L&T’s contribution in Development of RT shielding to achieve ALARA in Industrial radiography-Cost Vs Safety

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Abstract

Radiography Testing (RT) is considered most hazardous method amongst all Non Destructive Testing (NDT). Industrial radiography technique is most widely used to perform radiation operation in Capital goods industries as a quality measurement. Operational limits and Optimizing the risk level from ionizing radiation is prime concern for corporate industries. Radiation protection against the primary and scatter radiation is normally challenge since movement of huge equipment to enclosures is difficult or may not be economical.

At L&T, Hazira, we successfully identified & implemented the concept of special design movable shields to provide adequate protection to non-radiation workers. Construction of special design movable shield demands high level design and special arrangement for the movement, L&T ensures high level radiation safety and working environment to human safe working environment, L&T demonstrated high level of radiation safety over cost and time.

Keywords: Radiography Testing (RT), Dose limits, Movable shields, Radiation protection, Radiation safety.

Introduction

Radiography testing (RT) is a widely applied NDE method used in capital goods industries for detecting irregularities in casting, forging, piping and pressure vessel weld joints despite being considered as a most hazardous method amongst all Non-Destructive Testing (NDT).
Industrial Gamma Radiation Exposure Devices (IGREDs) are most widely used in industries to perform ionized radiation operations such as Enclosed Radiography/ Open field Radiography due to light weight and Portability.

Enclosed Radiography operations for capital good products such as Pressure vessels, heat exchanger and reactor are quite difficult due to their huge size and heavy weight. Movement of such equipment to approved Radiography enclosures demand high level of engineering plans and involves huge project cycle time and cost. Open field Radiography operations are most favorable for such huge equipment since movement to radiography enclosures is difficult or may not be economical.

Open field Radiography operations demands high safety precautionary measures as per legal guidelines provided by Atomic Energy Regulatory Board (AERB). Safety guidelines on “Open field Radiography/ Enclosed Radiography” mandates ensuring personnel dose limits of non-radiation workers as per ALARA principle. However achieving the same is impractical in industries as nil occupancy increases product cycle time and also, manufacturing large number of shields is not economical.

At L&T, Hazira, we have successfully overcome the situation by methodology of ALARA by implementing shielding management system where adequate protection for non-radiation workers is provided against the primary and scattered radiation within minimum operational limits considering safety as a prime concern.

The permissible dose limits given as 2mR per week for the areas occupied by the non radiation workers, L&T believes that the dose limits as only the guideline and not a GOAL.

Achieving radiation safety through large movable shields usually have large financial implications to the industry. This paper discusses L&T’s commitment towards maintaining high radiation safety standards despite the cost factors involved.

**Safety Management through ALARA:**

L&T, Hazira strictly follows the system guidelines as suggested by the International commission in Radiological protection (ICRP) for safe workplace

- All exposure shall be kept As Low As Reasonably Achievable (ALARA)
- Dose to individuals shall not exceed recommended limits
To meet the above objective, a dedicated radiation safety management system has been worked out and implemented. Safety was considered as the primary concern and objective and cost was not a criteria.

External radiations hazards can be easily controlled by controlling three fundamental factors

- Time
- Distance
- Shielding

Maintaining maximum distance between the source and workers is most effective means of reducing external radiation hazards, however at the same time it is not economic considering heavy production losses since industries work round the clock to achieve business goals.

Since maximum distance and minimum time do not ensure an acceptably low radition level, L&T has adopted the means of using a movable shield between source and the worker.

**Design of Shields**

It is really essential to consider the following aspects while designing the shields

- Dose limits
- Nature and activity of radiation available source
- Minimum cordonoff area distance
- Movement of shields
- Costingbased on material and thickness of sheilding

**Resource Allocation**

L&T Hazira is a leading organization in fabrications of steel products such as pressure vessels, heat exchanger and reactor equipment, for which there is extensive use of IGRED to perform radiography testing in enclosures.
Table-1: Allocation of IGRED Sources at L&T, Hazira

After envisaging movement restriction in bulky equipment for radiation operations, L&T has done specific allocation of available IGRED considering activity strength (Reference- Table-1).

**Micro mapping of open field area**

Establishment of boundary of each manufacturing area has been done through accurate mapping thus ensuring precise cordon off limit and intimation to non-radiation worker area team for the nil occupancy prior to open field radiography. Refer Figure: 1
The nature of source & activity, material thickness and maximum workload per week shall be taken into consideration for the calculation of area distance.

**Movement plan**

While designing the shields it is really essential to ensure the handling and movement capability at manufacturing area for which weight and size of shields shall be taken into consideration. Hence design of the shields shall incorporate location of lifting lugs, Center of gravity (CG) and adequate weld strength for the safe lifting and movement of shield.

**Costing**

While designing the shields it is also important to consider entire costing of engineering hours, manufacturing and each movements of shield for the open field radiography operations at manufacturing area. The required shielding thickness is calculated based on the Half value thickness (HVT) and Tenth value thickness (TVT) values of shielding material to keep the dose levels in permissible limits.

**Development of shield at L&T**

L&T Hazira had considered all above requirements provided in mandatory guidelines and overcome

From situation where open field radiography operation needs to be conducted at manufacturing area with extreme radiation protection to worker for achieving ALARA by the following means.

- Custom designed Mobile shields
- Movable Cement Blocks

**Customized design**

While designing the movable shields, L&T Hazira has considered all essential parameters such as weekly workload, weld thickness, nature and activity of IGRED, minimum cordonoff distance and established technical safety data as a inputs to design engineering, refer Table-2
<table>
<thead>
<tr>
<th>Source</th>
<th>Type of Shielding material used</th>
<th>Design thickness (mm)</th>
<th>HVT</th>
<th>TVT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iridium-192</td>
<td>Steel</td>
<td>30</td>
<td>2.4</td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td>Concrete</td>
<td>225</td>
<td>5.5</td>
<td>1.7</td>
</tr>
<tr>
<td>Cobalt-60</td>
<td>Steel</td>
<td>30</td>
<td>1.5</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Concrete</td>
<td>225</td>
<td>3.7</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Table-2: Technical data for the Shield design

Considering required shielding material thickness and combinations as per technical calculations, a detailed engineering design was done with the special features such as center of gravity (CG), minimum weld strength, lifting lug position. Overhead movable crane height and capacity were also taken into consideration by designers for movable RT shields, refer Table-3

Figure: 2 Detailed engineering drawing for the movable RT shield
The quantity of movable shields planned was Eight numbers for which the total manufacturing costing was approximately 80 lakh. The cost of each movement is not considered here.

<table>
<thead>
<tr>
<th>RT Shield Size (mm)</th>
<th>Weight</th>
<th>Required Qty.</th>
<th>Total costing (in Lakh INR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>Width</td>
<td>Height</td>
<td></td>
</tr>
<tr>
<td>255</td>
<td>6350</td>
<td>8000</td>
<td>31MT</td>
</tr>
</tbody>
</table>

Table-3: Design engineering data
Fabrications of movable RT shields

15mm Steel on both side

225mm concrete of 2.5 gm/cc

Figure: 5 Fabricated RT shields at L&T, HAZIRA

Closed shielding arrangement

Figure: 6 Placement of 3 shields during open field radiography operations
**Benifits of movable sheilds**

The special designed movable RT sheilds provide radiation protection to all non radiation workers who are outside the cordon off area.

ALARA principles are achieved through elimination of dose during openfeild radioagraphy operations.

**Path Forward**

Above established sheilding management system will support to drastically minimize potentional risk associated with security of IGRED,however L&T Hazira is in process to eleminating the same through avaliable advanced supporting techology such as advanced electromegnetic locking system,Global postioning tracking system and laser sensing device etc.

**Conclusion & Summary**

Provide safe work place in industry is responsibility of an institute. L&T Hazira demonstarted high radiation safety concern over cost by elimination of dose rate during open feild radiography of bulky equipment through development of special design movable RT sheilds.

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