Yield Optimization and Improvements by Cut-to-Weight Practice

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- A Brief History
- Equipment Overview
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- Future Considerations

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A Brief History

Nucor Steel, Auburn
Weighing System

- **Justification** - Target of 1% annual yield improvement
- **Installation** - 1999
- **Upgrade** - 2005 / 2007

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Equipment Overview
Weighing System Equipment Targets

- **Must be designed and built to provide extended operation with the minimum of maintenance**
- **Each weigh pod should be an individual weighing unit.**
- **Both manual and automatic modes of operation are needed**
- **Components should be oversized**

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Weigh Pod

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Weighing Systems

Basic Requirements

- Direct lift with hydraulic cylinder
- Canister designed for quick change
- Quick-connect stainless steel braided hoses
- Flex joint technology
- Enclosed, pressurized canister system
- Water cooled load cell mounting plates

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Weigh Pod Cutaway

Weighing Systems

Basic Requirements

- High "live load to dead load" ratio
- Load cell calibration "on the fly"
- Manual or PLC controlled operation
- Reliability
- Low maintenance
- Accuracy of 1/10 of 1%

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Typical Operation

- Sensor tells PLC that cut billet is in position
- Signal sent to PLC to weigh billet
- Billet is weighed
- Displayed weight is compared to Set Point weight
- PLC adjusts set point (SP) of billet length measuring unit
- Next cut is adjusted to new SP
- Operator has a digital display for each billet weight
- Operator can print out activity report summarizing individual billet weights, or sum of all billets and combined weights

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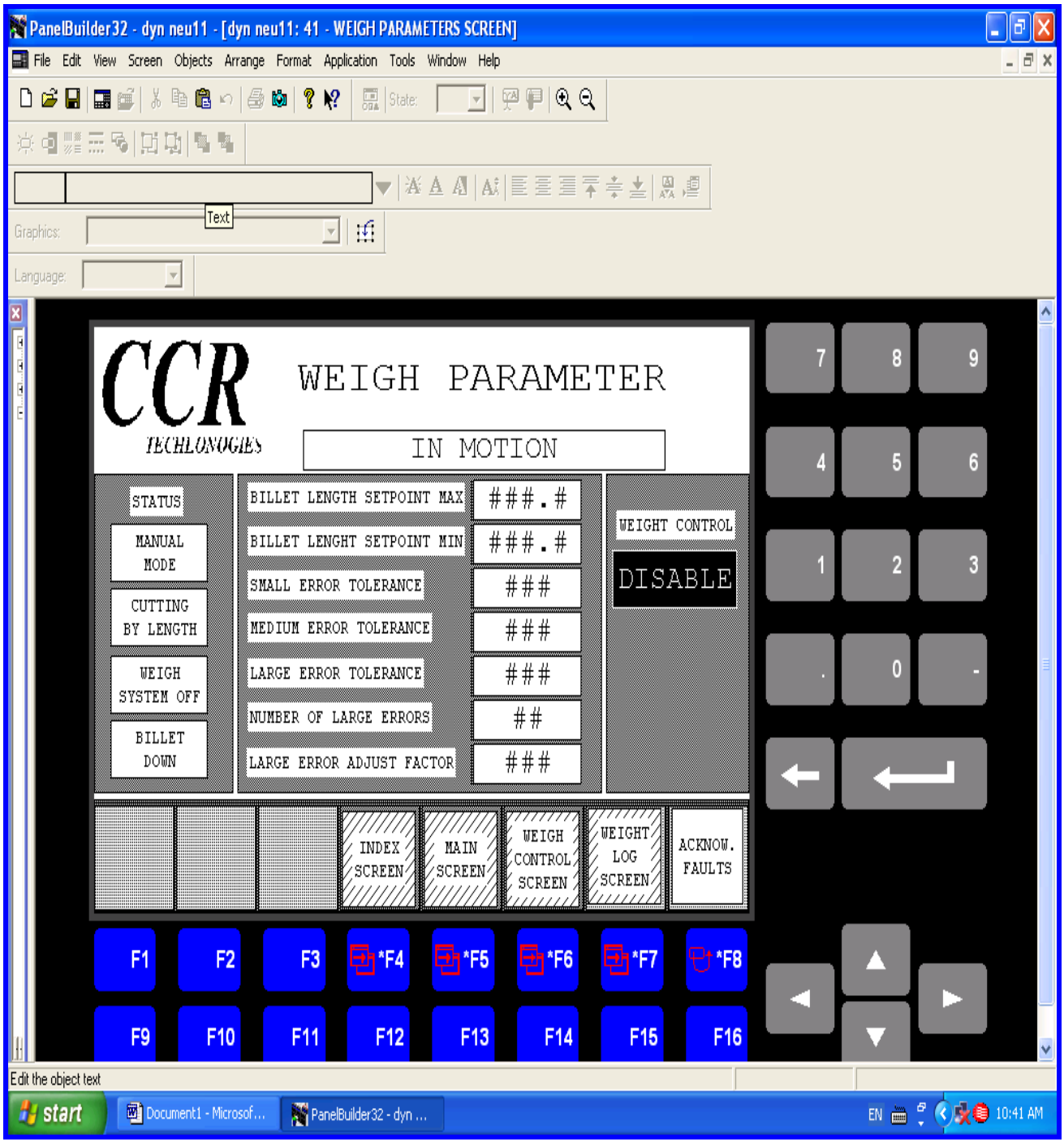
Operator’s Screen



List of Users
CCR Weighing Systems

- **CMC Steel, South Carolina**
  - billets
- **Gerdau Ameristeel, Cambridge & Manitoba**
  - billets, blooms
- **Hamilton Specialty Bar, Hamilton**
  - billets
- **Hyundai Steel, Incheon, Korea**
  - beam blanks
- **Nucor Steel, Auburn**
  - billets
- **Rocky Mountain Steel Mills**
  - 12.25” rounds
- **SDI Columbia City**
  - Jumbo beams

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Weighing System at Nucor Steel Auburn

Nucor Steel, Auburn

The Process

- Billet Length is measured by a scanner or encoder
- When Billet Length = Billet Length Set Point (SP), the torch cuts
- The billet is weighed
- The new length set point is calculated before the next billet is cut

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Why Weigh Billets?

- The temperature of the tundish, casting speed & mold condition all affect the thickness off the billet shell
- The thinner the shell, the more the billet may bulge
- The higher the billet density, the heavier the billet is for the same length
- The following chart shows the variance in billet weight for a fixed length

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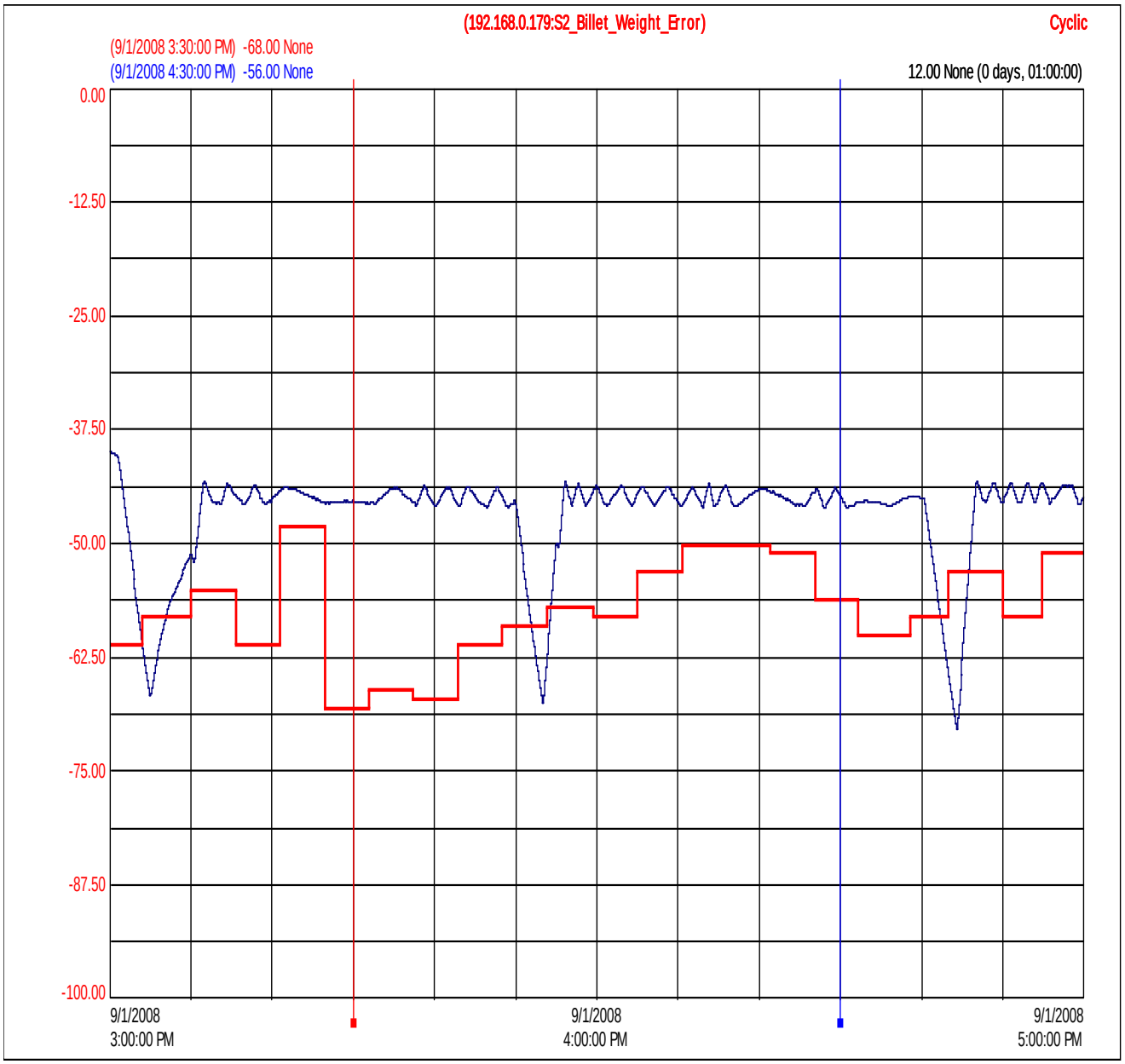
Weight Variance
Cut to Length



No.	Server	TagName	Minimum	Maximum	Units	Description
1	192.168.0.179	S2 Billet Weight Error	-100.0000	0.0000	None	
2	192.168.0.179	TundishWeight	0.0000	40000.0000	None	Tundish Weight

Billet Weight Adjustment

- **Billet Weight Error** (BWE) **= SP – PV** (therefore a negative (-) error is a heavy billet)

- **Billet Density** (lbs/inch) **= Actual Weight / Length SP**

  (A three-Billet Rolling Average is Used)

- **Length Correction** (In) **= Weight Error** (lbs.) **/ Avg. Density** (lbs. /in.)

- **The Length Correction is added to the next billet to be cut**

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Example

- **Weight SP = 5162 lbs,**
- **Length SP = 469.65,**
- **Density = 11 lbs /in**

- Next Billet Weight = **5172 lbs**

  Weight Error = 5162 – 5172 = **-10 lbs**

  Length Correction = -10 lbs / 11 lb/in

  =**0.909in**

Next Billet Length = 469.65 -0 .909 **= 468.74in**

- **The weight correction results in less variation in weight throughout the heat**

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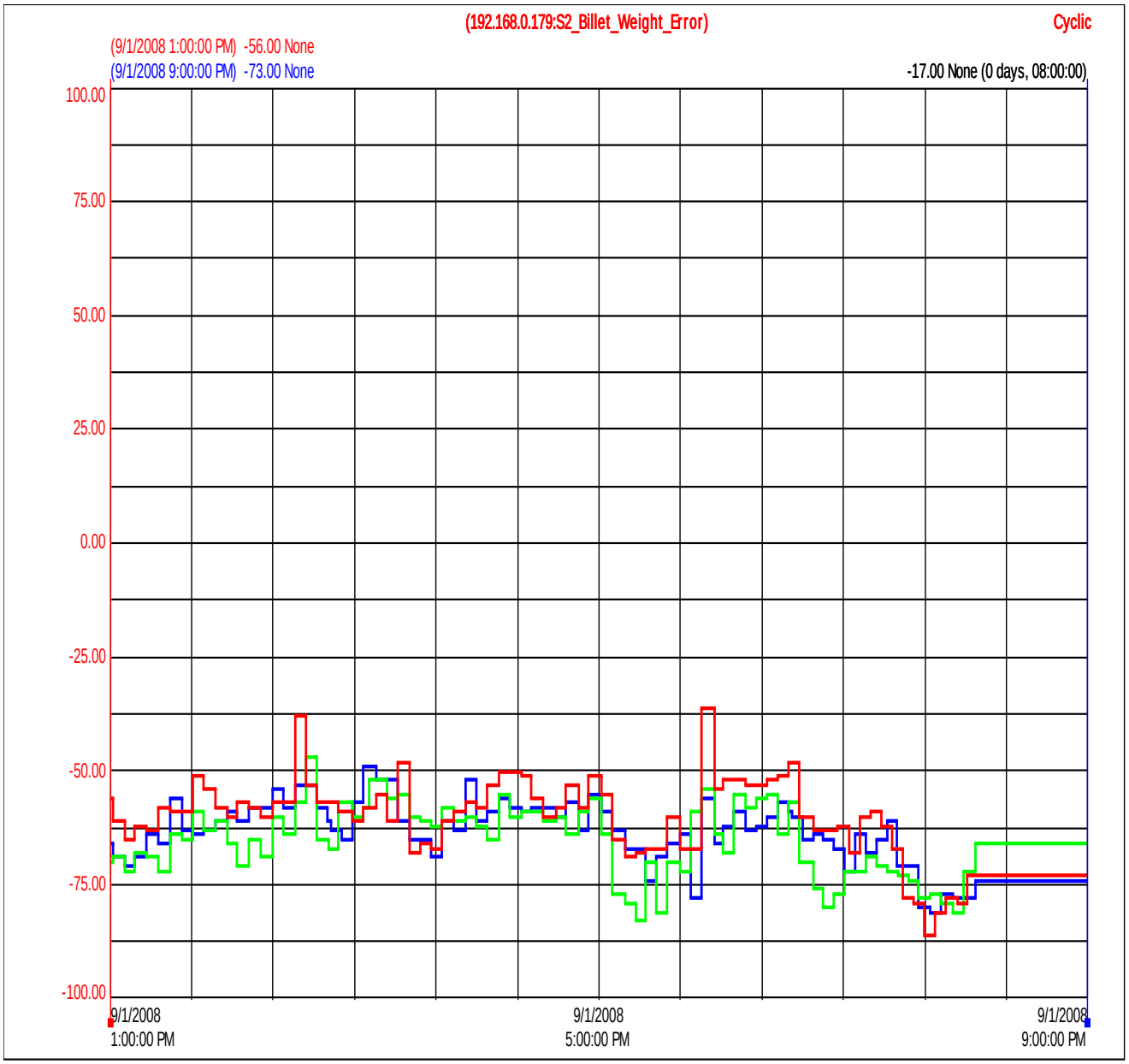
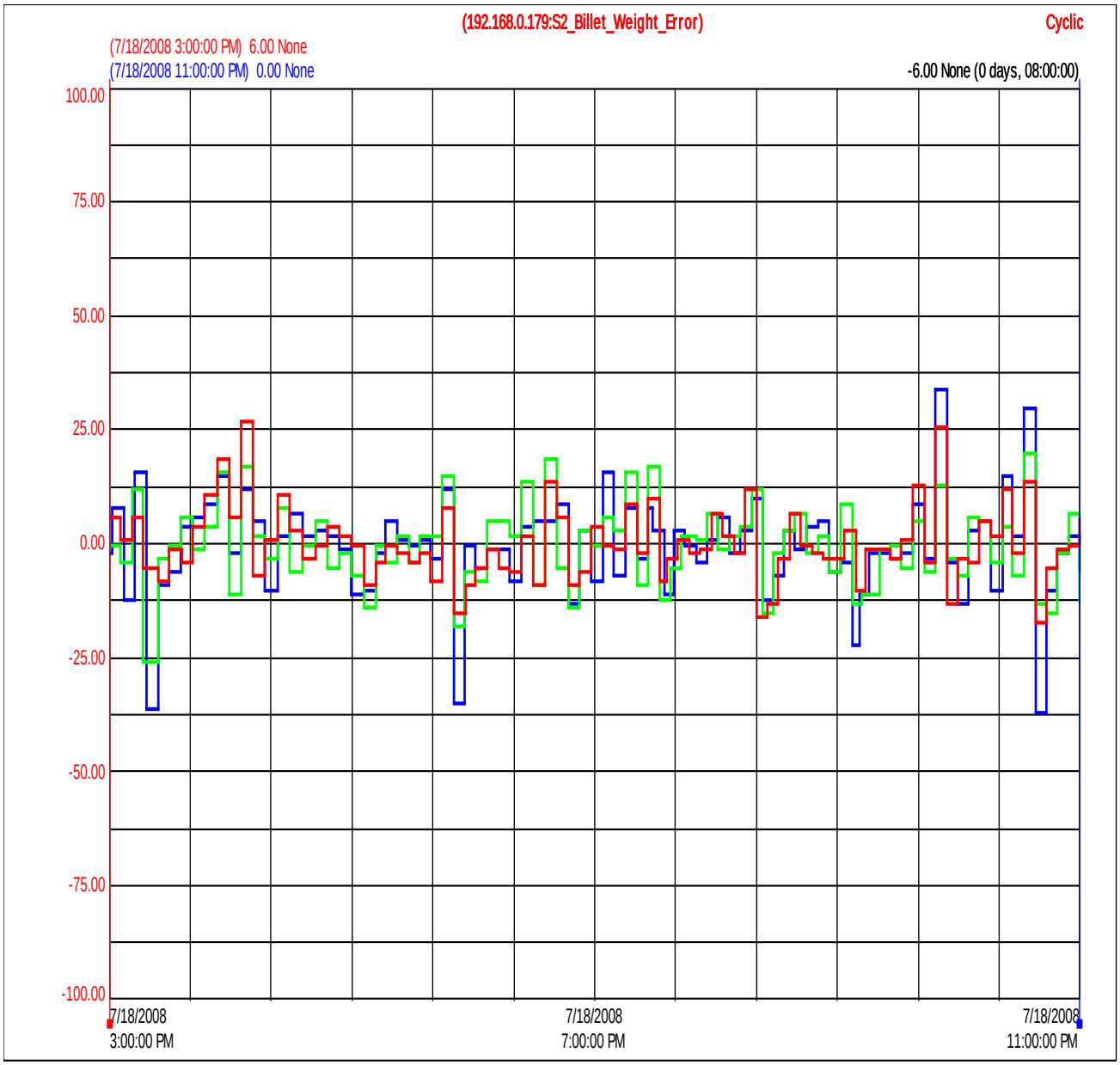
Cut by Length



No.	Server	TagName	Minimum	Maximum	Units	Description
1	192.168.0.179	S1 Billet Weight Error	-100.0000	100.0000	None	
2	192.168.0.179	S2 Billet Weight Error	-100.0000	100.0000	None	
3	192.168.0.179	S3 Billet Weight Error	-100.0000	100.0000	None	

Cut by Weight



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3	192.168.0.179	S3 Billet Weight Error	-100.0000	100.0000	None	

How the Adjustment Works

- **Verify the billet weight is real (> 500 lbs.)**
- **Zone Control**

  Zone 1 – No adjustment needed within 1/10 of 1%

  Zone 2 – Adjust per formula (+/-) 1%

  Zone 3 - Reduced adjustment per formula (+/-) 0.7% to 1%

  Zone 4 - No adjustment – operator alarmed

- **A separate formula is used for first 2-3 billets of a new heat**

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Additional Feedback

Additional feedback supplied by:

- **Gerdau Ameristeel**
- **CMC Steel**
- **Hyundai Steel**

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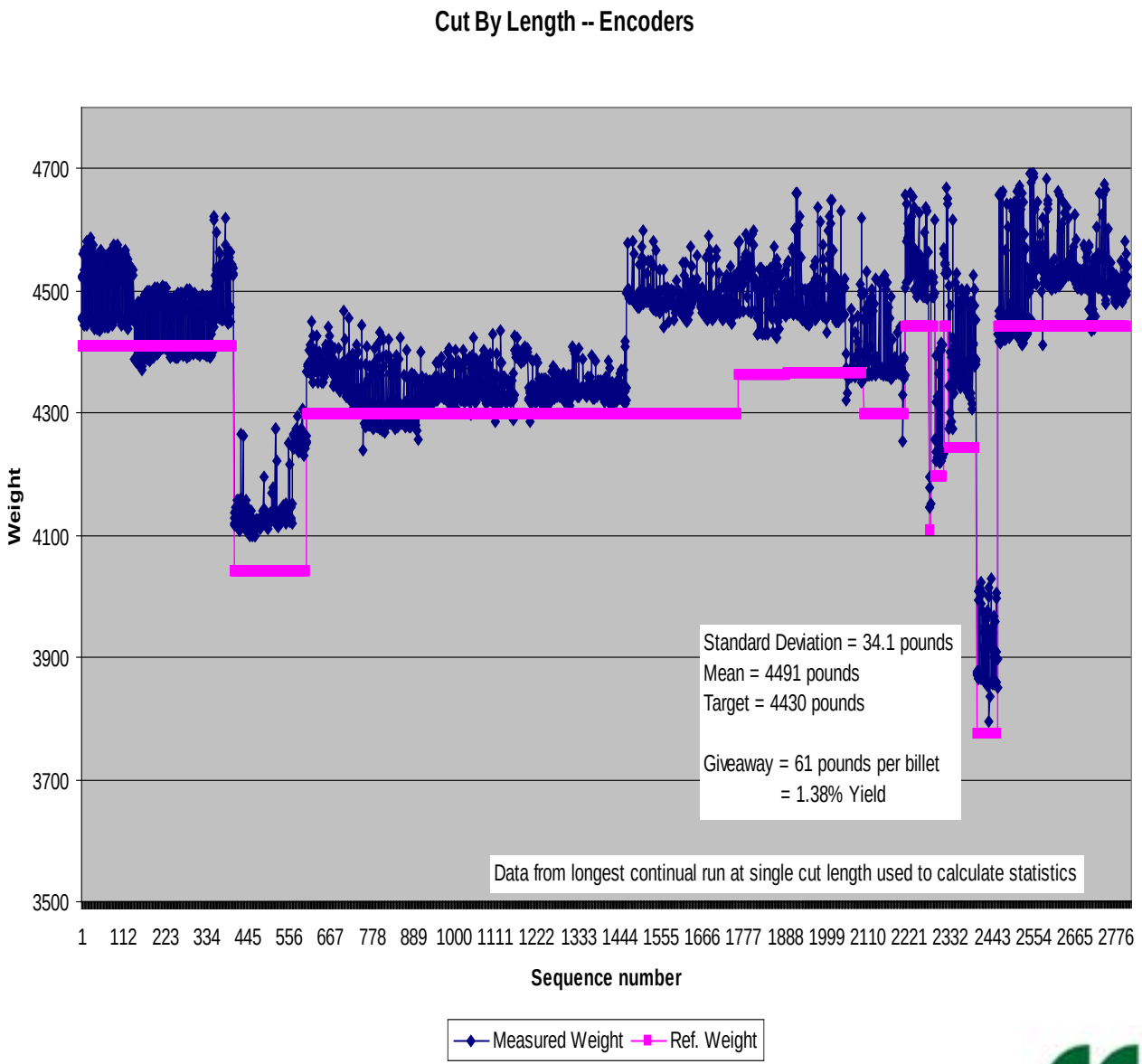
Additional Feedback
Cut by Length

Giveaway 61lbs / billet **Yield Loss 1.38%**



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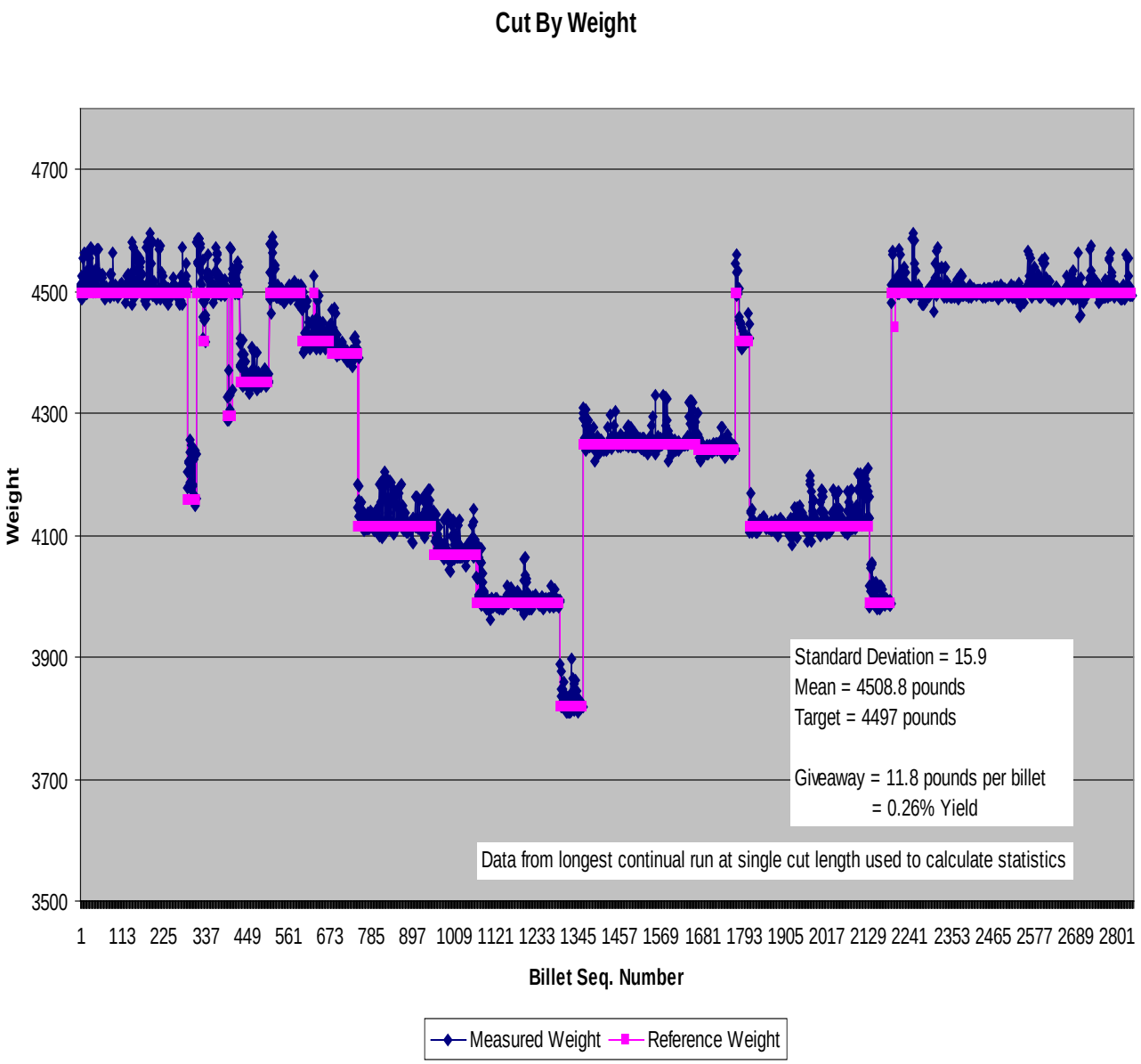
Additional Feedback
Cut by Weight

Giveaway 12lbs / billet **Yield Loss 0.26%**



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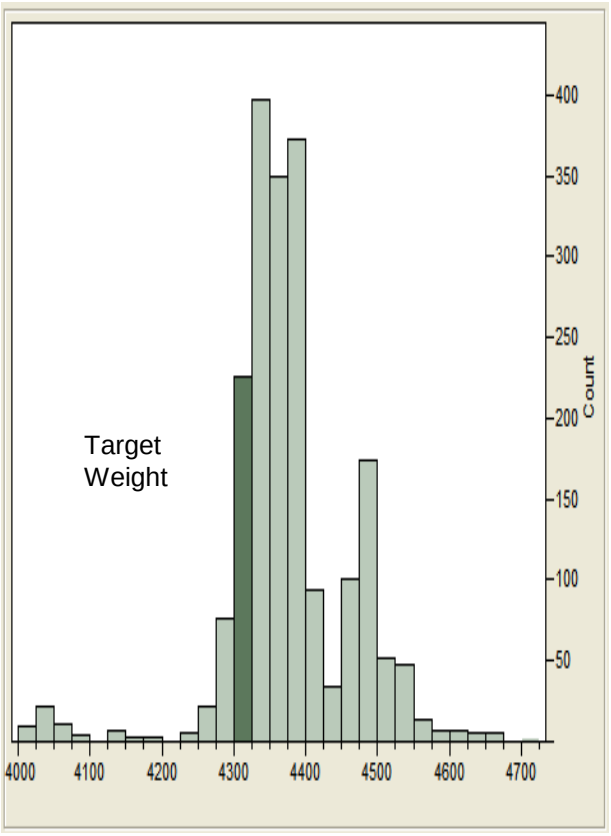
Additional feedback Distribution Comparison

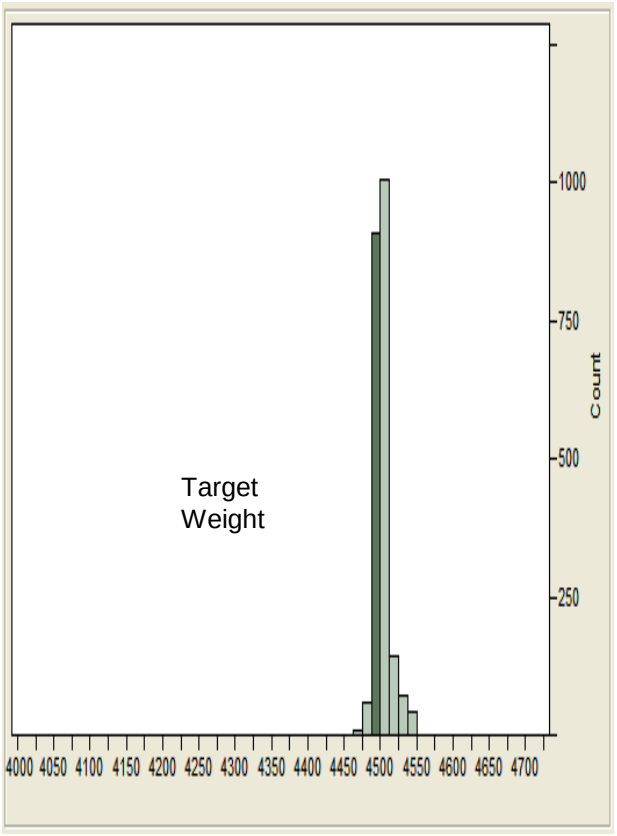
Cut by Length



Highest Overweight 296lb,
Lowest Underweight 282lb,
Mean giveaway 80lbs / billet

Yield loss1.86%

Cut by Weight



Highest Overweight 61lb
Lowest Underweight 27lb,
Mean giveaway 12lbs / billet

Yield Loss 0.26%

Net +1.6%

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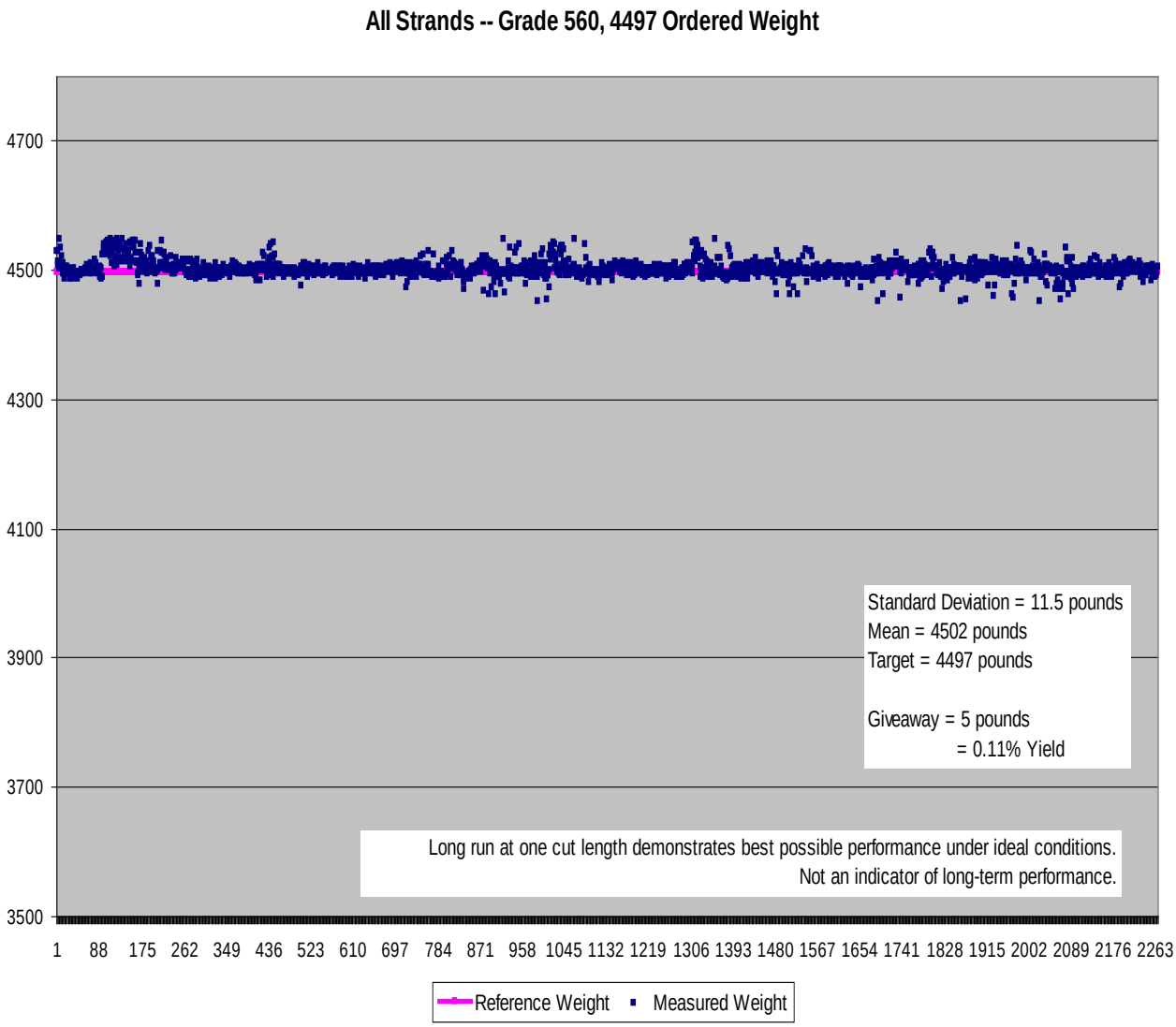
Additional Feedback
Cut by Weight
(Long Run) Giveaway 5 lbs / billet Yield Loss 0.11%



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Benefits of Billet Weighing

Melt Shop

- Less chance of ongoing operator error
- Real time feedback on every billet
- Energy savings
- Liquid to cast product yield optimized = $$$

Rolling Mill

- Consistent billet weights supplied to the Mill
- Scheduled mults / yield on Mill optimized
- Energy savings
- Shorts minimized, no steel given away = $$$

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Yield

Minimum of 1% improvement in Plant Yield

Value - $1.0 million / year

With

- **No additional cost or equipment**
- **Gains in throughput**
- **Savings in energy**
- **Logistical improvements**

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Future Considerations

Implementation of Predictive Adjustments based on Casting Conditions

- Temperature change
- Ladle change
- Flying nozzle change

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and
CCR Technologies Inc.

Wish to

THANK YOU