Economic considerations on MS actions

In-house versus external testing

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   What is “adequate scale”?
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Adequate scale: what does it mean?

• 765/2008 Art. 19 requirement
• Currently not clear what it means practically

To consider that sampling costs are “the” limiting factor in MS actions
Setting a cost function for “adequate scale”

Define cost function of market sampling
(system level sampling)

\[ C = C_1 \cdot n_{LR} + C_2 \cdot n_{MR} + C_3 \cdot n_{HR} + C_4 \cdot n_{SR} \]

Where:

- **C** = total cost of sampling and should be minimal.
- **LR**: Low-acceptable Risk product
- **MR**: Medium Risk
- **HR**: High Risk
- **SR**: Serious Risk
  (from EC Risk Assessment Decision 2010/15/EC).
Economic considerations

✓ **Estimation of testing (assessments) costs**

- Using a Business Plan approach – optimal sampling
- Calculations performed for small/medium large/large countries based on:
  - NCR = 15 %
  - Low risk equipment (e.g. specific type of household eq.)
Economic considerations

✓ Estimation of costs: comparison between external lab testing and combined in-house and external lab testing

✓ 3 essential requirements tested per sample
✓ 2 tests in-house, 1 test in lab
✓ Average cost of sample = 70 EURO (incl. transport costs)
✓ Cost of lab testing per test = 100 EURO
✓ In-house test equipment cost = 40,000 EURO (depreciated over 10 years)
✓ Cost of test technician per year = 50,000 EURO
Economic considerations

**Estimation of costs**

Simulations performed using sample sizes as follows:

<table>
<thead>
<tr>
<th>Size of the country</th>
<th>Number of items tested annually</th>
</tr>
</thead>
<tbody>
<tr>
<td>small</td>
<td>1000</td>
</tr>
<tr>
<td>medium large</td>
<td>2200</td>
</tr>
<tr>
<td>large</td>
<td>4400</td>
</tr>
</tbody>
</table>

These are estimates if one considers a NCR of 15% and low risk equipment.
Economic considerations

**Annual costs vs. number of items tested**

- Blue line: Annual cost for inspection with in-house lab.
- Red line: Annual cost for inspection without in-house lab.
- Green line: Small country.
- Purple line: Medium big country.
- Teal line: Big country.

Y-axis: Euros
X-axis: Number of items tested annually.
Economic considerations

✓ **Estimation of costs:** some conclusions

✓ If there are performed min. number of annual test \( \geq 270 \) (\( N_0 \)) per year, then in-house testing is economically justified (apart from big advantage of building know-how!)

✓ For large countries, this is even more important.

Formula used: \[ N > 0.15 \cdot \frac{c_{eq} + 10 \cdot c_{tec}}{c_{nin \cdot h} - c_{inh} - c_{nin \cdot h}} = N_0 \]
Part 1 gives the minimal number of items that should be tested annually in order to have in-house lab economically justified.

In this part we will discuss, using an example, the statistical justification of having in-house lab.

MATLAB simulation software was used for calculation of standard deviation (precision) of the inspection in 6 different cases.
✓ 6 cases were simulated

<table>
<thead>
<tr>
<th></th>
<th>Small country</th>
<th></th>
<th>Medium country</th>
<th></th>
<th>Big country</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Case 1</td>
<td>Case 2</td>
<td>Case 3</td>
<td>Case 4</td>
<td>Case 5</td>
</tr>
<tr>
<td>Number of items per product</td>
<td>1400</td>
<td>400</td>
<td>700</td>
<td>500</td>
<td>2000</td>
</tr>
<tr>
<td></td>
<td>14000</td>
<td>4000</td>
<td>7000</td>
<td>5000</td>
<td>20000</td>
</tr>
<tr>
<td></td>
<td>140000</td>
<td>40000</td>
<td>70000</td>
<td>50000</td>
<td>200000</td>
</tr>
<tr>
<td>Fraction tested external / in-house lab (%)</td>
<td>33 / 67</td>
<td>100 / 0</td>
<td>33 / 67</td>
<td>100 / 0</td>
<td>33 / 67</td>
</tr>
<tr>
<td>Cost: external / in-house lab (per item)</td>
<td>370 / 124</td>
<td>370 / 95</td>
<td>370 / 95</td>
<td>370 / 95</td>
<td>370 / 95</td>
</tr>
</tbody>
</table>
Common data for the 6 cases

- Number of different products on the market: 8
- Product risk of all products: Low
- Measurement error of the in-house lab: 10%
- Measurement error of the external lab: 5%
- Inspection by attributes is used.
- Estimate of the fraction of conforming items per product (known from previous inspections or by preliminary sampling):

<table>
<thead>
<tr>
<th>Product No</th>
<th>Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.96</td>
</tr>
<tr>
<td>2</td>
<td>0.99</td>
</tr>
<tr>
<td>3</td>
<td>0.97</td>
</tr>
<tr>
<td>4</td>
<td>0.98</td>
</tr>
<tr>
<td>5</td>
<td>0.95</td>
</tr>
<tr>
<td>6</td>
<td>0.93</td>
</tr>
<tr>
<td>7</td>
<td>0.94</td>
</tr>
<tr>
<td>8</td>
<td>0.92</td>
</tr>
</tbody>
</table>
Fixed cost example: inspection by attributes in a medium large country
✓ **Estimation of costs: some conclusions**

For fixed total costs of the inspection (on the x-axes), green markers lie below the red ones, i.e., standard deviation of the inspection if using in-house lab is smaller than using only external lab. This means that the precision of the inspection is higher when using combination of in-house and external testing.
Statistical justification

✓ **Estimation of costs: some conclusions**

**Explanation:** In-house testing is with higher measurement error, but it is cheaper. So, more items can be tested for the same budget, which finally brings lower standard deviation (error) of the inspection.
In-house testing: examples

- In-house test facility - some example of test equipment
  - Dielectric tester
  - Earth continuity tester
  - Test finger
In-house testing: examples

✓ In-house test facility

• Essential tests to be foreseen
  • LVD: earth continuity, HV-test, leakage current, isolation power supply (safety of the operator), temperature data recorder, test finger, etc.
  • EMCD: conducted emission test set-up, EFT (Electrical Fast Transient) test set-up, etc.
  • MD: Mechanical measuring equipment, ....
• The IEC standard for lab testing (TC 64) shall be considered to protect MS staff during assessments.
Based on the requirements of the NLF “adequate scale” and performing simulations using system simulation software, we can state that:

- Substantial cost savings are proved when performing a mix of in-house and external testing
- The importance of know-how building using in-house test facilities for the MSA, is a site-effect of performing in-house testing
- To protect MS staff during assessments.