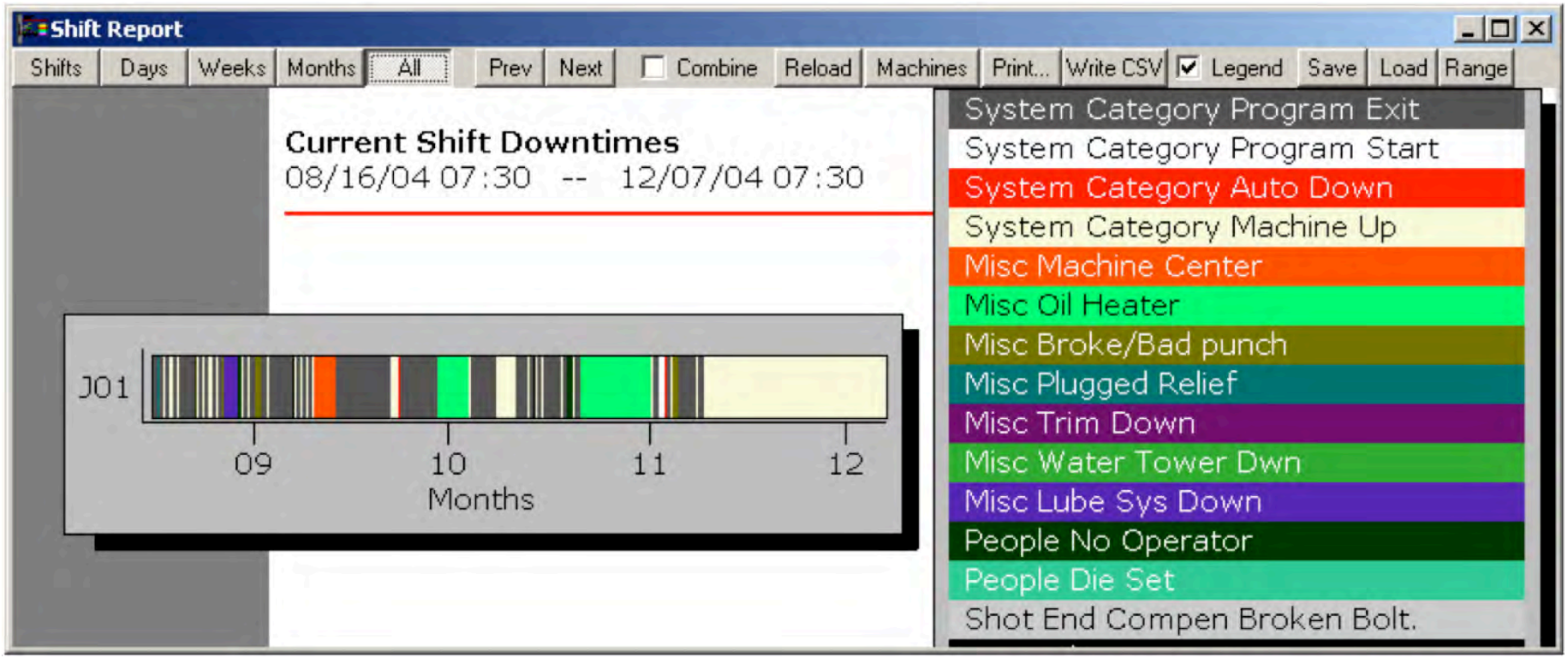
Visi-Trak®
SENSE, MONITOR, CONTROL

Process Automation in Action!

Improved Operational Insight

better planning
greater uptime
greater OEE

Monitor Downtime



Track causes of downtime

Production and Cycle Data with Optional HMI

AUSTRALIAN DIE CASTING ASSOCIATION

Visi-Trak®
SENSE, MONITOR, CONTROL

Total-Trak Powered by Visi-Trak | PROCESS VALUES | 5/6/2011 3:35:09 PM

Total-Trak tm

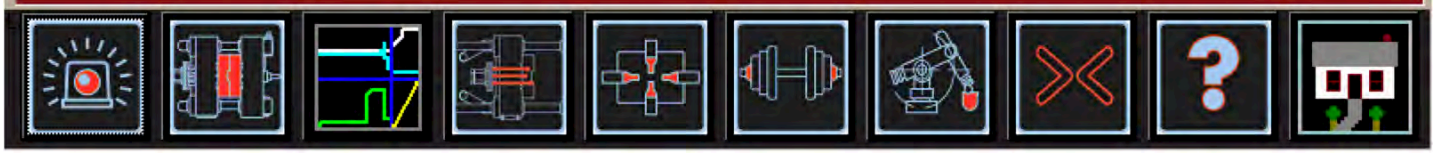
Current User: Administrator | Current Part: PortCity2

Cycle Counters	Setpt.	Actual	
Shot Count		10002	
Shot Count	1500	32767	Reset
Part Count	4	-12925	Reset
Scrap Counter	10000	9711	Reset
Oil Temperature	5	11000	
Oil Temp. Low	0	8000	
Die Temperature	3	1500	

Tonnage	Alarm	Actual	Cycle-1	Cycle-2	Cycle-3
Tie Bar #3	230	225	225	225	225
Tie Bar #4	230	226	226	226	226
Tie Bar #2	230	225	225	225	225
Tie Bar #1	230	227	227	227	227
Unbalance Alarm	15				
Total Tonnage	920	903	903	903	903

Cycle Timers	Actual	Cycle-1	Cycle-2	Cycle-3	Cycle-4
Total Cycle	0.00	30.001	30.001	30.001	30.001
Die Close Fast	0.00	3276.7	3276.7	3276.7	3276.7
Die Close Slow	0.00	3276.7	3276.7	3276.7	3276.7
Die Locking	0.00	3276.7	3276.7	3276.7	3276.7
Ladle Sequence	0.00	3276.7	3276.7	3276.7	3276.7
Shot Sequence	0.00	3276.7	3276.7	3276.7	3276.7

Cycle Timers	Actual	Cycle-1	Cycle-2	Cycle-3	Cycle-4
Part Curing	0.00	3276.7	3276.7	3276.7	3276.7
Die Open Cush	0.00	3276.7	3276.7	3276.7	3276.7
Die Open Fast	0.00	3276.7	3276.7	3276.7	3276.7
Die Open Slow	0.00	3276.7	3276.7	3276.7	3276.7
Part Removal	0.00	3276.7	3276.7	3276.7	3276.7
Sprayer Cycle	0.00	3276.7	3276.7	3276.7	3276.7



AUSTRALIAN DIE CASTING ASSOCIATION

Visi-Trak®
SENSE, MONITOR, CONTROL

Process Automation in Action!

Improved Quality Control

better parts
happy customers
informed Q.A. staff
actionable data

AUSTRALIAN DIE CASTING ASSOCIATION

Visi-Trak®

SENSE, MONITOR, CONTROL

REALTIME MONITORING & VISUALIZATION TERMINAL

Process, Production & Maintenance Personnel get instant access to process information from each machine

PART TRACEABILITY

Automated Marking Systems

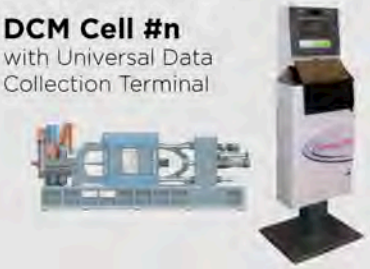
Unique ID
2D Data Matrix
or Pin Stamp

DCM Cell #1

with Universal Data Collection Terminal

DCM Cell #n

with Universal Data Collection Terminal



NETWORK

From DCM to Shop office, Back Office or Remote Locations

QUALITY CONTROL DATA BACK-UPS

Automatic Quality Control Backup of data on shift, day, week, month and yearly basis

PART INFO AND QUALITY CONTROL WORKSTATION

Q.A. and Plant Management

REALTIME REMOTE WORKSTATIONS

Plant Engineering and Management – Complete Process Insight from the other side of the plant or across the globe.

And even more….

- Design experiments to understand relationships and causes of variation
- Accrue production information including scrap and downtime data

Improve understanding *and* margins