Web-based inspections in industrial radiography

Digital inspections in an analogue world

www.nrpa.no
<table>
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<th>Use</th>
<th>Inspection Frequency (years)</th>
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<td>Dental radiography</td>
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<td>Nuclear medicine</td>
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<td>Radiotherapy</td>
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<tr>
<td>Diagnostic radiology – centres with complex equipment (e.g. computed tomography, interventional radiology, fluoroscopy, mammography)</td>
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<td>Diagnostic radiology – centres with conventional X ray equipment only</td>
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<td><strong>Industrial radiography</strong></td>
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<td>Irradiators (i.e. industrial)</td>
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Industrial radiography in Norway
Solution?

Hire the Flash…
Solution?

...an army of inspectors...
Solution?

...use The Internet.
Method

• Questionnaire sent to radiation protection officers (RPO) by e-mail.

• Unique link in e-mail leads RPOs to their company specific questionnaire online.

• Accompanying letter from NRPA emphasising that responding is obligatory, not voluntary.

• Questionnaire, e-mails, replies handled by EasyResearch™.
Questionnaire

• 52 questions.

• Questions grouped thematically over 8 pages.

• Multiple choice or specific format to enable automated analysis.

• All questions had to be answered to be able to complete questionnaire.
Questionnaire

• 8 possible non-compliances. (“Does there exist written instructions for RPO?”)

• 9 possible notifications. (“What year were instructions for RPO revised?”)

• 22 requests for information. (“Number of devices for gamma radiography?”)

• 13 questions regarding substitution. (“To what extent can UT replace gamma/x-ray?”)
Response timeline

- **Deadline 1**: 57
- **Deadline 2**: 67
- **Threat of fine**: 70
Results – overview

- 70 questionnaires completed – response rate 100 %.

- Updated information on radiography companies:
  - 928 radiation protection certified operators.
  - 255 gamma sources.
  - 237 x-ray sources.
Number of radiography operators is 10 or less for about two thirds of the companies.
Number of radiation sources is five or less for about two thirds of the companies.
22 non-compliances were found at 17 companies, no company more than two.
Non-compliances – causes

- Too high dose rate outside shielded enclosure.
- No written emergency procedures.
- No local log of gamma sources.
- No written procedure for radiography.
- Personal alarm monitor not available.
- Gamma sources not registered with the NRPA.
- No written instructions for the RPO.
- X-ray sources not registered with the NRPA.
13 companies were subjected to on-site inspections in parallel to the web-based ones. More non-compliances were found on-site, unsurprisingly.
Web-based vs on-site inspections

• **Company D.**
  In questionnaire, they confirmed having written procedures, thus in compliance. On-site these procedures were found sufficiently poor and outdated to warrant a non-compliance.

• **Company F.**
  Said in questionnaire that they were using a closed facility for radiography. On-site inspection revealed that this facility did not fulfill all conditions of a closed facility, and a non-compliance was issued.

• **Company G.**
  Gave a number of certified operators in questionnaire. Turned out on on-site inspection that one operator did not possess an accredited certificate in radiation protection.
Self reporting vs NRPA auditing

- Too high dose rate outside shielded enclosure.
- No written emergency procedures.
- No local log of gamma sources.
- No written procedure for radiography.
- Personal alarm monitor not available.
- Gamma sources not registered with the NRPA.
- No written instructions for the RPO.
- X-ray sources not registered with the NRPA.

Non-compliances from online inspection vs Non-compliances from registry audit
Self reporting vs NRPA auditing

![Graph showing data comparison between Self reporting and NRPA auditing for Gamma and X-ray]

- **Gamma**:
  - Online: 250
  - Registry: 200
  - Application: Least

- **X-ray**:
  - Online: 300
  - Registry: 150
  - Application: 225

Legend:
- Blue: Online
- Red: Registry
- Green: Application
Substitution

• **Question**: To what extent can gamma and/or x-ray be replaced by NDT methods which improve radiation protection?

• Six possible substitutions:
  1. X-ray for gamma.
  2. Ultrasound for gamma/x-ray.
  5. Eddy current for gamma/x-ray.

• Long story short: Only options 1 & 2 were considered viable.
How many gamma examinations could be performed with x-ray?

- Impossible to say.
- None.
- Some examinations (up to 25%).
- About half the examinations (25-75%).
- Most of the examinations (more than 75%).
- All.

About two thirds of the companies (64%) believe that at least some gammaradiography can be replaced with x-ray radiography.
What prevents x-ray from replacing gamma radiography?

Main argument against x-ray radiography is accessibility for relatively large equipment, poorer image quality and expense for customer (x-ray taking longer).
How many gamma/x-ray examinations could be performed with ultrasound?

About half the companies believe that at least some gamma/x-ray radiography can be replaced with ultrasound.
What prevents ultrasound from replacing gamma/x-ray radiography?

- Alternative method does not give desired results.
- The customers do not want alternative.
- Alternative impractical.
- No industrial standard for alternative.
- Alternative method more expensive.
- No in-house competence on the alternative.

The main problem with ultrasound replacing ionising radiation is that it cannot be applied in all situations (thickness of objects).
Substitution «conclusion»?

• There is potential for increasing use of x-ray to replace gamma and ultrasound to replace gamma/x-ray, and many companies phase out gamma for their own radiation protection purposes.

• Main obstacles for substitution are accessibility (size of x-ray) and applicability (object dimensions for ultrasound).

• Economical considerations may work against substitution, as x-ray takes longer, making it more expensive for customer.

• Technology developing rapidly, can authorities find incentives to speed substitution up?
Feedback – time spent

![Bar chart showing the number of companies according to the time spent to complete the questionnaire.](image)

- **< 1 h**: 45 companies
- **1-2 h**: 15 companies
- **> 2 h**: 5 companies
Feedback - usefulness

Number of companies

- Very useful: 35
- Somewhat useful: 34
- Not useful: 1
Conclusion

• Web-based inspections feasible – response rate 100 %.

• Much data gathered – quantity over quality.

• Future inspections may:
  – Utilise feature of «conditional questions».
  – Ask for attachment of documents (although currently not a feature in EasyResearch™).

• Method may also be applicable for inspections in other areas (veterinary, dentist, control sources, etc.)