Occupational Radiation Protection in Industrial Radiography – *Review and Recommendations*

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International Conference on Occupational Radiation Protection:
Enhancing the Protection of Workers – Gaps, Challenges and Developments
International Atomic Energy Agency, Vienna 1-5 December 2014

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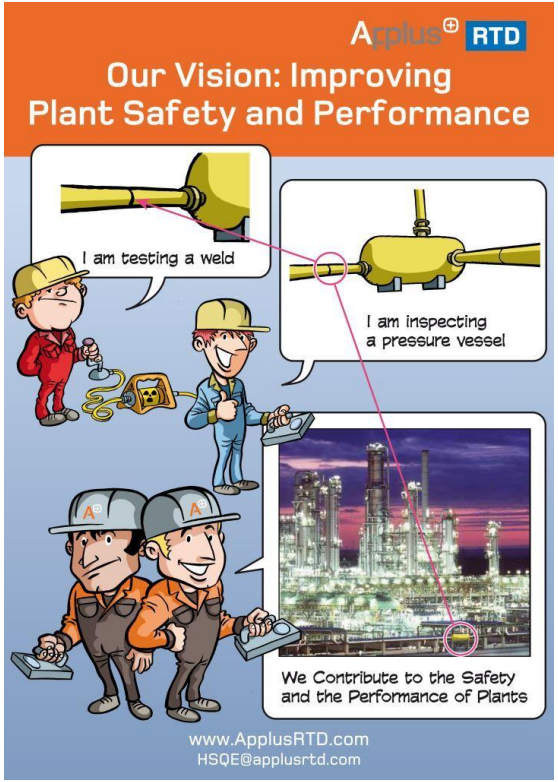
Introduction NDT / Industrial Radiography

Purpose of NDT / Industrial Radiography

- Determine integrity of materials, components and structures in a non-invasive way
- Provide information to make decisions on maintenance, repair and replacement
- Ensure safe and efficient use of products and production facilities
- Contribute to the protection of the health and safety of workers, the public and the environment.



Industrial Radiography

- Radiation sources:
  - Radioactive sources
  - X-ray tubes
  - Linear accelerators
- Location:
  - Shielded enclosures / Radiation Bunkers
  - In the field / customer site
  - Onshore / offshore

site x-ray radiography

site gamma radiography

Linear accelerator

site radiography x-ray crawler

Applus RTD Rayscan spoolbase

Applus RTD Rayscan pipeline

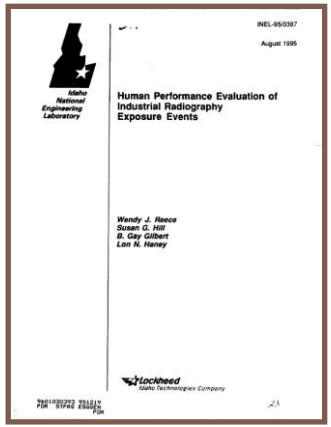
Challenges at the worksite / from work conditions

- RT technicians frequently have to work:
  - at not easily accessible locations, e.g. in confined spaces, in trenches or at height
  - in inhospitable areas and sometimes at extreme weather conditions
  - (long periods of) long subsequent day and/or night shifts

Human performance evaluation of industrial radiography exposure events

W.J. Reece et al. (1995)

- Categorization of events
  - Procedural errors (1/3)
    - Improper survey
    - Survey not performed
    - Camera not locked
  - Interaction with equipment (1/3)
    - Equipment design issues
    - Source Connection/disconnections
  - External factors (1/3)
    - Alarms
    - Supervision
    - Area control
- Information Processing Failures
- Performance Shapping Factors:
  - End of workday / midnight (1/3)
  - Poor lighting (1/5)
  - Inadequate raining (1/5)
  - Location specific conditions (1/5)
    - Trench
    - Muddy
    - Confined space
    - Scaffold


INEL-95/0387

August 1995

Idaho National Engineering Laboratory

Human Performance Evaluation of Industrial Radiography Exposure Events

Wendy J. Reece
Susan G. Hill
B. Gay Gilbert
Lon N. Haney

Lockheed Idaho Technologies Company

Review of current status of Radioprotection

ISEMIR Working Group Industrial Radiography

- **I**nformation **S**ystem on Occupational **E**xposure in **M**edicine, **I**ndustry & **R**esearch
- Supporting NDT Industry to keep ALARA:
  - the dose due to normal exposure
  - the risk of exposure due to accidents
- World-wide survey addressed to
  - Regulatory bodies
  - NDT companies
  - Individual RT technicians
- Results published in IAEA-TECDOC-1747

Name	Region	Stakeholder
G. Abela	Europe	Client
M. Purschke	Europe	NDT Society
T. Levey	North America	Operating Company
A. Razak Hamzah	Asia	Technical Service Organization
K. Sahaimi	Africa	Training provider
F. Da Silva	Latin America	Technical Service Organization
R. Van Sonsbeek	Europe	Operating Company
J. Le Heron	Scientific Secretary	IAEA
C. Lefaure	Consultant	IAEA

Survey; categories of subjects

1. qualifications and training of radiographers in radiation protection,
2. learning from incidents,
3. systems and procedures in place for safe operation,
4. emergency preparedness and response, and
5. individual monitoring.

The IAEA Specific Safety Guide on Radiation Safety in Industrial Radiography (IAEA Safety Standards Series No. SSG-11) was used to develop the questionnaires

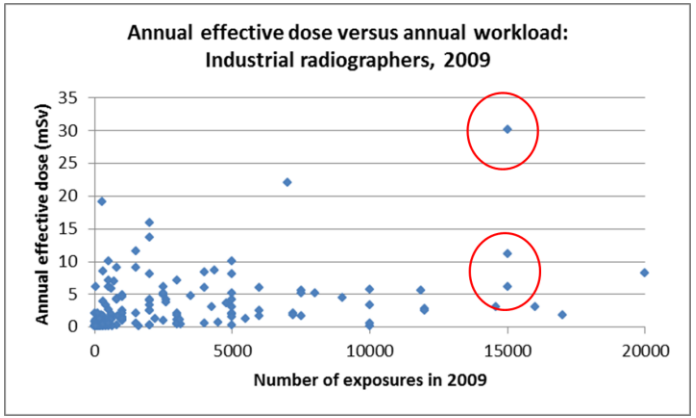
Findings ISEMIR WGIR Survey 1/2

- Initial radiation protection training for radiographers is reasonably well established, but there is room for improvement especially with respect to refresher training and practical emergency response training.
- The frequency of occurrence of incidents (accidents, near missed and deviations) is not trivial, and methods such as better incident reporting, analysis, feedback and sharing lessons learned need to be better utilized.
- Collimators and diaphragms are not being used as often as they should be.
- Survey meters are not as widely available as they should be and improper use of survey meters is mentioned by both NDT companies and regulatory bodies to be one of the most common shortcomings found during inspections.

Findings ISEMIR WGIR Survey 2/2

- Individual monitoring, as reported, is well established, with passive and, usually, active dosimeters. The establishment and use of investigation levels needs to be improved.
- Warning systems to prevent entry to the work area during site radiography were not always as effective as desired. Better communication at the site is indicated.
- Emergency plans were widely prevalent, but there seemed to be some issues regarding specific training for radiographers with respect to emergencies.
- Occupational doses received by radiographers varied considerably, with no correlation with radiographic workload.

No correlation found between dose and workload – but limited amount of data



- Mean occupational dose per radiographic exposure
  - 4.8 ± 2.3 µSv for all technicians
  - 2.9 ± 1.2 µSv for technicians with workload > 100 exposures

- No effect on dose per exposure found with:
  - level of NDT training
  - type of sources being used,
  - activity of sources,
  - use of collimation, or
  - incidence of events
- Radiation protection in industrial radiography is not being effectively optimized

Recommendations for further improvement actions

Rationale for an International Database (ID)

- The worldwide survey of the WGIR showed
  - significant occupational doses do occur,
  - accidents do happen, and
  - the variation in occupational dose per radiographic exposure is considerable
- This in turn shows that there is a need for
  - considerable improvement in occupational radiation protection
  - implementation of optimization of protection

ISEMIR - ID: an international database

- Tool for optimization of Occupational RP
  - Primarily for the end-user, i.e. NDT companies
  - **Not** for assessing compliance with dose limits
- Statistical Analysis
- Metric for optimization analysis
  - Occupational dose per radiographic exposure
  - But use with care to avoid comparing  with 

ISEMIR - ID: data collection

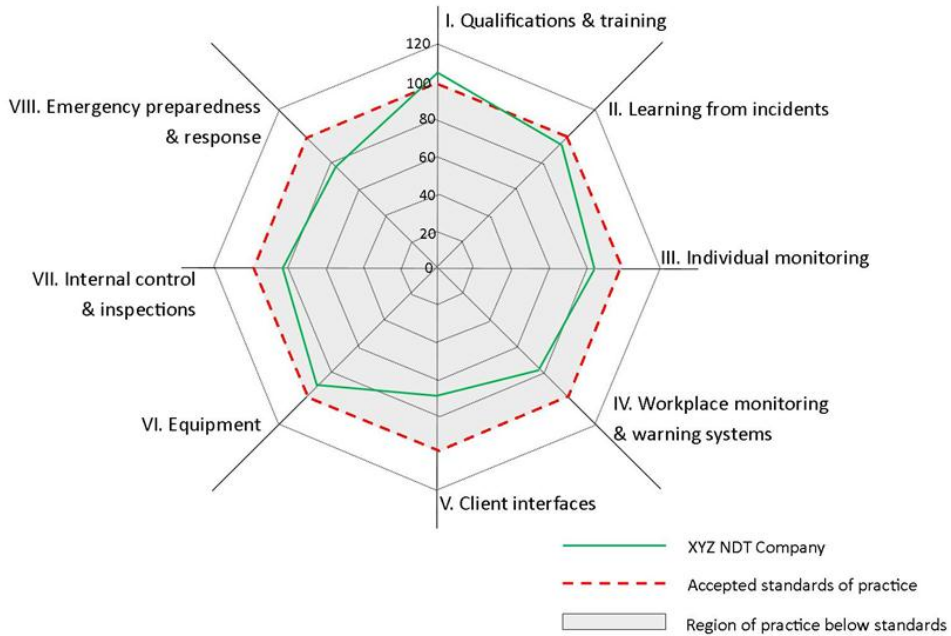
- Anonymized data on individual RT technicians:
  - occupational doses
  - radiographic workloads
  - level of NDT training
  - radiation protection training
  - sources used
  - percentage of site radiography
  - use of collimators
  - use of survey meters, and
  - number of incidents

ISEMIR - ID: Incident Reporting module

- A tool to provide information that should lead to a reduction of the risk of incidents in Industrial Radiography, including
  - Examples of incidents for training
    - Including emergency response
  - The ability to search for incidents related to a given factor, such as cause, equipment, conditions
  - Providing details on actual corrective actions implemented
  - Promotion of lessons learned

ISEMIR: Roadmap

- Self assessment tool for companies
- Same questions asked as in Company questionnaire
- Where applicable, third quartile of responses to Company questionnaire is used as benchmark
- Weighting of question based on relative importance for radiation protection



Technical Meeting on Radiation Safety in Industrial Radiography, Vienna 23-27 June 2014

- Recommendations to the IAEA from
  - Sessions on
    - Training
    - Equipment
    - Emergency response
    - Regulatory infrastructure
    - Safety/security interface
  - Breakout discussion groups
    - Review of current IAEA documents
    - Training material needs and desires
- Recommendations are captured in the report of the chairman (Kinneman (2014))

International Training Standard for radiation safety in industrial radiography

- Requirement for training
  - At different levels
  - For different roles
    - Assistants
    - Radiographers
    - RPO
    - Maintenance
    - Source Retrieval
- Similar to ISO 9712?

- Benefits
  - International baseline
  - Mutual recognition
    - except for national / local rules

A review of ISO 3999 is needed before further adoption is promoted

- ISO 3999 Radiation protection - Apparatus for industrial gamma radiography - Specifications for performance, design and tests
- ISO 3999 prescribes safety devices, however:
  - Failure of safety devices will lead to unsafe operations potentially leading to radiation incidents
  - Safety devices make source retrieval more complicated, potentially leading to more severe consequences of the radiation incidents
- A review is needed to verify the effectiveness of implementation of ISO 3999:
  - Is there a correlation between recent radiation incidents and compliance with ISO 3999?
  - Do tests account for the conditions under which the devices are used in the field?
  - Are exposure devices always manufactured and repaired according to design specifications?
  - Are end-users sufficiently involved in determining the design criteria?

Conclusion

Conclusion

- With a proper radiation protection program in place industrial Radiography can be performed safely
- There is still considerable opportunity for improvement of the implementation and harmonization of radiation protection programs
- The IAEA appears to be the organization to lead this improvement thereby following the various recommendations for further actions
- The Working Group Industrial Radiography of ISEMIR can play a significant role in the implementation of these actions
- The main challenge is to get involvement from the NDT industry

Be interested