

NUCLEAR INDUSTRY STANDARD PROCESS

Radiological Protection

Level 3 – Information Use

Radiography

NISP-RP-009

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This is an industry document for standardizing radiation protection processes. Standard processes and requirements are established to eliminate site-specific radiation protection procedures. The Institute for Nuclear Power Operations (INPO) maintains current procedures on the INPO website. Approval authority is granted by the industry contingent on a structured review and approval process by representatives of utility radiation protection organizations.

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1.0 Purpose

- 1.1 This procedure provides instructions to Radiation Protection personnel for establishing boundaries, postings, and controls in support of on-site radiography.

2.0 Scope

- 2.1 This procedure describes the basic overall process for the RP organization to support radiography. This procedure does not provide guidance for radiological controls involving pulse x-ray devices. If pulse x-ray devices are used the station will provide guidance to supplemental personnel on the radiological control requirements. Supplemental personnel may be assigned portions of the activities described in this procedure but should still understand the overall process and how assigned responsibilities contribute to successful, event-free radiography.
- 2.2 The forms referenced by this procedure are examples used to describe the pertinent information that should be recorded for future reference. Plant procedures may specify the use of equivalent forms or the use of electronic media for the same purposes.
- 2.3 Member utilities are expected to use this standard to enable supplemental workers to transition between nuclear power plants. Compliance with these instructions is expected without additional site requirements or process deviations being imposed that may require additional training or challenge the performance of supplemental workers.
- 2.4 This procedure will be used to train and instruct supplemental radiological protection technicians. Member utilities will implement these process requirements in site procedures and update site procedures whenever requirements or process steps in this Nuclear Industry Standard Process (NISP) are revised. Current revisions are maintained on the INPO website.

3.0 Definitions

- 3.1 Terms, acronyms, and definitions are provided in NISP-RP-013, *Radiation Protection Standard Glossary of Terms*.

4.0 Responsibilities

- 4.1 Radiation Protection (RP) Personnel are responsible for implementation of the requirements of this procedure per Efficiency Bulletin 17-01 and the Nuclear Industry Standard Process Initiative.

4.2 Radiography Personnel:

4.2.1 Responsible to the requirements of 10 CFR 20, 10 CFR 34, 10 CFR 37, and the by-product material license for the radiographic sources used. In addition, Radiography Personnel must abide by the requirements of this procedure and all applicable station procedures when performing radiography.

4.3 Site Security Personnel

4.3.1 Responsible to implement and maintain the revised Part 37 Security Plan.

4.4 Radiation Protection Program Owner

4.4.1 Responsible for the identification and accountability of Part 37 Category 1 and Category 2 quantities of radioactive material.

5.0 General Requirements

5.1 The radiographer is the licensed individual for the use and storage of a radiography source and shall always maintain overall responsibility of radiography activities. Conducting radiography on a nuclear plant site introduces overlapping responsibilities with the site Radiation Protection program. The relationships between these overlapping responsibilities are summarized below:

5.1.1 The radiographer shall comply with site specific procedures as required.

5.1.2 The radiographer shall establish locked access controls in conjunction with site RP and Security as required by site procedures and 10CFR37.

5.1.3 The radiographer shall be accompanied by at least one other qualified radiographer assistant (or higher qualification) to discharge the duties of 10 CFR 34.41(a). While station personnel may assist in the control of unauthorized entry, the radiographer shall **not** delegate this responsibility to RP personnel. Radiography shall **not** be performed if only one (1) qualified individual is present. (10 CFR 34.41).

5.1.4 The radiographer shall have direct control over any movement of the source.

5.1.5 The radiographer is responsible for establishing the location of boundaries, postings, and access points using input from the site RP organization.

5.1.6 RP personnel shall provide input to the radiographer on the best location for boundaries based on the plant layout and activities in surrounding areas.

5.1.7 The Radiography Radiation Safety Officer has the responsibility for implementation of emergency procedures in the event of a malfunction or damaged radiography source.

5.1.8 The RP organization has the responsibility to provide controls necessary to protect site personnel during radiographic operations.

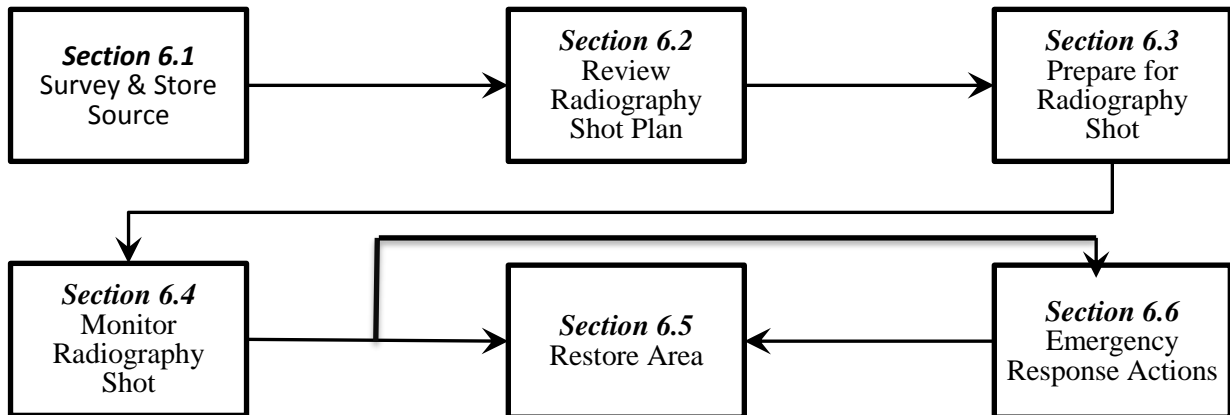
- 5.1.9 RP has overall responsibility in determining how boundaries will be controlled through locked access and/or boundary monitoring.
- 5.1.10 Radiography shall not proceed until both the site RP organization and the radiographer concur on the location of boundaries and the manner in which they are controlled. Attachment 2, *Curie to Dose Rate Projection Chart* shows calculated unshielded dose rates at various distances from typical radiography sources.
- 5.1.11 The Radiographer and Radiation Protection shall both ensure all unauthorized personnel have been removed from inside the posted area prior to the start of radiography.
- 5.2 Radiography licenses typically prohibit unauthorized personnel from being in the radiography area without approval of the radiography license, i.e. the radiographer and trained assistants. Approval for RP to be inside the radiography boundary must be obtained from the radiographer prior to the start of work activities.
- 5.3 Document radiological surveys using plant-specific forms.
- 5.4 Radiography shall be performed using a specific RWP written for that activity.

NOTE: 10 CFR 37 requires additional physical protection measures and security zones if a source exceeds or an aggregate of sources in an area exceed Category 1 or Category 2 limits. The values specified are Category 2 limits. Category 1 limits are a factor of 100 higher.

- 5.5 Ensure plant Security personnel are engaged in establishing security zones for the use and storage of the radiography source if 10CFR37 requirements apply. 10CFR37 will be applicable if the aggregate of the sources stored in the area meets the following thresholds.
 - 5.5.1 8.1 Ci or 0.3 TBq of Co-60
 - 5.5.2 21.6 Ci or 0.8 TBq of Ir-192
 - 5.5.3 54.0 Ci or 2 TBq of Se-75
- 5.6 Any removal and transit of source from a storage area must be under the direct control of the radiographer and site Radiation Protection personnel.
- 5.7 Effective communications are essential to successful implementation of radiography. The impacts of radiography boundaries can be significant on other work group such as operations and security. Communication plans should prepare the site before the start of radiography, during the exposure of the source, and at the completion and restoration of the area.

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- 5.7.1 If possible, 48 hours before the start of radiography review the radiography shot plan with operations and security to verify that all potential impacts have been accounted for.
 - 5.7.2 If radiography is scheduled to be performed without a 48 hour notice to the station, then site management should consider providing additional oversight of the process to ensure an error free implementation.
 - 5.7.3 Inform the station of the upcoming radiography through the use of site wide communications tools such as the plant or outage schedule, risk assessment, or daily status sheets. When possible use plant layout maps to show the area that will be restricted during radiography.
 - 5.7.4 Notify operations and security prior to establishment of radiography boundaries. Once the boundaries have been established notify operations and security when the source has been moved into the area and radiography is about to begin.
 - 5.7.5 Prior to the exposure of the source, make an announcement to the station over the plant paging system that radiography is about to commence and all personnel are to avoid the area established by the radiography boundary.
 - 5.7.6 Prior to the exposure of the source communicate with each boundary guard and validate they are in the proper location.
 - 5.7.7 When the source is exposed communicate with RP personnel to perform radiation surveys.
 - 5.7.8 Notify operations and security when radiography has been completed and the area restored to normal conditions.
 - 5.7.9 Make an announcement over the plant paging system once the area has been restored that normal access is now allowed.

6.0 Process Instructions



6.1 Survey and Store a Radiography Source

6.1.1 Survey the radiographic exposure device for the following:

- a. Contact radiation levels
- b. Radiation levels at 30 cm
- c. Radiation levels at 1 m

CAUTION

Stop, secure the area, and notify RP supervision if any of the following conditions exist (REI 10 CFR 34.21):

- Contact radiation levels ≥ 200 mrem/hour
- Radiation levels at 1 m ≥ 10 mrem/hour
- Removable contamination from the exterior of the device $\geq 1,000$ dpm/100 cm²

d. Removable contamination on the external surface of the device

6.1.2 Ensure the storage device is labeled and the storage area posted per NISP-RP-004.

- a. Notify RP supervision if the storage area must be controlled as a High Radiation Area.
- b. Radiation Protection should maintain a locking device on the radiography storage location.

6.1.3 Ensure RP personnel escort movement of the source to and from the storage location.

6.1.4 Ensure the storage area is surveyed each time a source is returned for storage.

6.1.5 Notify RP supervision if the device appears to have physical damage.

6.1.6 Notify security personnel for implementation of 10 CFR 37 security controls if the source meets the criteria in section 5.5.

6.2 Review the Radiography Shot Plan

6.2.1 A Radiography Shot Plan should be developed using Attachment 4, Guidelines for Development of Radiography Shot Plans. All stakeholders should be involved in the development of the plan.

NOTE: A Radiography Shot Plan is developed and approved by RP management to provide a high level of communication and coordination to ensure the process is conducted error free. The format and content of a shot plan may vary among plants but should always describe the basic information site organizations need to prevent exposures and should contain all of the elements listed in Attachment 4. The Radiography Shot Plan is a collaborative effort among the radiographer, RP, Security, Operations, Engineering (NDE) and Planning & Scheduling.

6.2.2 Review the Radiography Shot Plan to understand the following:

- a. Radionuclide and activity of the source
- b. Number, direction, and duration of exposures
- c. Determination if the source will be collimated or a free air exposure
- d. Projected boundary locations delineated on plant map or survey
- e. Location of source and personnel during exposure
- f. Impacts to plant equipment including radiation and process monitors
- g. Number and location of boundary guards
- h. Communication plans between radiography personnel, control room, boundary guards, radiation protection and plant personnel including announcements over the plant paging system. Type of communication devices (cell phones, radios) should be defined.
- i. Dose reduction actions including identification of low dose waiting areas.
- j. Use of remote monitoring devices to indicate radiation levels while the radiography source is exposed

- k. Impacts to security, operations and emergency response personnel and actions to be taken in emergency situations where they need to enter the area
- l. Contingency actions to be taken if source malfunction should occur

6.2.3 Walk-down boundary locations assigned for control prior to the radiography shot to ensure the following:

- a. Potential access points have been posted with access controls established per the Shot Plan.
- b. Ladders and scaffolds have not been placed creating access points not addressed per the Shot Plan.
- c. Identify any other potential access points not addressed by the Shot Plan.
- d. Identify any penetrations that could potentially allow streaming into an adjacent location.

6.2.4 Ensure the Shot Plan includes projected radiography boundaries for both a High Radiation Area and Radiation Area.

NOTE: The radiographer and assistant(s) are required by the radiography license to maintain continuous direct visual surveillance of the operation to protect against unauthorized entry into a high radiation area as defined in 10 CFR 20.

- a. High Radiation Areas will be established in accordance with the radiographer's policy and may include the duration of exposure when estimating where an individual may exceed 100 mrem in an hour.

NOTE: In some situations it might not be possible to establish the boundary at < 2mrem/hr due to plant configuration or components in the area. The RPM should approve the establishment of the boundary at any other dose rate

- b. Boundaries and access should be established where the expected dose rate is expected to be < 2 mrem/hour while the source is exposed.
- c. The RPM is responsible for review and approval of the radiography shot plan prior to implementation.

6.3 Prepare for the Radiography Shot

- 6.3.1 Prepare RWP appropriate for the work per site procedures. Set SRD setpoints per site procedures and guidance in 10 CFR 34.47.
- 6.3.2 Setup boundaries and postings per the Shot Plan and NISP-RP-004. Notify operations and security when boundaries are being established.
- 6.3.3 Lock doors and gates specified by the Shot Plan.
- 6.3.4 Ensure personnel have the required dosimetry, survey instruments, and communications equipment. Verify all equipment is operable.
- 6.3.5 Ensure boundary guards have been assigned, briefed, and provided with any identification measures as required by RP supervision, e.g. vests or arm sleeves. Use Attachment 3 to inform boundary guards of their responsibilities.
- 6.3.6 Setup remote monitoring as required by the Shot Plan to verify the source is in a shielded position and/or to monitor radiography personnel.
- 6.3.7 Complete the steps in Attachment 1, *Radiography Checklist*. Requirements of Attachment 1 may be included in site forms which provide additional details or requirements.
 - a. Ensure all personnel involved in the shot attend the prejob brief.
- 6.3.8 Escort the radiography source to the radiography area.
 - a. Inform the radiography team that the source is inside the radiography boundary.
- 6.3.9 Work with the radiographer to walk-down areas within the posted area to ensure unauthorized personnel are not present. Document completion of this step on Attachment 1. **(CM-1)**.
 - a. Ensure visual inspections include the top of scaffolds, roofs, open tanks, condenser manways, and behind doors.
 - b. Inform the coverage team when potentially affected areas have been verified to be clear of unauthorized personnel.
- 6.3.10 RP shall provide the final approval for the start of radiography after having completed the requirements established in the RT checklist and high risk brief.
- 6.3.11 Ensure the radiographer understands to inform the coverage team when the source has been placed in position for the radiography shot and when the source has been retracted back into the camera.

6.4 Monitor the Radiography Shot

6.4.1 Notify operations, security, and plant site that radiography is about to commence.

6.4.2 RP Supervision providing oversight for radiography should have no other responsibilities while radiography is taking place.

6.4.3 Perform boundary surveys when the source has been exposed.

- a. Notify RP supervision if the dose rate external to the posted Radiography Area is > 2 mrem/hour above initially established dose rates in the area.

6.4.4 If telemetry or a remote monitoring instrument has been set up, verify when the source has been retracted to a fully shielded position.

- a. Ensure the radiography team has been informed when the source is no longer exposed.
- b. RP surveys do not alleviate the requirement for the radiographer to survey the camera to verify the source has been fully retracted into the camera.

6.4.5 Ensure no one enters the posted radiographer boundary unless approved by lead radiographer.

6.4.6 Maintain communication with boundary guards. Stop Work if a boundary breach occurs.

6.4.7 Ensure boundary surveys are documented.

6.4.8 Ensure that communications are maintained in accordance with the RT shot plan.

6.5 Restore Area

6.5.1 Check doses received by the radiographer and assistant(s) to ensure unplanned doses have not occurred.

6.5.2 Remove boundaries, posting, and barrier guards.

- a. Ensure boundaries and postings required due to plant radiological conditions remain in place. Document a survey of current radiological conditions.

6.5.3 Perform a radiation survey of the exterior of the storage device to verify the source is fully shielded and physical damage is not apparent.

- a. Document the survey per site procedures.
- b. Notify RP supervision if acceptable conditions are not verified.

- 6.5.4 Inform Operations that radiography shot has been completed and access into the area has been restored.
- 6.5.5 Provide escort of the source to the storage location with the radiographer.
 - a. Survey the storage area and document the results per site procedures.

6.6 Emergency response actions

- 6.6.1 Radiography sources are mechanical devices which can fail. While the radiography licensee has the responsibility for recovery of the device the following actions should be taken immediately when a source failure has occurred.
 - a. Stop work and place source in safe condition if possible.
 - b. Ensure personnel are not in an area of increased dose rates due to the failure of the device
 - c. Validate personnel dose
 - d. Validate radiological boundaries and ensure boundary guards are alert to maintaining security of the area
 - e. Notify RPM and Site Management as defined by the communications plan
- 6.6.2 The Radiographer Radiation Safety Officer has the responsibility for the development of a recovery plan.
- 6.6.3 The site Radiation Protection Manager will concur with the plan and provide support as necessary.
- 6.6.4 Ensure all surveys performed during the event are documented on site forms.

7.0 Records/Documentation

- 7.1 Retain completed Attachments in accordance with the provision of the stations records management program.
- 7.2 Computer generated equivalents may be used in place of the Attachments provided that, at a minimum, the information contained on the Attachment is contained on the equivalent.

8.0 References

- 8.1 Commitments

- 8.1.1 Clinton-**CM-1**CR 102646 “Inadequate Walkdown of Radiography Boundaries” (Step 6.3.8).
- 8.2 General
 - 8.2.1 Shleien, B. (1998), The 3rd edition of the Handbook of Health Physics and Radiological Health, pp 6-9, 6-12.
 - 8.2.2 USNRC Information Notice 96-04, “Incident Reporting Requirements for Radiography Licensees”
 - 8.2.3 USNRC Information Notice 99-04, “Unplanned Exposures to Radiographers”
 - 8.2.4 Advanced, Second-Generation Selenium-75 Gamma Radiography Sources, Dr Mark G. Shilton
 - 8.2.5 USNRC Information Notice 2014-06, “Damage of Industrial Radiographic Equipment Due to Falling Equipment and Improper Mounting”
 - 8.2.6 NEI 14-02, “Implementation Guidance for 10 CFR Part 37 Physical Protection of Category 1 and Category 2 Quantities of Radioactive Material”
 - 8.2.7 NRC Enforcement Guidance Memorandum 2014-001: Interim Guidance for Dispositioning 10 CFR Part 37 Violations With Respect To Large components Or Robust Structures Containing Category 1 or Category 2 Quantities of Material at Power Reactor Facilities Licensed Under 10 CFR Parts 50 and 52 (RIN 3150-A112), March 13, 2014.
 - 8.2.8 NRC Temporary Instruction 2800/041 Revision 1 (July 1, 2015).
 - 8.2.9 NUREG-2155, “Implementation Guidance for 10 CFR Part 37 Physical Protection of Category 1 and Category 2 Quantities of Radioactive Material.
 - 8.2.10 NISP-RP-002, Radiation and Contamination Surveys
 - 8.2.11 NISP-RP-004, Radiological Posting and Labeling
 - 8.2.12 NISP-RP-013, Radiation Protection Standard Glossary of Terms
 - 8.2.13 10 CFR 34
 - 8.2.14 10 CFR 37
 - 8.2.15 EPRI Nondestructive Evaluation: Recommended Practices for Maintaining Radiation Safety of Radiographic Operations at a Nuclear Plant. Technical update report 1022356

9.0 Attachments

- 9.1 Attachment 1 - Radiography Checklist – Sample
- 9.2 Attachment 2 - Curie to Dose Rate Projection Chart
- 9.3 Attachment 3 - Boundary Guard Briefing Sheet
- 9.4 Attachment 4 - Guidelines for Development of Radiography Shot Plans

**ATTACHMENT 1
Radiography Checklist – Sample
Page 1 of 2**

Required Steps Prior to Commencing Radiography	Initials/Date
1. Review and approval of Radiography shot plan by RPM.	
2. Ensure radiography has been factored into the station schedule so impacts with other work groups is understood and communicated.	
3. Conduct a high risk brief that includes <u>ALL</u> personnel involved in Radiography to include Radiographers, Job Supervisor, RP Technicians, and Boundary Guards. <ul style="list-style-type: none"> a. Radiography Source Type & Activity b. Radiography shot location and component c. Identify the single point of contact for radiation protection and radiography d. Requirement to notify Shift Operations Manager before and after each exposure e. The shot plan, to include equipment layout, and expected dose rates on or near the radiography equipment during the shot(s) as appropriate f. Identify and assess any protected equipment in the areas effected by radiography g. Mitigating actions if radiography may create an unshielded exposure (e.g. large open areas) h. Number of Exposures and Duration i. RWP and Procedure Requirements j. Applicable Industry Operating Experience k. The potential for <i>Sky Shine</i> and associated mitigating actions l. The importance of ALARA and low dose waiting areas m. Boundary Location(s), areas to be affected n. Boundary Guard assignment, responsibilities and understanding that NO PERSONNEL may cross boundary without Radiographer and RPT permission o. Unusual Occurrences and Required Actions p. Response to Dosimeter alarms, including anticipated alarms when the source is being exposed. q. 3 way communication between all involved parties r. Stop work criteria s. Required Dosimetry for all personnel 	

**ATTACHMENT 1
Radiography Checklist – Sample
Page 2 of 2**

4. The Radiographer and Radiation Protection complete a walk down of all areas within the radiography boundary and ensure unauthorized personnel are cleared from ALL areas enclosed by these barriers including roofs.	
5. Communications completed to plant organization as required by the radiography shot plan	
6. Boundary guards have been verified to be in place and understand roll for that position.	
7. Surveys completed and documented when source is exposed	

**ATTACHMENT 2
Curie to Dose Rate Projection Chart
Page 1 of 3**

IR-192

5 curies		10 curies		15 curies		20 curies	
Feet	mR/hr	Feet	mR/hr	Feet	mR/hr	Feet	mR/hr
1.0	26,000	1.0	52,000	1.0	78,000	1.0	104,000
*35.0	21.2	*35.0	42.4	*35.0	63.7	*35.0	84.9
16.1	100	22.8	100	27.9	100	32.3	100
72.1	5	102.0	5	124.9	5	144.2	5
114.0	2	161.2	2	197.5	2	228.0	2
25 curies		30 curies		35 curies		40 curies	
Feet	mR/hr	Feet	mR/hr	Feet	mR/hr	Feet	mR/hr
1.0	130,000	1.0	156,000	1.0	182,000	1.0	208,000
*35.0	106.1	*35.0	127.3	*35.0	148.6	*35.0	169.8
36.1	100	39.5	100	42.7	100	45.6	100
161.2	5	176.6	5	190.8	5	204.0	5
255.0	2	279.3	2	300.0	2	322.5	2
45 curies		50 curies		55 curies		60 curies	
Feet	mR/hr	Feet	mR/hr	Feet	mR/hr	Feet	mR/hr
1.0	233,000	1.0	260,000	1.0	286,000	1.0	312,000
*35.0	191.0	*35.0	212.2	*35.0	233.5	*35.0	254.7
48.4	100	51.0	100	53.5	100	55.9	100
216.3	5	228.0	5	239.2	5	249.8	5
342.1	2	360.6	2	378.2	2	395.0	2
65 curies		70 curies		75 curies		80 curies	
Feet	mR/hr	Feet	mR/hr	Feet	mR/hr	Feet	mR/hr
1.0	338,000	1.0	364,000	1.0	390,000	1.0	416,000
*35.0	275.9	*35.0	297.1	*35.0	318.4	*35.0	339.6
58.4	100	60.3	100	62.4	100	64.5	100
260.0	5	269.8	5	279.3	5	288.4	5
411.1	2	426.6	2	441.6	2	456.1	2
85 curies		90 curies		95 curies		100 curies	
Feet	mR/hr	Feet	mR/hr	Feet	mR/hr	Feet	mR/hr
1.0	442,000	1.0	468,000	1.0	494,000	1.0	520,000
*35.0	360.8	*35.0	382.0	*35.0	403.3	*35.0	424.5
66.5	100	68.4	100	70.3	100	72.1	100
297.3	5	305.9	5	314.3	5	322.5	5
470.1	2	483.7	2	497.0	2	509.9	2
105 curies		110 curies		115 curies		120 curies	
Feet	mR/hr	Feet	mR/hr	Feet	mR/hr	Feet	mR/hr
1.0	546,000	1.0	572,000	1.0	598,000	1.0	624,000
*35.0	445.7	*35.0	466.9	*35.0	488.2	*35.0	509.4
73.9	100	75.6	100	77.3	100	79.0	100
330.5	5	338.2	5	345.8	5	353.3	5
522.5	2	534.8	2	546.8	2	558.6	2

* Average cranking distance (control end of free end of guide tube)

**ATTACHMENT 2
Curie to Dose Rate Projection Chart
Page 2 of 3**

CO-60

5 curies		10 curies		20 curies		30 curies	
Feet	mR/hr	Feet	mR/hr	Feet	mR/hr	Feet	mR/hr
1.0	70,000	1.0	140,000	1.0	280,000	1.0	420,000
*40.0	43.8	*40.0	87.5	*40.0	175	*40.0	262.5
26.5	100	37.4	100	52.9	100	64.8	100
118.3	5	167.3	5	236.6	5	289.8	5
187.7	2	264.2	2	374.2	2	458.3	2
40 curies		50 curies		60 curies		70 curies	
Feet	mR/hr	Feet	mR/hr	Feet	mR/hr	Feet	mR/hr
1.0	560,000	1.0	700,000	1.0	840,000	1.0	980,000
*40.0	350	*40.0	437.5	*40.0	525	*40.0	612.5
74.8	100	83.7	100	91.7	100	99.0	100
334.7	5	374.2	5	409.9	5	442.7	5
529.2	2	591.6	2	648.1	2	700.0	2
80 curies		90 curies		100 curies		110 curies	
Feet	mR/hr	Feet	mR/hr	Feet	mR/hr	Feet	mR/hr
1.0	1,120,000	1.0	1,260,000	1.0	1,400,000	1.0	1,540,000
*40.0	700	*40.0	787.5	*40.0	875	*40.0	962.5
105.8	100	112.2	100	118.3	100	124.1	100
473.3	5	502.0	5	529.2	5	555.0	5
748.3	2	793.7	2	836.7	2	877.5	2

* Average cranking distance (control end of free end of guide tube)

**ATTACHMENT 2
Curie to Dose Rate Projection Chart
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SE-75

10 Curies		20 Curies		30 Curies		40 Curies	
Feet	mR/hr	Feet	mR/hr	Feet	mR/hr	Feet	mR/hr
1.0	22,000	1.0	44,000	1.0	66,000	1.0	88,000
*35.0	18.0	*35.0	35.9	*35.0	53.9	*35.0	71.8
14.8	100	21.0	100	25.7	100	29.7	100
66.3	5	93.8	5	114.9	5	132.7	5
104.9	2	148.3	2	181.7	2	209.8	2
50 Curies		60 Curies		70 Curies		80 Curies	
Feet	mR/hr	Feet	mR/hr	Feet	mR/hr	Feet	mR/hr
1.0	110,000	1.0	132,000	1.0	154,000	1.0	176,000
*35.0	89.8	*35.0	107.8	*35.0	125.7	*35.0	143.7
33.2	100	36.3	100	39.2	100	42.0	100
148.3	5	162.5	5	175.5	5	187.6	5
234.5	2	256.9	2	277.5	2	296.6	2
90 Curies		100 Curies		110 Curies		120 Curies	
Feet	mR/hr	Feet	mR/hr	Feet	mR/hr	Feet	mR/hr
1.0	198,000	1.0	220,000	1.0	242,000	1.0	264,000
*35.0	161.6	*35.0	179.6	*35.0	197.6	*35.0	215.5
44.5	100	46.9	100	49.2	100	51.4	100
199.0	5	209.8	5	220.0	5	229.8	5
314.6	2	331.7	2	347.9	2	363.3	2
130 Curies		140 Curies		150 Curies		160 Curies	
Feet	mR/hr	Feet	mR/hr	Feet	mR/hr	Feet	mR/hr
1.0	286,000	1.0	308,000	1.0	330,000	1.0	352,000
*35.0	233.5	*35.0	251.4	*35.0	269.4	*35.0	287.3
53.5	100	55.5	100	57.4	100	59.3	100
239.2	5	248.2	5	256.9	5	265.3	5
378.2	2	392.4	2	406.2	2	419.5	2

ATTACHMENT 3
Boundary Guard Briefing Sheet
Page 1 of 1

Boundary Guard Function

The Boundary Guard (BG) provides an additional layer of protection during radiography activities to prevent an over exposure to radiation due to an inadvertent entry to the radiography restricted area. The RP Supervisor will have boundaries (ropes, doors, ladder locks) established that identify the radiography restricted area. The Boundary Guard assures that no personnel enter the area once established unless approved by the RP Supervisor and the lead radiographer.

Boundary Guard – Rules of the Boundary

1. **NO ONE** is allowed to reach **OVER** or **UNDER** the RT boundary at **ANY** time for **ANY** reason during radiography unless authorized and under the direct surveillance of Radiation Protection.
2. Boundary Guards **WILL NOT** engage in **IDLE** conversation with anyone as this can pose a distraction.
3. Boundary Guards **WILL NOT** use cell phones (texting, etc.) except for use in plant emergency.
4. Boundary Guards **WILL NOT** leave the area or request to move for any reason unless relieved by an individual assigned by the RP Supervisor. This includes site assembly, site evacuation, etc. There are two exceptions to this rule:
 - a. Imminent danger to self; notify the RP Supervisor and retreat to a safe position.
 - b. Someone approaches on the wrong side of the boundary **OR** an individual decides to cross after being challenged. In this situation the Boundary Guard shall:
 - Communicate with radiography team to stop work
 - Get the individual on the safe side of the boundary
 - Notify the RP Supervisor
 - Obtain information from the individual inclusive of name, work group, supervisor and badge number
5. Boundary Guards **WILL NOT** leave the site at the end of the scheduled shift unless released by the RP Supervisor.
6. Boundary Guards will normally be scheduled for a **rotation** at the guarded location that does not result in mental fatigue that would challenge boundary surveillance.
7. Boundary Guards should be positioned such that visual surveillance of the boundary can be implemented and in the lowest dose rate possible.

Signed _____ / _____
Print Name/Sign / Date

Briefed By _____ / _____
Print Name/Sign / Date

ATTACHMENT 4
Guidelines for Development of Radiography Shot Plans
Page 1 of 2

A radiography shot plan should be developed using the following guidelines. The shot plan should be developed with input from all stakeholders including Radiation Protection, Radiographers, Operations and Security personnel. The plan should be well communicated to the station and each group should clearly understand their roles and responsibilities. The plan can be documented in any format to make effective communication possible.

1. Determine the isotope and curie content of the source being used. Using the charts in Attachment 2, Curie to Dose Projection Chart, determine the expected dose rates.
2. Define the projected boundaries based on the dose rate projections, direction of the shots, and shielding. Take into consideration sky shine and possible impacts to roof areas or the operation of overhead cranes. When deciding the location of the boundaries consider human factors such as the ability to see the posting and position of boundary guards.
3. Operations should evaluate the potential impacts to plant equipment considering the location and direction of the radiography exposures.
4. Determine the expected duration of the activity. Take into consideration the number of shots required and the time for setup and removal of boundaries. This will determine how long the area will be restricted and is important to operations and security personnel to assess the impacts to their routine operations.
5. Determine the number of boundary guards required to maintain control of the area. A boundary guard should be positioned at all potential entry points. Additional relief personnel may be needed depending on the duration.
6. Determine the number of radiation protection technicians necessary to perform surveys of the boundaries when the source is exposed.
7. Determine the communication methods that will be used between radiographer, radiation protection, and boundary guards. Validate that the equipment is available and works in the area where the radiography will take place.
8. Develop a communication plan that ensures the site is aware of the radiological risk when performing radiography, the areas of the plant which are affected, when areas will be restricted, and when access is restored. Significant stake holders such as operations and security should kept informed on the status of radiography as it is taking place through either plant announcements or direct communications.
9. Determine low dose waiting areas for each member of the team.
10. If available, determine where remoting monitoring equipment can be located to effectively monitor radiography.
11. Develop a specific RWP which contains the following
 - a. Stop work criteria including immediate actions that are to be taken when stop work orders are issued.
 - b. Alarming dosimeter set points and expected response to alarms
 - c. Contingency actions should the source malfunction during operation.

**ATTACHMENT 4
Guidelines for Development of Radiography Shot Plans
Page 2 of 2**

12. IDENTIFY all Process and Area Radiation Monitors within the exposure area or areas through which the radiographic source may be transported. REFER to station-specific procedures for list of radiation monitors. With the assistance and approval of Operations, ESTABLISH actions or pre-job planning to acknowledge or disable alarms.