Analysis of Regulatory Inspection Findings of Industrial Radiography Facilities

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Abstract:
Analysis of inspection findings of Industrial Radiography (IR) facilities which were inspected by AERB during February 2017 to July 2018 was carried out. A total of 408 Non Compliances (NCs) were reported by the inspectors from 129 IR facilities inspected during this period. There were some IR facilities in which good safety performance was observed with no NCs, and there were some facilities in which more than 6 NCs were observed. On average, 3 NCs were observed in each IR inspection during this period.
The analysis indicated that most of the observations made during inspection were related to inadequacies in obtaining regulatory approvals & record keeping. There were few safety related observations such as untrained manpower operating IGRED, non-functional GZM, non-availability/use of pocket dosimeters etc.
The report brings out specific areas which need more regulatory focus to improve safety further. A Safety Pamphlet has been prepared by AERB for the industrial radiography facilities which brings out the minimum safety precautions to be taken in the form of “Do’s and Don’ts”.

1.0 Introduction
Industrial Radiography (IR) is one of the most widely used non-destructive testing (NDT) techniques for examination of internal defects (cracks, porosity, voids etc.) in materials and structures such as vessels, pipes, welded joints, castings. Industrial Radiography equipment utilizes either a high activity sealed Gamma Source (10-100GBq) housed in a shielded exposure device known as Ionising Gamma Radiation Exposure Device (IGRED), or a radiation generation equipment that generates X-rays.

Adequate infrastructure, proper operating procedures, and qualified & trained operating personnel are the prerequisites for ensuring radiation safety during IR activities. In case of Source based radiography, the Source remains shielded in the exposure device when not in use, and brought to exposed position during exposure and retracted back remotely by a flexible cable of a driving unit after desired exposure time. As the high activity sealed Source is in exposed condition during the activity, protection of the operator and the public completely depends on operational controls. In-situ radiography (open field radiography) as well as enclosed radiography (inside a shielded enclosure) are generally undertaken with Source based exposure devices and X-ray based exposure devices are generally used in enclosures.

There are 486 licensed Industrial Radiography (IR) facilities in India [as on March 2018]. With an inspection frequency of once in every 3 years and other priorities, 129 facilities were inspected during February 2017 - July 2018 and 408 Non-Compliances (NC) were observed. These NCs were analysed to identify areas for improvement and take corrective measures to improve safety.
2.0 Objective
One of the mandates of Directorate of Regulatory Inspection (DRI), AERB is to maintain database for all types of regulatory inspection’s observations, recommendations and carry out periodic analysis for feedback, improvement and optimization for future inspections, safety review processes and developing regulatory inspection indicators. Based on this, compilation and analysis of frequently occurring non-compliances at various Industrial Radiography facilities have been carried out.

The objective of this analysis was to identify generic non-compliances and suggest remedial actions to improve safety further.

3.0 Methodology & Analysis
In order to find out the type of non-compliances occurring frequently, 408 inspection findings recorded during regulatory inspection at 129 IR facilities over the period from February 2017-July 2018 were reviewed. After careful study of the non-compliances (NC) and the type of observations, it was found that these NCs can be majorly grouped into two categories namely –

a) Safety related (can affect the safety of the equipment, worker, public & environment)
b) Management System related (Licences, approvals, procedural deficiencies, record keeping etc.)

With an aim to identify weaknesses in specific areas/aspects to target focused inspections, these NCs were further grouped under 10 sub-sections as listed below-

a) Layout (Source Storage/ Enclosure)
b) Personnel Monitoring
c) Workplace Radiation Monitoring
d) Emergency Plan & Preparedness
e) Regulatory Submissions & Approvals
f) Operating Personnel
g) Security of Sources
h) Source Inventory & Disposal
i) Source /Device Procurement
j) Operational Safety

4.0 Safety Performance
A total of 408 NCs were reported by the inspectors from 129 IR facilities inspected during this period. There were some IR facilities in which good safety performance was observed with no NCs, and there were some facilities in which more than 6 NCs were observed. On average, 3 NCs were observed in each IR inspection during this period. The following Chart depicts the distribution of No. of NCs with respect to Number of IR Facilities:
Data Interpretation

7% of facilities (9) did not have any NCs
7% of facilities (9) had > 6 NCs
86% of facilities (111) had 1-6 NCs
Maximum no. of Facilities (23%) had 3 NCs

5.0 NC Categorisation (Safety Significance)

Reported NCs were grouped into two major categories based on the safety significance of the inspection observation –

- Safety related (can affect the safety of the equipment, worker, public & environment)
- Management System related (procedural deficiencies, record keeping, approvals etc.)

Aspects considered for categorising NCs as safety related NCs are –

- Operating with untrained personnel
- Source Storage Pit/Enclosure does not meet regulatory requirements with respect to radiation safety and/or security of Sources
- Safety interlocks of the IGRED defective/disabled
- Non-availability of Personal Dosimeters (active/passive) with the radiation workers
- In-situ radiography without barricades/warnings

Aspects considered for categorising NCs as Management System related NCs are –

- Operating without License, but meeting safety requirements
- Source movement without approval
- Record keeping issues (Logbook/records)

Type of NCs Vs Number of IR Facilities

<table>
<thead>
<tr>
<th>Type of NC</th>
<th>No. of NCs</th>
<th>(% NCs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety related</td>
<td>137</td>
<td>34</td>
</tr>
<tr>
<td>Management System related</td>
<td>271</td>
<td>66</td>
</tr>
<tr>
<td>Total</td>
<td>408</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Data Interpretation
66% of NCs were reported on deficiencies related to management systems of the facility.
34% of NCs which are related to safety were mostly on safe storage of IGREDs, availability of emergency equipment, Personnel Monitoring (TLD/DRD) etc.

6.0 **Area/Aspect specific NC Analysis**
All the 408 NCs were analysed and grouped into 10 sub-sections to focus on specific attributes/aspects of IR Facilities. The following Chart depicts the distribution of NCs with respect to these major attributes.

![Operational Safety Chart]

**6.1 Operational Safety**
Observations related to unsafe work practices and equipment (Operational Safety) accounted for nearly 14% of all the non-compliances noted during these inspections. The major contributors were –
- Discrepancies related to putting up radiation warning symbols on open field radiography Sites as well as Enclosure radiography Sites
- Non maintenance of Equipment O&M Log books

*In ~10% observations, it was noted that the IGRED was operated by untrained personnel which is a concern as such operations normally lead to radiation exposures due to lack of training and awareness.*

### 6.2 Source / Device Procurement
Observations related to procurement/supply of IRED without NOC /TA test accounted for only 1% [6 findings] of the total Non-compliances noted during these inspections. This is an indication of a reasonably good compliance to the regulatory requirements with respect to supply & procurement of IREDs.

### 6.3 Source Inventory & Disposal

<table>
<thead>
<tr>
<th>Source inventory &amp; disposal (no of observations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Record Keeping Issues (Inventory / Disposal Records not updated in e-LORA)</td>
</tr>
<tr>
<td>Unused X-ray machine pending for disposal</td>
</tr>
<tr>
<td>Disused Sources pending for disposal</td>
</tr>
</tbody>
</table>

Observations related to maintaining Source Inventory and safe disposal of disused Sources accounted for ~6% of the Non-compliances noted during these inspections. There were 11 disused Sources (Category-I) at facilities waiting for safe disposal which is a concern, as such devices in future may become vulnerable and orphan. Source inventory management in e-LORA was also an area which needs further strengthening as this is the window through which AERB can keep a tab on the number of Category-I radiography Sources in the Country.

### 6.4 Security of Sources
Nearly 6% of the Non-compliance observed during these inspections were related to inadequacies in maintaining Security of Sources. The major contributor (>50%) was the non-availability of a Security plan. This non-compliance can be attributed to lack of sufficient clarity and information to the facility about AERB’s expectations.

6.5 Operating Personnel

Inadequacies in maintaining trained and qualified operating personnel including RSO contributed to nearly 7% of the total non-compliances observed during these inspections. The major contributors were –

   a) Non-availability of AERB approved RSO
   b) Not maintaining/obtaining regulatory approvals for operating personnel

These non-compliances can be attributed to lack of regulatory control over the activities through e-LORA, as such non-compliances does not prevent the facility performing its activities.

Non-compliances with respect to inadequacies in the number of qualified radiographers can be attributed to lack of clarity in the AERB Safety Code. The Code specified adequate number of radiographers for the IR facilities which is subjective.

6.6 Regulatory Submissions & Approvals
Non-compliances related to regulatory submissions and approvals accounted for 24% of the total observations made during these inspections. The major contributor (>30%) was related to not obtaining regulatory approvals in time. Such non-compliance can be attributed to the present method of regulatory control through e-LORA which does not prevent the facility from operating without an approval.

Moreover, the X-ray based device owners do not bother to register their equipment and obtain a license for operation as the present method of regulation cannot prevent such owners performing such activities without a license.

6.7 Emergency Plan & Preparedness

11% of the observations made during these inspections were related non-availability of an Emergency Preparedness plan as well as preparedness of the facility for such emergencies. Non-availability of emergency handling tools and accessories, and an emergency plan were the major contributors (~70%) to this sub-section. The reason for such non-compliance can be attributed to the resent regulatory approval mechanism where approvals are accorded based submissions before a physical inspection of the facility.

6.8 Workplace Radiation Monitoring
11% of the total observations were related to inadequacies in providing a functional workplace radiation monitoring system for IR activities. Nearly 30% of observations were related to non-availability/non-functional Radiation Survey Meter (RSM) or Gamma Zone Monitor (GZM). In some of the cases, the installation of the GZM was improper (Sensor as well Monitor installed outside the Enclosure). An equal contributor to this sub-section was Instrument calibration at non-recognised laboratories. Such non-compliances can be attributed to the lack of awareness about the importance of GZM/RSM in IR activities.

6.9 Personnel Monitoring

14% of the observations made during these inspections were related to inadequacies in Personnel Dose monitoring. A major observation (~50%) in this sub-section was related to not maintaining the dose records of Pocket Dosimeters.

Non-availability of a PMS Service as well not providing TLD to each Radiation worker was also a concern as this accounted for nearly 25% of observations in this sub-section. Moreover, record keeping and declarations in e-LORA was also a problem area as this contributed to the overall non-compliance in this sub-section.

6.10 Layout (Source Storage / Enclosure)
5% of the observations noted during inspection were related to inadequacies with respect to Source Storage and Enclosure Layout. Nearly 75% of the observations in this category were related to either non-availability of a proper Source Storage Pit, or the available pit not meeting the safety & security requirements.

There were also observations related Enclosures where the construction was not done as per the approved layout.

Such non-compliances can be attributed to lack of regulatory controls in the present regulatory mechanism where approvals are accorded before an inspection has been done.

### 7.0 Most frequent NCs (Top 5)

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Nature of NC</th>
<th>Occurrence</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pocket dosimeter records not maintained.</td>
<td>26</td>
<td>Lack of awareness/ clarity in regulatory requirements.</td>
</tr>
<tr>
<td>2</td>
<td>Site approval/movement permission not obtained</td>
<td>24</td>
<td>System of approval in eLORA is based on facility declarations without AERB interventions and no financial penalty on the Facility for violations/false declarations. Moreover, the transfer window is open for indefinite period.</td>
</tr>
<tr>
<td>3</td>
<td>Licence for few IRED (IGRED/X-ray/Linac) not obtained</td>
<td>17</td>
<td>Registration in eLORA though mandatory, does not pose any restriction on the facility to procure and use the equipment without the same.</td>
</tr>
<tr>
<td>4</td>
<td>Calibration of Radiation Survey Instrument(s) not done from Recognised Cal. Lab</td>
<td>16</td>
<td>Lack of awareness</td>
</tr>
</tbody>
</table>

### 8.0 Conclusions

The analysis indicated that most of the observations made during inspection were related to inadequacies in obtaining regulatory approvals & record keeping. There were few safety
related observations such as untrained manpower operating IGRED, non-functional GZM, non-availability/use of pocket dosimeters etc. With a view to improve safety and regulatory compliance further, a Safety Pamphlet has been prepared (Annexure) which brings out the salient points of this Analysis in the form of Do’s & Don’ts. This Pamphlet will be sent to each IR Facility to sensitise them on radiation safety aspects of IR activities.

Besides, a self-assessment checklist will be sent to these facilities which will help them assess their own safety & regulatory compliance. This will help to build the safety culture and improve safety through self-regulation.

Acknowledgements

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References

Annexure
Radiation Safety in Industrial Radiography

Dos' and Don'ts

Directorate of Regulatory Inspection, AERB has analysed the Inspection findings of Industrial Radiography facilities to identify areas for improving safety. Based on the analysis results, this information pamphlet has been prepared to provide a quick and easy reference on the basic safety precautions to be taken by all the stakeholders involved in the industrial radiography activity to ensure the radiological safety of the radiation workers and the public.

Trainee Radiographer
Do's
- Work under direct physical supervision of radiographer/RSO
- Comply with the instructions of radiographer/RSO on radiation protection
- Use radiation survey meter, TLD badges and protective accessories while conducting industrial radiography

Don'ts
- Don't operate Induslial Radiography Exposure Device (IRED) or handle any emergency involving IRED in the absence of the radiographer/RSO
- Don’t attempt repair of IRED
- Don’t leave TLD badges near radiation area

Radiographer
Do's
- Check the IRED for operational healthiness of all safety interlocks before first use
- Use protective accessories, radiation survey meter, TLD badges while conducting industrial radiography
- Inform about any defects of the IRED, accidents, near miss accidents, or potential hazards to the RSO/Licensee/Employer promptly
- Comply with the safety instructions of RSO/Licensee/Employer

Licensee
Do's
- Use only AERB type approved IGRED/X-ray based equipment
- Recruit only certified radiographers for radiography and ensure that adequate staff is available depending on the number of available IGREDs
- Provide all necessary facilities and resources to the RSO/radiographer for safe radiography activity [Collimators, radiation survey meters, pocket dosimeters, TLDs, fence ropes, warning signs, lead pot etc.]

Don'ts
- Ensure that industrial radiography installation is constructed according to the design approved by AERB
- Ensure that at least one calibrated radiation monitoring instrument in working condition is earmarked for every IRED
- Ensure safety & security of the IRED / X-ray based equipment during storage, use and transport
- Ensure safe disposal of disused radioactive source(s) and other decayed source(s) at an authorised waste management facility or return it to the country of origin with prior approval of AERB

Radiological Safety Officer (RSO)
Do's
- Instruct workers on safety measures & safe work procedures
- Provide all protective devices, monitoring devices to each radiation worker during radiography
- Ensure that radiographer & trainee follow all safety instructions
- Ensure safe movement of IGREDs
- Report any unusual occurrence to the Licensee and AERB
- Investigate unusual occurrences & ensure prompt remedial measures to prevent reoccurrence
- Maintain inventory records of radiography Sources, dose records of radiation workers, Source movement records etc.
- Conduct emergency drills

Non-compliances with respect to safety may attract on-the-spot enforcement actions such as sealing of IGRED.

Don'ts
- Don’t transport IGREDs by public transport

Contract Awarding Party
Do's
- Appoint only AERB approved radiography agency
- Ensure that the radiography device is approved by AERB and the work is carried out by radiographers and RSO authorised by AERB
- Ensure that the radiography agency has emergency plans, preparedness and contact numbers in case of emergency/accidents involving radiography devices
- Provide safe workplace (Illumination, working platform etc.) for radiography activity
- Provide safe and secured storage facility for the IGREDs
- Facilitate inspection by AERB at the radiography Site

Don'ts
- Do not force the radiography agency for radiography activity, if the environmental conditions are not favourable for the job
- Do not engage multiple radiography agencies with overlapping of overlapping area

AERB may visit any radiography Site unannounced at anytime for Inspection.

Atomic Energy Regulatory Board (AERB)

Applications to AERB can be submitted online through http://www.aerb.gov.in/AERBPortal.CRA.htm
Above information is for quick reference only. Refer AERB Safety Code on Industrial Radiography available at http://www.aerb.gov.in/publications/codes-guides