Duke Energy
Managing Industrial Radiography Operations
Duke Energy Operates a Fleet of 7 Nuclear Units Located at 3 Sites With a Total Electrical Output of Approximately 7000 MW

<table>
<thead>
<tr>
<th>Site</th>
<th>Description</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oconee</td>
<td>Three B&amp;W designed PWRs</td>
<td>near Seneca, SC</td>
</tr>
<tr>
<td>McGuire</td>
<td>Two Westinghouse designed PWRs</td>
<td>located north of Charlotte, NC</td>
</tr>
<tr>
<td>Catawba</td>
<td>Two Westinghouse designed PWRs</td>
<td>located south of Charlotte, NC</td>
</tr>
<tr>
<td>Lee</td>
<td>Proposed Two Westinghouse AP-1000s s</td>
<td>located near...</td>
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</table>
What is Industrial Radiography?

Radiography: A nondestructive examination of the structure of materials by utilizing penetrating radiation to make radiographic images.
Film Radiography

The part is placed between the radiation source and a piece of film. The part will stop some of the radiation. Thicker and more dense area will stop more of the radiation.

The film darkness (density) will vary with the amount of radiation reaching the film through the test object.

- = less exposure
- = more exposure
Radiographic Images
SO, Why is Radiography a Big Deal?

There are really only 2 ways to have a serious acute radiation exposure incident at a nuclear plant...

**TIP Room (BWR)/Incore Thimble Room (PWR)**

These rooms are inside the reactor building and locked at all times with entry strictly controlled by the Radiation Protection staff

AND
Industrial RADIOGRAPHY

Which can be performed pretty much any place you can think of
What’s so dangerous about it, what’s the risk?

• Take a large amount of radioactive material (Typically 50 to 100 Curies of Ir-192 or Co-60)
• Contain it in a small volume
• Make it portable
• Control it with a couple guys and rope boundary

• No worries, RIGHT?
Doing the math....

A typical new source used at Duke arrives with 100 Curies of Iridium 192

\[
100 \, \text{Ci} \times 5.2 \, \text{R/hr/Ci} \, @ \, 1 \, \text{ft} =
\]

520 \, \text{R/hr} \, @ \, 1\text{ft}
## Putting this in perspective

<table>
<thead>
<tr>
<th>Dose (Rads*)</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-50</td>
<td>First sign of physical effects (drop in white blood cell count)</td>
</tr>
<tr>
<td>100</td>
<td>Threshold for vomiting (within a few hours of exposure)</td>
</tr>
<tr>
<td>320 - 360</td>
<td>~ 50% die within 60 days (with minimal supportive care)</td>
</tr>
<tr>
<td>480 - 540</td>
<td>~50 % die within 60 days (with supportive medical care)</td>
</tr>
<tr>
<td>1,000</td>
<td>~ 100% die within 30 days</td>
</tr>
</tbody>
</table>
So, in about an hour, a person could receive a lethal whole body exposure.

But what would happen if you touched a radiography source?

Using our 100 Ci Ir-192 example and the inverse square law, the intensity of the source at ¼ inch equals

\[
520 \text{ R/hr} \times 12 \text{ in.}^2 = I \times 0.25 \text{ in}^2
\]

\[
1.198 \times 10^6 \text{ R/hr}
\]
Radiography is **Definitely a High Risk Activity!**
What does a radiation injury look like?
Hand exposure to a Cobalt-60 source
Day of the event
Deep ulceration - 6 months after exposure
After 8 months, plastic surgery and healing.
The image on the right shows severe radiation burns on the back of a man. The man was one of three woodsmen who found a pair of canisters in the mountains of the country of Georgia (formally part of the USSR). The men did not know the canisters were intensely radioactive relics that were once used to power remote generators. Since the canisters gave off heat, the men carried them back to their campsite to warm themselves on a cold winter night.
How is radiography regulated?

Licensed by the NRC and regulated through 10 CFR 34

Or if an agreement state like North Carolina, licensed by the state.

Agreement state regulations basically follow 10 CFR 34
At Duke, Radiography is performed by State licensed in-house Radiographers with supplemental radiographers contracted for outages.

All radiological controls associated with the radiography source are the ultimate responsibility of the Radiographer in Charge.

However, the station radiation protection staff is intimately involved to ensure that all station personnel are protected.
So, how does it all work?

You take a source
Place it in a “camera”
Attach a source guide tube to the camera then attach control cable to the source, also known as the ‘crank’
The source is exposed using the control cable to push the source through the guide tube.
After the radiography exposure “shot”, the source is then retracted into the camera where it is automatically locked in place.
Duke Energy Fleet
Radiological Controls for Radiography Operations

• Due to several near miss events over the past couple years at all three nuclear sites the Duke management team has implemented a more rigorous process for radiography operations.

• In addition to the state radiography license requirements for radiological safety, the Duke Radiation Protection Managers now require direct RP involvement in planning and execution of each radiography shot. But the RIC still has ultimate authority and
Radiological controls required for all radiography operations include:

• Dual locks on source storage safe – Requires RP Manager involvement to access a radiography source
• Complex Activity Plans required for all field radiography
• Pre-Job Briefings with all team members present
• Boundary guards are placed at all accessible boundaries
• Independent area searches by the RIC & RP
• Special boundary postings
• RP verification of source location using remote monitoring to assist the radiographers with their safety
• All activities involving manipulation of the source are controlled by a technical procedure requiring sign-off steps to be completed by the RIC and RP
Radiation area boundaries for radiography operations are based on the dose limit of 2 mrem in any consecutive 60 minutes (1 hour).
The radiography procedure is entitled – **Control and Notification of Radiography Operations** and addresses the following:

- Field Radiography
- Vault Radiography
- Sources Changes
- Source and DU Leak Testing
- Boundary Guard Training
- Boundary Posting
- Radiography Area Searches
- RP Boundary Dose Rate Verification
- Response to Abnormal Conditions
- Control of Multiple Exposures
Additionally

A Complex Plan is Required for all Field Radiography and Must Address the Following:

- Scope
- Boundaries
- Area Searches & Maps
- Boundary Guard Locations & Staffing
- Schedule Coordination/Turnover for Longer Tasks
- Communication Plan
- PJB Requirements (A Common PJB Form is Used at the 3 Sites)
- Special Considerations Such as Use of 2 Cameras in the same Area or Adjacent Areas
Questions?