No compromises in Quality Assurance:
When to select XRF, LIBS or Spark Technology

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NDT Products Ltd
No compromises in Quality Assurance: When to select XRF, LIBS or Spark Technology
Agenda

• Why is a rigorous alloy Quality Assurance Program needed?

• Potential Supply Chain Risks

• Selecting the right technology
Cycle of Metals

- Raw Ore
  - Mostly analysis

- Scrap Yard/Tier 1 Recycler
  - Mostly sorting, some analysis

- Scrap Yard/Tier 2 Recycler
  - Mostly sorting

- Scrap Yard/Tier 3 Recycler
  - Mostly sorting

- Foundry/Mill
  - Incoming inspection
  - QA/QC
  - Internal scrap

- Plant/Consumer
  - PMI

- Fabricator/Manufacturer
  - Incoming inspection
  - QA/QC
  - Internal scrap
Supply Chain Management

Manufacturing

Can you control all your incoming material?

Who is responsible for goods that leave your facility?

Can you control your process?

YOU!
Supply Chain Management

Potential concerns

• Unknown suppliers
• Unknown raw material
• Negligence
• Deception
• Counterfeit parts

...but you’re responsible for product going out your door
Supply Chain Management

What can you do?

• Trust, but verify
• Request certificates of compliance
• Test incoming materials
• Test outgoing product

A successful program will have a combination of ALL of the above!
Right tool for the job

LIBS

XRF

OES (arc / spark)
XRF - Strengths

• Fast, accurate and precise tool many application

• Mg - U

• Analysis from ppm-level to 100 %

• Rugged

• Most adaptive
XRF- Limitations

• Detection limits higher than OES

• Slower than LIBS on all elements

• Cannot analyse Carbon, Lithium (Al-alloys) or Beryllium (Cu-alloys)
LIBS- Strengths

• Fastest sorter on the market
• No x-rays
• Very simple to use
• Less vulnerable to sharp samples than HHXRF
• Easy user maintenance
• Samples can be measured in hand
• Short learning curve on how to use
• Point and shoot operation
LIBS - Limitations

• Analytically not as accurate as HHXRF

• Detection limits higher than HHXRF

• More sensitive than HHXRF to operating conditions (temperature, humidity)

• More sensitive to surface conditions (dust, dirt, rust/oxide layer, water) than HHXRF

• Battery needs to be replaced during a working day
OES instruments - Strengths

- High accuracy analysis
- Truly portable can be taken to where the samples are
- Ultimate performance on light alloys and trace elements
- Precise analyse for elements like C, P, S and even Nitrogen (for Duplex steels)
- OES is the only method capable to separate L- from H-grades
OES Instruments - Limitations

- Mobile but not hand-held
- Requires sample preparation
- No automatic calibration selection
- Total measurement time longer than when using XRF or LIBS
- Narrower element selection compared to XRF and LIBS
- Price compared to customer requirements and alternative instrumentation available
Metal Producers

• Ensure melt chemistry
  – Verify incoming scrap matches specifications
  – Detect poison elements
  – Test raw ores, ferrometallic additives

• Outgoing QC
  – Verify target chemistry was achieved
  – Certify batch chemistry
  – Warehouse screening

• Test internal scrap
  – Re-use
  – Sell

• On-site supplier vetting
# Metal Producers

<table>
<thead>
<tr>
<th></th>
<th>HHXRF</th>
<th>LIBS</th>
<th>OES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Incoming material inspection, internal scrap</strong></td>
<td>Scrap metal X</td>
<td>Scrap metal Rapid, non-destructive testing</td>
<td>Scrap metal Fastest metal sorting for high volume</td>
</tr>
<tr>
<td></td>
<td>Scrap metal – poison elements</td>
<td>Most elements available</td>
<td>Picks up some elements XRF can’t</td>
</tr>
<tr>
<td></td>
<td>Minerals</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><strong>Outgoing QC</strong></td>
<td>Batch certification</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Warehouse screening</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>On-site supplier screening</strong></td>
<td>X</td>
<td>X</td>
<td>X</td>
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</tbody>
</table>
Metal Fabricators
Metal Fabricators

Fabricator/Manufacturer

[Images of metal sheets, copper fittings, and a pump]
Metal Fabricators

• Start with metals and finish with different shape or size, or create completed assembly
• Outgoing products are built to customer specifications
• Best (or only) chance to verify composition is incoming inspection
• Metals should arrive with material test report (MTR) but...
  – May be incorrect or incomplete
  – Residual elements may not be included or tested
Metal Fabricators

• In oil & gas industry:
  – Mechanical integrity is biggest source of “large property damage losses”
  – Per API 578 “Mill test reports should not be considered a substitute for a PMI test.”
  – Installing equipment with an erroneous MTR could result in catastrophic release of hazardous chemicals or energy
  – Fabricators may be required to test before shipping products
Metal Fabricators

• Verify incoming materials
  – Reject off-spec material
  – Additional information to MTR
  – Ensure they go into right warehouse location

• Quality control
  – Last check before goods leave the production line
  – Create certificate

• Welding inspection
# Metal Fabricators

<table>
<thead>
<tr>
<th></th>
<th>HHXRF</th>
<th>OES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Incoming inspection</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metal sheet, coil, billet</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Warehouse screening</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Outgoing QC</strong></td>
<td></td>
<td></td>
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<tr>
<td>NDT verification</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Seal of approval</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Warehouse screening</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Internal scrap</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Weld inspection</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw materials</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>When C not needed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In situ</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>When C is needed</td>
<td></td>
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</tbody>
</table>
Summary – Choosing the right tool

I want to...

<table>
<thead>
<tr>
<th>Feature</th>
<th>LIBS</th>
<th>HHXRF</th>
<th>OES</th>
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</thead>
<tbody>
<tr>
<td>rapidly sort stainless steels</td>
<td>⭐⭐⭐⭐⭐</td>
<td>⭐⭐⭐</td>
<td>⭐</td>
</tr>
<tr>
<td>sort Aluminium alloys</td>
<td>⭐⭐⭐⭐⭐</td>
<td>⭐⭐⭐</td>
<td>⭐⭐⭐⭐⭐</td>
</tr>
<tr>
<td>accurately determine the chemical composition of Aluminium and Titanium alloys</td>
<td>⭐⭐⭐⭐</td>
<td>⭐⭐⭐⭐</td>
<td>⭐⭐⭐⭐⭐</td>
</tr>
<tr>
<td>determine the Ni, Cu and Mo contents accurately</td>
<td>⭐⭐⭐⭐</td>
<td>⭐⭐⭐⭐⭐</td>
<td>⭐⭐⭐⭐⭐</td>
</tr>
<tr>
<td>analyse penalty and trace elements on &lt; 0.1 % level</td>
<td>⭐⭐⭐⭐</td>
<td>⭐⭐⭐⭐⭐</td>
<td>⭐⭐⭐⭐⭐</td>
</tr>
<tr>
<td>analyse samples with minimum preparation needed</td>
<td>⭐⭐⭐⭐⭐</td>
<td>⭐⭐⭐⭐⭐</td>
<td>⭐⭐⭐⭐</td>
</tr>
<tr>
<td>bring the analyser where the samples are</td>
<td>⭐⭐⭐⭐⭐</td>
<td>⭐⭐⭐⭐⭐</td>
<td>⭐⭐⭐⭐⭐</td>
</tr>
<tr>
<td>sort plastics</td>
<td>-</td>
<td>⭐⭐⭐</td>
<td>-</td>
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<tr>
<td>sort electronic scrap</td>
<td>-</td>
<td>⭐⭐⭐⭐</td>
<td>-</td>
</tr>
<tr>
<td>sort / analyse catalytic converters</td>
<td>-</td>
<td>⭐⭐⭐⭐⭐</td>
<td>-</td>
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Paper by Karl Mayle

Delivered by Marc Forbes

19th Annual Conference - Banff 2015