Guest Speaker – Andrew Frei

- Regional Manager of Fortress Technology
  - Managing Northeastern, South central regions of the US along with Western Canada

- 30 years experience in product inspection equipment applications

- Knowledgeable with food safety standards (i.e. HACCP, FSMA, BRC) and issues in the milling industry

- Worked with Fortune 500 and local customers to provide cost effective metal detection solutions for product and equipment protection
Metal Detector Basics
Milling Industry
Who We Are

Custom manufactures our equipment and software, to suit a customers’ needs, applications and specifications

Never Obsolete Commitment: detectors are always upgradable

Simple Operation | Outstanding Reliability | Exceptional Performance
The Global Supplier

Manufacturing Sites:

- NORTH AMERICA: Toronto, Canada
- SOUTH AMERICA: São Paulo, Brazil
- EUROPE: Banbury, UK
- AUSTRALIA/ASIA: Dynamic Inspection Cambridge, New Zealand

Installed detectors
Representatives
THE BASICS
Metal Detection – The Basics

- Balanced Coil
• Balanced Coil
Vertical Coil

Product Flow

Metal Contaminant

Product

Vertical Coil

Magnetic field
Vertical Coil

- Product Flow
- Magnetic Field Disturbance
- Metal Contaminant
- Product
- Vertical Coil
- Magnetic field
Vertical Coil

Product Flow

Vertical Coil

Magnetic Field Disturbance

Product

Magnetic field
Vertical Coil

Product Flow

Vertical Coil

Magnetic Field Disturbance

Product

Magnetic field
Vertical Coil

Product Flow

Vertical Coil

Magnetic Field
Disturbance

Magnetic field
Vertical Coil

Product Flow

Vertical Coil

Magnetic Field Disturbance

Magnetic field

Product
Vertical Coil
Metal Detection – The Basics

• Product Effect

Conductive Scale  Magnetic Scale
Metal Detection – The Basics

- **Types of Metal – Detection Ratios**

<table>
<thead>
<tr>
<th>Dry Product Mode</th>
<th>Wet Product Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.00mm Ferrous</td>
<td>2.00mm Ferrous</td>
</tr>
<tr>
<td>2.00mm Non-Ferrous</td>
<td>3.00mm Non-Ferrous</td>
</tr>
<tr>
<td>3.00mm Stainless</td>
<td>4.00mm Stainless</td>
</tr>
</tbody>
</table>

(Example of Ratios ONLY)
## Typical Guidelines for Sensitivity

<table>
<thead>
<tr>
<th>Aperture Height</th>
<th>Dry Product Ferrous &amp; Non Ferrous</th>
<th>Wet Product Ferrous</th>
<th>Wet Product Non Ferrous</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 50 mm (2 in)</td>
<td>&lt; 0.8 mm</td>
<td>&lt; 0.8 mm</td>
<td>&lt; 1.2 mm</td>
</tr>
<tr>
<td>≤ 125 mm (5 in)</td>
<td>&lt; 1.0 mm</td>
<td>&lt; 1.0 mm</td>
<td>&lt; 1.5 mm</td>
</tr>
<tr>
<td>≤ 200 mm (8 in)</td>
<td>&lt; 1.5 mm</td>
<td>&lt; 1.5 mm</td>
<td>&lt; 2.2 mm</td>
</tr>
</tbody>
</table>
## Sphere Size vs. Volume

<table>
<thead>
<tr>
<th>Diameter (mm)</th>
<th>Volume (mm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>0.008</td>
</tr>
<tr>
<td>0.50</td>
<td>0.065</td>
</tr>
<tr>
<td>0.75</td>
<td>0.221</td>
</tr>
<tr>
<td>0.80</td>
<td>0.268</td>
</tr>
<tr>
<td>1.00</td>
<td>0.524</td>
</tr>
<tr>
<td>1.25</td>
<td>1.023</td>
</tr>
<tr>
<td>1.50</td>
<td>1.767</td>
</tr>
<tr>
<td>2.00</td>
<td>4.189</td>
</tr>
<tr>
<td>2.50</td>
<td>8.181</td>
</tr>
<tr>
<td>3.00</td>
<td>14.137</td>
</tr>
<tr>
<td>3.50</td>
<td>22.449</td>
</tr>
<tr>
<td>4.00</td>
<td>33.510</td>
</tr>
<tr>
<td>4.50</td>
<td>47.713</td>
</tr>
<tr>
<td>5.00</td>
<td>65.450</td>
</tr>
<tr>
<td>5.50</td>
<td>87.114</td>
</tr>
<tr>
<td>6.00</td>
<td>113.098</td>
</tr>
<tr>
<td>6.50</td>
<td>143.794</td>
</tr>
<tr>
<td>7.00</td>
<td>179.595</td>
</tr>
<tr>
<td>7.50</td>
<td>220.894</td>
</tr>
<tr>
<td>8.00</td>
<td>268.083</td>
</tr>
<tr>
<td>8.50</td>
<td>321.556</td>
</tr>
<tr>
<td>9.00</td>
<td>381.704</td>
</tr>
<tr>
<td>9.50</td>
<td>448.922</td>
</tr>
<tr>
<td>10.00</td>
<td>523.600</td>
</tr>
</tbody>
</table>

### Diameter - Volume Plot

![Diameter - Volume Plot](Diameter_Volume_Plot.png)

- **Volume of Metal (mm³)**
  - 0.524
  - 4.189
  - 14.137

- **Sphere size (mm)**
  - 1
  - 2
  - 3
Metal Detection – The Basics

• Sensitivity

![Graph showing the relationship between metal size, aperture size, and signal size.](image)

- Metal Size vs. Aperture Size
- Signal Size vs. Position in Aperture
Metal Detection – The Basics

• Shapes & Orientation of Metals

Ferrous Wires:
• A - Easiest position, biggest signal.
• B, C - Hardest Position, smallest signal.

Non-Ferrous and Stainless Steel Wires:
• B, C - Easiest position, biggest signal.
• A - Hardest position, smallest signal.
Metal Detection – The Basics

- **Metal-free Area**
Applications – Conveyor

• Ideally suited for:
  ▪ Packaged products of any kind
  ▪ Bulk flow solids and powders

• Critical design factors:
  ▪ Aperture size
  ▪ Product rates
  ▪ Reject design
  ▪ Testability
  ▪ Compliance factors
Metal Detection – The Basics

• Detector Performance
  - Isolated rollers - prevents loops
  - High quality belt – metal-free, carbon-free, interlocked finger
  - Splice or plastic modular belt (white or natural)
  - Low vibration and static
  - Adequate metal-free area

1. Metal Free Area
2. Non-Metallic Slider Bed
3. Clearance
4. Foot Isolation
5. Metal Free Belt
6. Roller Isolation
Metal Detection – The Basics

- Typical Metal Detector Conveyor Reject Options
Applications – Drop Through / Gravity

• Ideally suited for inspecting dry, free flowing products such as:
  ▪ Grains, flours, cereals
  ▪ Rice, nuts, sugar
  ▪ Plastic pellets and flakes

• Critical design factors:
  ▪ Flow rate
  ▪ Bulk density
  ▪ Free fall distance
  ▪ Pipe size
  ▪ Space available
  ▪ Testing procedure (insert + recovery)
Applications – Drop Through / Gravity

- Drop Height Distance
- Detector To Valve Distance
- Product Freefall Start Point (Test Piece Access)
- Plastic Pipe Selection
- Detector
- Overall Length
- Reject Output
- Good Product Output

- D1
- D2
Applications - Pipeline

• Ideally suited for inspecting liquid, slurries, or paste products that can be pumped through, such as:
  - Sauces, dairy products, meat slurries, Juices etc.

• Critical design factors:
  - Pipe I.D.
  - Pipe clamp connection style (tri-clamp, I-line etc)
  - Product flow rate (GMP)
  - Product viscosity
  - Product temperature range
  - Product pressure
  - Expected cleanup procedures (wash down, pipe pig, etc.)
Applications - Pipeline

Detector

Non Metallic Pipe Section

Reject Valve

Flow

Good Product

Rejected Product

Flow

Detector

Non Metallic Pipe Section

Reject Valve

Good Product

Rejected Product
Food Safety Audit
Metal Detectors

• Metal Detectors have been reported as a leading cause of audit non-conformances

Most common issues:

- Lack of training / knowledge at all levels
- Lack of commitment at management levels
- Improper test procedures
- Equipment function failures
1) How to test? Test methods?
2) When to test? How frequently?
3) What to test with? What size & type of metal, and what encapsulation type (Test wand, card, ball, other)?
4) Basic Test Procedures
5) What to do with the results (Test records, pass/fail, decisions & actions)?
1) How to test?

Minimum considerations:

- Center of aperture
- Consistent position
- Speed same as product speed
- Number of passes/tests
- Use product where feasible
- Test must include rejection device
- Safety of procedure
2) When to test?

Minimum considerations:

- Shift change or shorter regular interval (i.e., every 4 hours)
- Product change
- Application change (speed, reject position, etc.)
- After line maintenance
- Consider the logistics of a test failure
3) What to test with?

Minimum considerations:

- Choose Sphere sizes that are reliably detectable
- Stainless Steel sample always;
- Ferrous & Non-Ferrous can be at lesser frequency
- Form of test sphere encapsulation should suit the application (size, colour differential)
- Certified test samples
4) Basic Test Procedures?

- Test sample should travel through the centre of the aperture
- Use ‘real’ product to carry the test sample whenever possible
- The test sample must be allowed to be rejected and enter the reject bin
- Record results
5) What to do with results?

Minimum considerations:

- Manual record of each test event
- System of collection/storage of records
- Easy method to decide pass/fail
- Clear action upon test failure
- Example of daily test log

### Daily Metal Detector Test Log

**Plant / Factory Information:**

<table>
<thead>
<tr>
<th>Plant / Factory</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Detector Information:**

<table>
<thead>
<tr>
<th>Model:</th>
<th>Line ID:</th>
<th>Reject Type:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Product:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

**Test Sample Sphere Information:**

<table>
<thead>
<tr>
<th>Ferrous Size:</th>
<th>mm</th>
<th>Non-Ferrous Size:</th>
<th>mm</th>
<th>Stainless Steel Size:</th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
<th>Detected Pass / Fail</th>
<th>Rejected Pass / Fail</th>
<th>Corrective Action (if failed)</th>
<th>Test By:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Management Reviewed:</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Product Released:</th>
<th>Yes / No</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Page of
<table>
<thead>
<tr>
<th>Date/Time</th>
<th>Type</th>
<th>Powering up</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/20/2013 8:51:28 AM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11/20/2013 12:39:30 PM</td>
<td>Configuration Change</td>
<td>Main Reject Duration: 0.25 -&gt; 2.25</td>
<td></td>
</tr>
<tr>
<td>11/20/2013 12:51:04 PM</td>
<td>Reject</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11/20/2013 12:56:56 PM</td>
<td>Test Request Failed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11/20/2013 12:56:56 PM</td>
<td>Fault Ended</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11/20/2013 1:57:02 PM</td>
<td>Test Request Failed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11/20/2013 2:57:08 PM</td>
<td>Test Request Failed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11/20/2013 3:57:16 PM</td>
<td>Test Request Failed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11/20/2013 4:57:22 PM</td>
<td>Test Request Failed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11/20/2013 5:00:52 PM</td>
<td>Fault Started</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11/20/2013 5:17:42 PM</td>
<td>Reject</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11/20/2013 5:17:50 PM</td>
<td>Configuration Change</td>
<td>Sensitivity: 105 -&gt; 85</td>
<td></td>
</tr>
<tr>
<td>11/20/2013 5:17:54 PM</td>
<td>Configuration Change</td>
<td>Sensitivity: 85 -&gt; 65</td>
<td></td>
</tr>
<tr>
<td>11/20/2013 5:18:00 PM</td>
<td>Reject</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11/20/2013 5:18:14 PM</td>
<td>Test Request - Fe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11/20/2013 5:18:50 PM</td>
<td>Test Request - SS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11/20/2013 5:18:52 PM</td>
<td>Test Request Passed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11/20/2013 5:18:54 PM</td>
<td>Reject Counter Clear</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11/20/2013 5:19:04 PM</td>
<td>Manual Test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11/20/2013 5:19:24 PM</td>
<td>Configuration Change</td>
<td>Test Mode: Request -&gt; Auto</td>
<td></td>
</tr>
<tr>
<td>11/20/2013 5:19:42 PM</td>
<td>Auto Test - Operator Triggered</td>
<td>Peak: 32767</td>
<td></td>
</tr>
<tr>
<td>11/20/2013 5:19:54 PM</td>
<td>Auto Test - Operator Triggered</td>
<td>Peak: 32767</td>
<td></td>
</tr>
<tr>
<td>11/20/2013 5:20:08 PM</td>
<td>Auto Test - Operator Triggered</td>
<td>Peak: 32767</td>
<td></td>
</tr>
<tr>
<td>11/20/2013 5:20:18 PM</td>
<td>Configuration Change</td>
<td>Test Time Interval: 60 -&gt; 1</td>
<td></td>
</tr>
<tr>
<td>11/20/2013 5:23:00 PM</td>
<td>Reject Counter Clear</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11/20/2013 5:23:50 PM</td>
<td>Auto Test - Operator Triggered</td>
<td>Peak: 32767</td>
<td></td>
</tr>
<tr>
<td>#</td>
<td>Description</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----</td>
<td>---------------------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Infeed Photo Eye (photo gate sensor for accurate reject timing)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Beacon Lamp – On Metal Reject Beacon Lamp/or Alarm – On Fault Beacon Lamp – On Sensitivity Test Due</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Fixed Cover – from detector and over reject area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Bin Door Open Sensor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Lockable Bin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Reset Keyswitch for faults Reject Override Keyswitch – for testing reject Build Back Signal from next conveyor to indicate product build back. Output signal to upstream conveyor to cause it to stop if reject failure</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Failsafe Systems

#7 Automatic Reject Device - Application Dependant
Air Pressure Failure Switch (with facility to test)

#8 Belt Speed Monitor – encoder or inverter for variable speeds/stoppages

#9 Second Reject Check/Confirm Sensor

#10 Bin Full Sensor (typically installed for 1/3 bin capacity)
Test facility for Bin Full sensor

#11 Reject Confirmation Sensor
Testing of Failsafe Systems

During an Audit, Proof of failsafe sensing devices may need to be demonstrated.

- In-feed eye blocked / misaligned
- Reject bin full
- Reject confirm fail
- No / low air
- Belt stop / start timing compensation
- Reject exit eye blocked
Audit Preparation

- Know GFSI scheme requirements
- Training for all levels of staff up-to-date
- Metal Detection equipment reviewed
  - Condition and Operation
  - Scheme requirements
- Test Samples – certified and appropriate size
Audit Preparation

- Audit team: review documentation & procedures
  - Accurate
  - Current
  - Compliance
- Detector calibration certificates from recognized source
- Test procedures, critical limits and report records
- Maintenance records and/or agreements
Food Safety Audit

Rejected Product

- Isolate – Locked Bins/Enclosures
- Examine/Re-inspect
- Use of Off Line or Lab Metal Detectors
- Identify metal
- Identify Source
Summary

• Training, Training, Training
  ▪ All levels of staff should be proficient
  ▪ Management especially

• Documentation
  ▪ All pertinent documentation organized and available

• Recall Procedures
  ▪ Everyone on the audit team should know

• Metal Detector Supplier
  ▪ Source for training and information
CONTACT Software
Events and Data Logging
Contact Communication system is designed to help with quality assurance record-keeping and reporting.
• Reject types:
  - Reject: Reject event from normal operation.
  - Reject Counter Cleared: Indicates counter was cleared by operator.
  - Photo Peak: Peak from a product in which metal was not detected.
    - Used for statistical analysis for discrete products.
  - Auto-Test
  - Test Request: Test done as part of a test request (FE, NFE, SS)

• Date & time

• Signal – Indicates the magnitude of the reject signal.

<table>
<thead>
<tr>
<th>Event</th>
<th>Date &amp; Time</th>
<th>Signal</th>
<th>Operator/Result</th>
<th>Rej. No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reject</td>
<td>Mar-05-2008 22:19:26</td>
<td>640</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Counter Cleared</td>
<td>Mar-05-2008 22:19:27</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reject</td>
<td>Mar-05-2008 22:19:27</td>
<td>1835</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>
Contact Reporter Software
OVERVIEW

- Windows applications
- Displays detector status
- Generates reports on information collected
  - Reports can be exported to PDF or EXCEL

- Multiple languages
  (English, French, Spanish, Portuguese, German)
Provides a list of parameters for all defined products on a detector.

<table>
<thead>
<tr>
<th>Product List</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product Number:</strong></td>
</tr>
<tr>
<td><strong>Product Name:</strong></td>
</tr>
<tr>
<td><strong>Setup Start:</strong></td>
</tr>
<tr>
<td><strong>Setup End:</strong></td>
</tr>
<tr>
<td><strong>Phase Angle</strong></td>
</tr>
<tr>
<td><strong>Phase Fault</strong></td>
</tr>
<tr>
<td><strong>Phase Mode Hold</strong></td>
</tr>
<tr>
<td><strong>Phase Trigger Limit</strong></td>
</tr>
<tr>
<td><strong>Phase Trigger Threshold</strong></td>
</tr>
<tr>
<td><strong>Photo Calibration</strong></td>
</tr>
<tr>
<td><strong>Photo Eye Block Fault</strong></td>
</tr>
<tr>
<td><strong>Photo Eye Block Time (# x Package Length)</strong></td>
</tr>
<tr>
<td><strong>Photo Eye Distance</strong></td>
</tr>
<tr>
<td><strong>Photo Reject Mode</strong></td>
</tr>
<tr>
<td><strong>Product Memory Fault</strong></td>
</tr>
<tr>
<td><strong>Product Name</strong></td>
</tr>
<tr>
<td><strong>Product Number</strong></td>
</tr>
<tr>
<td><strong>R Threshold</strong></td>
</tr>
<tr>
<td><strong>Reference Fault</strong></td>
</tr>
<tr>
<td><strong>Reject Check</strong></td>
</tr>
</tbody>
</table>
Metal Detection Systems

• Contacting Fortress Technology

**Headquarter**
Fortress Technology Inc.
Toronto, Canada
Phone: (416) 754-2898
Fax: (416) 754-2976
Email: info@fortresstechnology.com

**Europe**
Fortress Technology (Europe) Ltd.
Banbury, UK
Phone: +44 (0) 1295 256266
Fax: +44 (0) 1295 255987
Email: info-UK@fortresstechnology.com

**South America**
Fortress Technology
Sistemas de Inspeção Ltda.
São Paulo, Brazil
Phone: +55 11 3641 6153
Fax: +55 11 3641 6153
Email: brasil@fortress-iis.com.br

www.fortresstechnology.com
Thank you for your attention!