Yield Optimization and Improvements by Cut-to-Weight Practice

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• A Brief History
• Equipment Overview
• Weighing Procedure
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A Brief History

Nucor Steel, Auburn
Weighing System

• **Justification** - Target of 1% annual yield improvement
• **Installation** - 1999
• **Upgrade** - 2005 / 2007
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
Weigh Pod
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
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%
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
Operator’s Screen

PanelBuilder32 - dyn neu11 - [dyn neu11: 41 - WEIGH PARAMETERS SCREEN]

Graphics: Text
Language: 

CCR WEIGH PARAMETER

IN MOTION

STATUS
MANUAL MODE
CUTTING BY LENGTH
WEIGH SYSTEM OFF
BILLET DOWN

BILLET LENGTH SETPOINT MAX
BILLET LENGTH SETPOINT MIN
SMALL ERROR TOLERANCE
MEDIUM ERROR TOLERANCE
LARGE ERROR TOLERANCE
NUMBER OF LARGE ERRORS
LARGE ERROR ADJUST FACTOR

WEIGHT CONTROL
DISABLE

INDEX SCREEN
MAIN SCREEN
WEIGH CONTROL SCREEN
WEIGHT LOG SCREEN
ACTION FAULTS

F1 F2 F3 F4 F5 F6 F7 F8 F9 F10 F11 F12 F13 F14 F15 F16

← ← → →

Edit the object text

start Document1 - Microsoft PanelBuilder32 - dyn neu11
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
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
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
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
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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<thead>
<tr>
<th>No.</th>
<th>Server</th>
<th>TagName</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Units</th>
<th>Description</th>
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</thead>
<tbody>
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<td>192.168.0.179</td>
<td>S1 Billet Weight Error</td>
<td>-100.00</td>
<td>100.00</td>
<td>None</td>
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<td>100.00</td>
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<td>-100.00</td>
<td>100.00</td>
<td>None</td>
<td></td>
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## Cut by Weight

### Table: Billet Weight Error

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### Graph: Billet Weight Error

- **(192.168.0.179:S2_Billet_Weight_Error)**
- **Cyclic**

- (7/18/2008 3:00:00 PM) 6.00 None
- (7/18/2008 11:00:00 PM) 0.00 None

- -6.00 None (0 days, 08:00:00)
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
Additional Feedback

Additional feedback supplied by:

- Gerdau Ameristeel
- CMC Steel
- Hyundai Steel
Additional Feedback
Cut by Length
Giveaway 61 lbs / billet Yield Loss 1.38%

Cut By Length - Encoders

Data from longest continual run at single cut length used to calculate statistics

Standard Deviation = 34.1 pounds
Mean = 4491 pounds
Target = 4430 pounds
Giveaway = 61 pounds per billet
= 1.38% Yield

Measured Weight
Ref. Weight
Additional Feedback
Cut by Weight
Giveaway 12lbs / billet Yield Loss 0.26%

Cut By Weight

Data from longest continual run at single cut length used to calculate statistics

Standard Deviation = 15.9
Mean = 4508.8 pounds
Target = 4497 pounds
Giveaway = 11.8 pounds per billet
= 0.26% Yield
Additional feedback
Distribution Comparison

Cut by Length

Cut by Weight

Yield loss 1.86%

Yield Loss 0.26%

Net +1.6%
Additional Feedback
Cut by Weight
(Long Run) Giveaway 5 lbs / billet Yield Loss 0.11%

All Strands -- Grade 560, 4497 Ordered Weight

Standard Deviation = 11.5 pounds
Mean = 4502 pounds
Target = 4497 pounds
Giveaway = 5 pounds  
= 0.11% Yield

Long run at one cut length demonstrates best possible performance under ideal conditions.
Not an indicator of long-term performance.
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 = $$$
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
Future Considerations

Implementation of Predictive Adjustments based on Casting Conditions

- Temperature change
- Ladle change
- Flying nozzle change
Nucor Steel and CCR Technologies Inc. wish to thank you.