Performing Radiation & Contamination Surveys

RP02.02

Approved Rev: 5/18/18

Standardized Task Evaluation Program

The Standardized Task Evaluation (STE) program promotes a work-ready workforce through the standardization of common tasks by defining the knowledge and skills required to perform a given task. Subject Matter Experts (SMEs) analyze the task and generate lesson plans, knowledge examination, and performance evaluation elements. These elements are combined to create an STE package.

The Electric Power Research Institute (EPRI) facilitates the development, oversees the quality, and programmatically implements each STE. EPRI STE members have access to these materials and permission to implement these STEs in accordance with their site training and qualification procedures.

Guidance for Completing this Module

- Duration of this Computer-Based Training course is approximately 2 to 3 hours.
- Material for this presentation is primarily derived from the NISPs; and in particular, NISP-RP-02, Radiation and Contamination Surveys. Various industry references have also been used in the development of this presentation.
- This training is objective-based. **Brown-colored text** at the top of a slide designates an objective with related material on the given slide.
- Feedback on this presentation should be provided to EPRI and STPNOC. Send email to: tmstroschein@stpegs.com.
- After viewing this presentation, be sure to complete the associated 25-question, multiple choice exam. Passing score is 80% or better.

Performing Radiation & Contamination Surveys Overview

- Efficiency Bulletin (EB) 17-01, Portable Supplemental Radiation Protection Technician Training and Qualification directed:
  - Development and implementation of Nuclear Industry Standard Processes (NISPs) to standardize RP procedures for supplemental workforce.
  - Creation of standardized, portable RP qualifications for the supplemental workforce.
- Overall goals of EB 17-01 are to:
  - Eliminate site-specific qualifications of supplemental radiation protection technicians through development of a standard vendor training program.
  - Significantly reduce or eliminate the time each site historically spends to qualify the supplemental RP technicians (SRPTs) prior to the start of an outage or project.
  - Additionally, this will result in improved SRPT performance due to standardization of key radiation protection processes and procedures.
- "Performing Radiation & Contamination Surveys" is one of these standardized processes and uses NISP-RP-02, titled Radiation and Contamination Surveys as the primary reference.

Performing Radiation & Contamination Surveys Overview

- In addition to reviewing this presentation, you should also read the associated procedure, NISP-RP-02, in its entirety. This presentation largely follows the procedure as it is written.
- Clarifying notes are provided in Section 4 of the procedure and are numerically referenced – as a superscript – at the end of certain sentences within the procedure.
- You should note in the procedure, the process diagram which provides overall direction.
- Also note that the procedure provides various standardized numerical threshold levels that are now common in the industry.
- Radiological Survey Map Symbol & Abbreviations are provided as an attachment to the procedure.

Performing Radiation & Contamination Surveys Overview

- In the procedure, note the general requirements which include:
  - Prior to performing a survey, review the most current survey information for the expected plant conditions.
  - Site procedures establish the areas and frequencies for routine surveys.
- Surveys of radiation levels, surface contamination, and airborne radioactivity are required to:
  - Evaluate the potential radiological hazards in the workplace.
  - Inform workers on the radiological hazards to which they are exposed.
  - Identify the presence of licensed radioactive material to ensure controls are established to minimize exposure to personnel and the public.
  - Evaluate changes in radiological conditions due to work activities or changing plant conditions.
  - Ensure compliance with NISP-RP-04, *Radiological Posting and Labeling*.
  - Ensure personnel are provided with the appropriate dosimetry considering the magnitude, gradient, and types of radiation present.
  - Estimate potential doses to personnel and identify the need for protective measures to prevent unplanned dose.
  - Determine the radiological risk of work activities per site procedures.

Terminal Objective

- Given an area where ionizing radiation is expected to be a concern, and in accordance with the standards of NISP-RP-02, Radiation and Contamination Surveys, comprehend the requirements to develop a survey map and associated products that are intended to communicate radiation dose rates and levels of radioactive contamination.

Enabling Objectives

1. Describe the precautions and survey techniques for entering an area in which radiation levels are unknown.
2. Define "general area" and "contact" dose rates.
3. Describe instrument selection criteria.
4. Describe expectations for taking dose rate gradient measurements.
5. Explain how to obtain and record dose rates from mixed radiation fields.
6. Calculate beta dose rates from known or suspected highly contaminated areas.
7. Describe requirements for surveying areas greater than 7 feet above the floor.
8. Identify source of high radiation levels (e.g., overhead piping, floor piping, or highly contaminated surfaces).
9. Explain the purpose and function of area radiation monitors.
10. State the background limits for using contamination survey instruments and counting equipment.
11. Describe actions to estimate contamination levels when contamination survey instruments are off-scale.
12. Describe actions to be taken if count rate exceeds 50,000 ncpm when frisking with a pancake GM detector.

Enabling Objectives

13. Describe actions to be taken if contamination levels in excess of 500,000 dpm / 100 cm^2 are identified.
14. Describe how to perform a large area smear survey.
15. Describe large area smear survey results that would indicate cleaning is required.
16. Describe procedures and limitations for performing special contamination surveys, including radioactive particles on personnel or equipment, radioactive particles in area.
17. Differentiate methods to be selected for analyzing smears.
18. Identify unusual conditions that might affect counting equipment response including high humidity, abnormal background, electronic noise, wet surfaces, oily surfaces, or extreme temperature.
19. Describe the different levels of alpha contamination, including the associated controls with each level, associated dose contribution of each level, and beta, gamma and alpha ratios.
20. Describe expected response to abnormal survey results.
21. Describe survey documentation expectations in accordance with NISP-RP-02.

Performing Radiation & Contamination Surveys

- **Survey Dose Rates in an Area**
- Directly Frisk a Surface
- Perform a Smear Survey
- Perform a Large Area Smear Survey
- Survey for Discrete Radioactive Particles
- Analyze Smears
- Evaluate Transuranics
- Respond to Abnormal Survey Results
- Document a Radiological Survey
- Radiological Survey Map Symbols & Abbreviations

Describe instrument selection criteria.

- Select and use portable survey instruments that are suitable to the specific job with respect to the type, energy, and range of the anticipated radiation fields and expected dose rates.
- Specifically:
  - For alpha monitoring, you will need to use a zinc sulfide detector or a proportional counter detector.
  - For beta monitoring, you will need to use a pancake GM detector (frisk a surface) or an ion chamber instrument (dose rate).
  - For gamma monitoring, you will need to use a Geiger counter instrument or an ion chamber instrument
  - For neutron monitoring, you will need to use a Rem meter (such as a Rem ball).

Describe instrument selection criteria.

- Specifically:
  - For underwater surveys, you will need a remote instrument with an underwater detector.
  - For removing items from the Refueling Cavity or Spent Fuel Pool, you will need an extendable probe to survey as the item is removed from the water to ensure highly activated items are not present. Do not allow the probe to enter the water.

Describe the precautions and survey techniques for entering an area in which radiation levels are unknown.

- Minimize dose during the survey to the extent practicable by considering use of the following:
  - Using extendable probes to maintain distance from the source.
  - Standing behind shielding materials or structures when possible.
- Set the instrument on a scale representative of expected dose rates prior to entering the area if the instrument does not have an automatic scaling feature.
  - If entering areas with unknown dose rates, use the highest anticipated scale and adjust as needed.
  - If using multi detector instrument with an automatic scaling feature, know where the instrument switches between detectors and allow the instrument to stabilize once if shifts to the high range detector.

Describe the precautions and survey techniques for entering an area in which radiation levels are unknown.

- Extend the instrument in front of the body upon entering the area and slowly scan the work area and travel paths.
- Perform a work area survey to understand the radiation field the surveyor will experience before performing a detailed contact and general area survey.
- When using an extendable probe, be aware that the surveyor’s dose rate may be higher than that indicated at the end of the extended probe.

Define "general area" and "contact" dose rates.

- General Area dose rate is defined as a dose rate performed in the general area at least 30 cm from the radiation source or from any surface the radiation penetrates.
- Contact dose rate is defined as a dose rate obtained as close as possible to the radiation source or to any surface that the radiation penetrates.

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Survey Dose Rates in an Area

- Measure contact and 30 cm dose rates from known and potential sources, e.g. pipes, elbows, valves, penetrations, spills, transfer lines, etc.
- Measure dose rates approximately chest high to assess dose rates where dosimetry is normally placed.

Describe expectations for taking dose rate gradient measurements.

- If dose rates exceed 100 mrem/hour between the knees and the head close to a source of high radiation levels, determine if a dose rate gradient exists that may require relocation of the chest dosimetry or additional dosimetry as described in NISP-RP-10, *Radiological Job Coverage*.
  - Identify the source of the high radiation levels, e.g. overhead piping, floor piping, or highly contaminated surfaces.
  - Measure dose rates at heights approximating a worker's knees, waist, chest, and head in close proximity to the source of high radiation levels where a worker may be positioned.
  - If the highest dose rate is not at chest level, record dose rates as follows:
    - Record the chest dose rate on the survey record along with the locations of higher dose rates.
    - Annotate each dose rate based on body location, i.e. knees, waist, chest, or head per Attachment 2.

Survey Dose Rates in an Area

- Verify the adequacy of current postings and change postings as needed to comply with NISP-RP-04, *Radiological Posting and Labeling*.
  - Notify RP supervision of any changes in area postings.
- Compare measured dose rates to those stated in applicable RWPs and notify RP supervision if the actual dose rates deviate from the range recorded on an RWP.

Explain how to obtain and record dose rates from mixed radiation fields.

- Surface contamination will sometimes consist of both beta and gamma emitters.
- In such instances, the Technician will need to determine if the survey will need to measure the concentration of the contaminant (dpm/100 cm^2) or the radiation field near the contamination, or both.
- An ion chamber used with an open window (OW) will measure the total of both the beta and gamma dose rates. Closed window (CW) will measure only the gamma dose rate. The difference between these is the beta dose rate.

Calculate beta dose rates from known or suspected highly contaminated areas.

- Measure beta dose rates in known or suspected areas with contamination levels in excess of 500,000 dpm/100 cm^2 (for example, open primary reactor system components or drained radwaste tanks and reactor cavities).
  - Scan the surface with an open window ion chamber instrument and obtain static measurements where the radiation levels are the highest.
  - Obtain a closed window (CW) and open window (OW) measurement as close to the surface as possible without contaminating the instrument.
  - Calculate the beta dose rate by using the following formula:

$$\frac{mrad}{hour} = (OW - CW)(beta\ correction\ factor)$$

  - The beta correction factor is provided by RP supervision; the factor may be located on the instrument calibration label.
  - Also obtain CW and OW measurements at 30 cm and determine the gamma and beta dose rates as described above.

Describe requirements for surveying areas greater than seven (7) feet above the floor.

- Survey areas greater than 7 feet above the floor only if ladders, scaffolds, or platforms are in place to gain access.
  - Survey permanent installations and post per NISP-RP-04, *Radiological Posting and Labeling*.
  - If access is allowed on a temporary installation without a prejob survey, place a survey tag at the base of the ladder such as that shown in Attachment 1 (see next slide).
  - If a prejob survey is required for accessing a temporary installation, post or tag the base of the ladder to contact RP prior to entry.

Temporary Survey Tag

Temporary SURVEY TAG

Location: ______________________

Unit: _____ Bldg: ______ Elev: _____

Row: __________ Column: ________

Dose Rates (mrem/hour)

Highest Contact: ________________

Highest 30 cm: ________________

Work Area: ________________

Contamination (dpm/100 cm^2)

Maximum: ________________

General Area: ________________

Comments: ________________

____

____

____

Initial Surveyor (Print Last Name & Date)

____

Survey Updates (Print Last Name & Date)

____

____

____

____

____

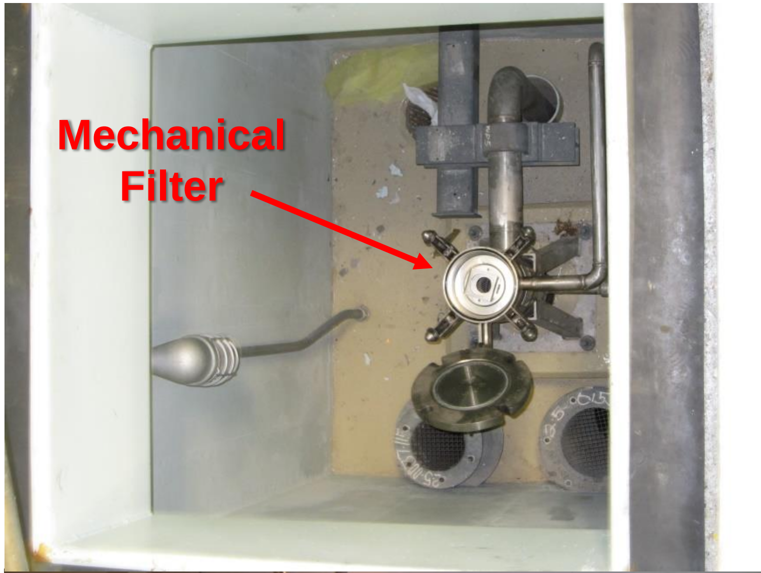
Identify source of high radiation levels (e.g., overhead piping, floor piping, or highly contaminated surfaces).

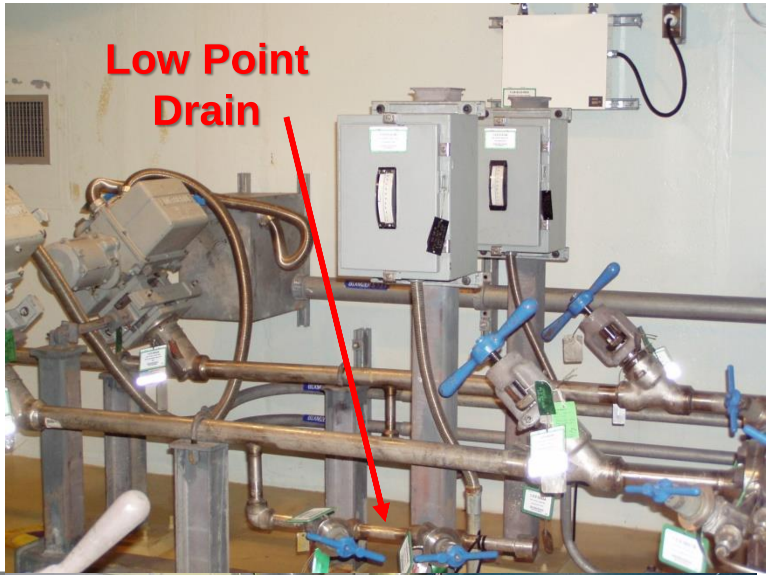
- Identify any areas with radiation streaming and evaluate the dose rates, the source, and the configuration.
  - Notify RP supervision to assess the need for mitigating actions.

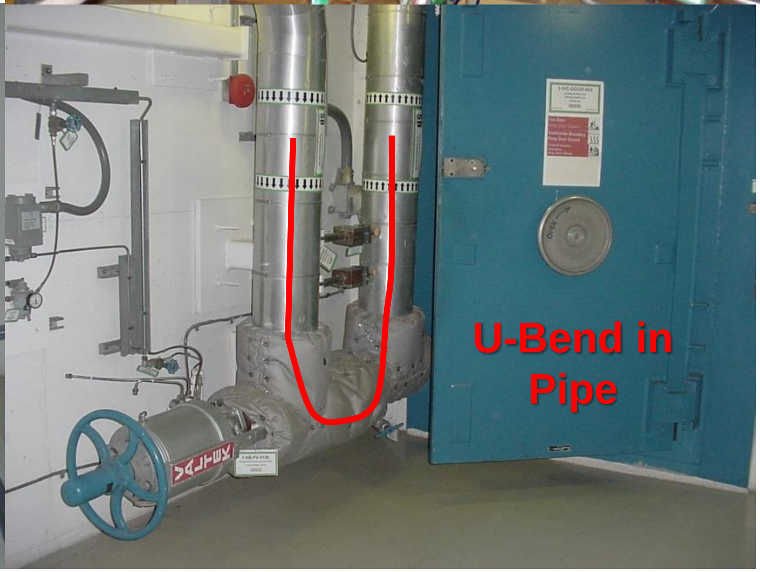
Examples of Possible High Radiation Sources

- Piping with low or no flow where irradiated corrosion products could accumulate
  - Low point drains in piping
  - U-bends (forming a low point) in piping
  - Valve bodies
  - Mechanical filters
- Piping used to transfer contaminated liquids
  - Unshielded overhead piping designed and located at a height to be sufficiently distant from occupied spaces
  - Unshielded floor piping that could build-up irradiated products when flow is stagnant
- Contaminated surfaces
  - From spills
  - From dried deposits
- Gaps in shielding

Examples of Possible High Radiation Sources







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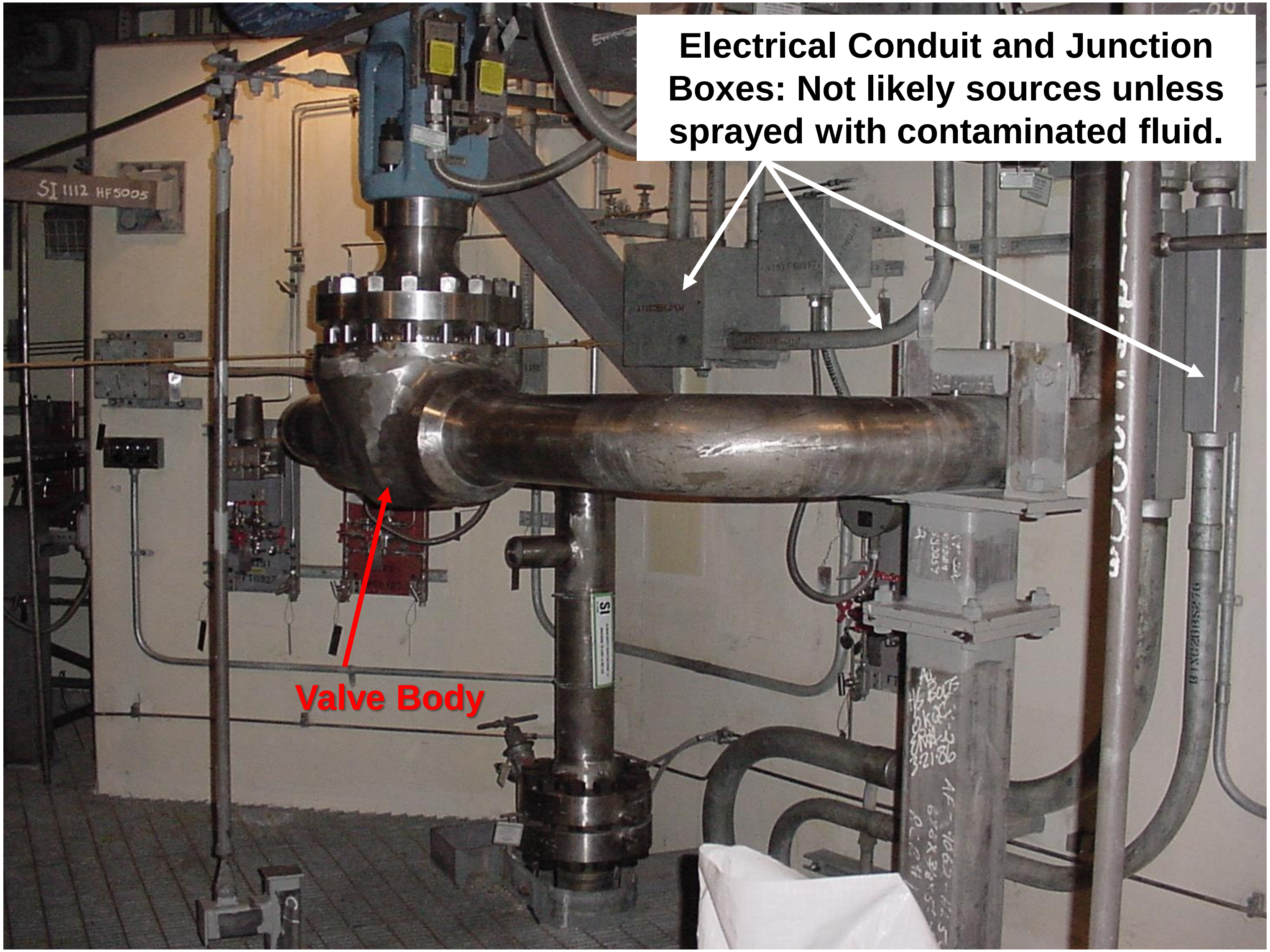
Examples of Possible High Radiation Sources



Explain the purpose and function of area radiation monitors.

- The primary purpose of an area radiation monitor is to warn of abnormally high radiation levels in an area.
- They may also be used to:
  - Detect changes in radiation levels in an area
  - Measure dose rates in a fixed area
  - Provide a reading of background radiation
  - Trend dose rates in a an area

Performing Radiation & Contamination Surveys

- Survey Dose Rates in an Area
- **Directly Frisk a Surface**
- Perform a Smear Survey
- Perform a Large Area Smear Survey
- Survey for Discrete Radioactive Particles
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State the background limits for using contamination survey instruments and counting equipment.

- Select the appropriate instrument based on the following:
  - Use a zinc sulfide or gas flow proportional detector to frisk for transuranic nuclides (that is, alpha-emitting).
  - Use a pancake GM detector to frisk for βγ emitters.
- If verifying the absence of contamination, ensure background <u>does not exceed</u> the following:
  - 200 cpm to detect with a pancake GM detector.
  - 1 cpm to detect transuranic nuclides (that is, alpha-emitting).

Directly Frisk a Surface

- Slowly move the probe over the surface (e.g., 1 to 2 inches per sec) as closely as possible without contacting the surface (approximately ¼ inches for alpha detector, approximately ½ inches for a GM detector). Upon noticing an increased count rate, perform the following:
  - Stop the probe.
  - Move the probe as close as possible to the area of interest.
  - Observe the instrument reading long enough to determine the count rate above background (ncpm).
  - Consider contamination as being present if the count rate is above background.

Describe actions to estimate contamination levels when contamination survey instruments are off-scale.

- Methods to estimate contamination levels:
  - Use an ion chamber to measure the activity on a highly contaminated smear (that is, > 100,000 dpm) by placing the open window as close as possible to the smear without touching it, and observe the readout or meter indication.
  - Apply correction factors as provided by site procedures as needed to convert readings to mRad/hour. Calculate the beta dose rate by using the following formula:

$$\frac{mrad}{hour} = (OW - CW)(beta\ correction\ factor)$$

Describe actions to be taken if contamination levels in excess of 500,000 dpm / 100 cm^2 are identified.

- Measure beta dose rates in known or suspected areas with contamination levels in excess of 500,000 dpm/100 cm^2, e.g. open primary reactor system components or drained radwaste tanks and reactor cavities.
  - Scan the surface with an open window ion chamber instrument and obtain static measurements where the radiation levels are the highest.
  - Obtain a closed window (CW) and open window (OW) measurement as close to the surface as possible without contaminating the instrument.
  - Calculate the beta dose rate by using the following formula:

$$\frac{mrad}{hour} = (OW - CW)(beta\ correction\ factor)$$

  - The beta correction factor is provided by RP supervision; the factor may be located on the instrument calibration label.
  - Also obtain CW and OW measurements at 30 cm and determine the gamma and beta dose rates as described above.

Describe actions to be taken if count rate exceeds 50,000 ncpm when frisking with a pancake GM detector.

- If the count rate exceeds 50,000 ncpm when frisking with a pancake GM detector, determine if the cause is a discrete radioactive particle (DRP) by the following method:
  - Determine if the count rate rapidly drops as the probe is slowly moved approximately 1 inch from the centerline geometry. This is a characteristic of a DRP.
  - Attempt to remove the DRP with tape or other suitable media and repeat the direct frisk after each attempt to determine if it has been removed.
  - Verify if the particle has been isolated with the tape by frisking the tape.
  - Notify RP supervision if a DRP was present.
  - Ensure areas are posted for Discrete Radioactive Particles per NISP-RP-04, *Radiological Posting and Labeling*.

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Perform a Smear Survey

- Wipe or rub a disc smear over a surface area of approximately 100 cm^2 using moderate pressure.
  - If an object has less than 100 cm^2 of surface area, wipe all of the surface area.
    - Estimate the surface area and ratio it to 100 cm^2 in order to document survey results in units of dpm/100 cm^2

      OR

    - Document the results as dpm/smear.

Perform a Smear Survey

- Smear enough locations to adequately assess the locations and quantities of surface contamination in the area.
  - Number the smears and their location on the survey map.
  - If a map or drawing is not available, record information sufficient to recall where each smear was taken.
  - Comply with site procedures for smear surveys in Foreign Material Exclusion (FME) areas.
- Take precautions to avoid cross-contaminating smears.
- Analyze smears using one or more of the methods shown beginning with slide 48.

Performing Radiation & Contamination Surveys

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Perform a Large Area Smear Survey

NOTE

- Large area smears (also called wipes or sweeps) provide a qualitative assessment that is used to verify the absence of removable contamination in a relatively large area.

- Large area smears have a detection threshold but they are not used to quantify removable contamination levels.

Describe how to perform a large area smear survey.

- Wipe one side of the survey cloth on the surface area as follows:
  - Wipe floors with a cloth mop to obtain a representative sampling of the area.
  - Wipe the entire surface of items such as boxes, containers, equipment, etc.
  - Suspend wiping the surface if the survey cloth becomes wet or loaded with debris, dust, or dirt.
  - Do not use wipes if the surface is so rough that the cloth is torn by rubbing it on the surface.
  - Use multiple wipes as needed.
  - Wipe an area greater than 5 times the surface area of the wipe to achieve a detection threshold less than 1,000 dpm/100 cm^2 of loose surface contamination.[2]
- Directly frisk the surface of the wipe in an area where the background is less than 200 cpm.

Describe large area smear survey results that would indicate cleaning is required.

- If an increase above background is observed but the count rate is less than 100 ncpm, then take either of the following actions:
  - Repeat wipes in the area until contamination is not detected above background.
  - Perform a smear survey to identify areas that need cleaning and initiate actions to clean affected areas.
- If the direct frisk yields greater than 100 ncpm, take the following actions:
  - Post the area where the large area smear was obtained as a Contaminated Area per NISP-RP-04, *Radiological Postings and Labeling*.
  - Perform a smear survey (100 cm^2 smears) within the posted area to identify specific areas that need cleaning.
  - Initiate actions for decontamination as desired for removal of Contaminated Area postings.
  - Record a survey to show the following:
    - The area that was smeared by the large area smear and subsequently posted.
    - The highest ncpm reading from the direct frisk of the large area smear.
    - Results from the follow-up smear survey (100 cm^2 smears).
    - Post-decontamination results to justify removal of Contaminated Area postings.

Perform a Large Area Smear Survey

- If an increase above background is not observed, the removable contamination levels are less than the detection threshold of 1,000 dpm/100 cm^2.[2]

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Performing Radiation & Contamination Surveys

- Survey Dose Rates in an Area
- Directly Frisk a Surface
- Perform a Smear Survey
- Perform a Large Area Smear Survey
- **Survey for Discrete Radioactive Particles**
- Analyze Smears
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Describe procedures and limitations for performing special contamination surveys, including radioactive particles on personnel or equipment, radioactive particles in area.

- Wipe the surface with a survey cloth or other tacky material where contamination levels are greater than 100,000 dpm/100 cm^2, i.e. a High Contamination Area.
- Directly frisk the wipe material using the audible function if available to help discern quick increases and decreases in count rate.
  - If available, use a collimator cover for the detector with a small hole or slit to help identify the exact location of the particle.
- Attempt to isolate and contain the particle as described on slide 33. If the particle cannot be removed, it is sufficiently entrained where it is located.

Describe procedures and limitations for performing special contamination surveys, including radioactive particles on personnel or equipment, radioactive particles in area.

- Survey the particle with an ion chamber instrument to obtain both closed window (CW) and open window (OW) measurements.
  - An OW/CW ratio less than 10 normally indicates a fuel fragment.
  - An OW/CW ratio greater than 30 normally indicates a corrosion product.
- Ensure areas with discrete radioactive particles are posted and controlled per NISP-RP-04, *Radiological Postings and Labeling*.
- Submit the particle for gamma spectroscopy analysis as directed by RP supervision.

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Identify unusual conditions that might affect counting equipment response including high humidity, abnormal background, electronic noise, wet surfaces, oily surfaces, or extreme temperature.

CAUTION

- Ion chamber instruments are sensitive to temperature, pressure and humidity.
- Many instruments are also sensitive to electronic noise which is often part of background.
- In general, instruments should not be:
  - Exposed to high temperatures or humidity
  - Used where they are likely to become wet or contaminated, unless properly bagged
  - Exposed or used in an environment where there is excessive electronic noise

Identify unusual conditions that might affect counting equipment response including high humidity, abnormal background, electronic noise, wet surfaces, oily surfaces, or extreme temperature.

CAUTION

- Wet or oily smears can result in significant self-absorption of alpha particles.
- Dry wet smears prior to analysis using a method that will not result in losing contamination from the smear.
- Consult RP supervision for direction to analyze oily smears.

Differentiate methods to be selected for analyzing smears.

- Analyze a smear using a pancake GM detector to measure βγ emitting nuclides.
  - The detector may be connected to a rate meter or scaler.
  - Ensure background is less than 200 cpm if the purpose of the smear is to verify contamination levels are less than 1,000 dpm/100 cm^2.
  - Center the detector over the smear within ½ inch from the smear.
  - Subtract background from the gross count rate to obtain ncpm above background.
  - Divide the ncpm by the efficiency factor to obtain dpm/100 cm^2. Use an efficiency factor of 0.1 unless otherwise directed by RP supervision.

Differentiate methods to be selected for analyzing smears.

- Analyze a smear using a portable ion chamber survey instrument to measure βγ emitting nuclides.
  - Obtain closed window (CW) and open window (OW) measurements with the instrument as close to the smear as possible without contaminating the instrument.
  - Calculate the beta dose rate by using the following formula:

$$\frac{mrad}{hour} = (OW - CW)(beta\ correction\ factor)$$

  - The beta correction factor is provided by RP supervision; the factor may be on the instrument calibration label.
  - The gamma dose rate is the closed window measurement.

Differentiate methods to be selected for analyzing smears.

- Analyze smears for transuranic nuclides as follows:
  - For Alpha Level I Areas **AND** a High Contamination Area, analyze at least 10%, or 3 at a minimum, of the smears with the higher contamination levels.
  - For Alpha Level II Areas **AND** removable contamination levels are greater than 20,000 dpm/100 cm^2, analyze at least 10%, or 3 at a minimum, of the smears with the higher contamination levels.
  - For Alpha Level III Areas, analyze at least 50% of the smears to evaluate the magnitude and extent of the alpha contamination.

Differentiate methods to be selected for analyzing smears.

- Analyze smear samples for transuranic nuclides using an instrument capable of quantifying alpha emission.
  - The detector may be connected to a rate meter or scaler.
  - Ensure background complies with posted limits to provide the required MDA value and to ensure light is not penetrating the zinc sulfide detector covering.
  - Center the detector over the smear within ¼ inch from the smear without contacting the surface.
  - Subtract background from the gross count rate to obtain ncpm above background.
  - Divide the ncpm by the efficiency factor posted with the detector to obtain dpm/100 cm^2.

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Analyze Smears

CAUTION

- Prevent contamination of smear counters by complying with site limits for the maximum amount of contamination that can be on a smear.
- Limits are based on the highest allowed cpm measurement from the smear using a frisker.

Analyze Smears

- Analyze a smear using an automated smear counter.

NOTE Most automated counters have operating software that calculates both alpha and beta dpm values during one pass through the counter.

- Achieve familiarity with operating the software for the smear counter.
- Ensure background is within posted parameters for the counter.
- Exercise extreme care in placing and removing smears in planchets to avoid contaminating the counter and detector, causing an increase in background.

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Describe the different levels of alpha contamination, including the associated controls with each level, associated dose contribution of each level, and beta, gamma and alpha ratios.

Activity Ratio (βγ/α)	Designated Level
> 30,000	Level I (Minimal)
30,000 to 300	Level II (Significant)
< 300	Level III (Elevated)

Describe the different levels of alpha contamination, including the associated controls with each level, associated dose contribution of each level, and beta, gamma and alpha ratios.

Alpha Relative Intake Hazard:

- Level I Area is minimal (low)
  - Internal exposure from the alpha emitters not likely to exceed 10% of the total internal dose
- Level II Area is significant (medium)
  - Alpha emitters are likely to contribute between 10 – 90% of the internal dose and airborne radioactivity levels expressed as DAC fractions
- Level III Area is elevated (high)
  - Internal exposure from the alpha emitters is likely to exceed 90% of the total internal dose based on the inhalation retention model

Evaluate Transuranics

- If a smear has been analyzed for transuranic nuclides, determine the βγ/α Ratio of each smear as follows:

$$\beta\gamma/\alpha \text{ Ratio} = \frac{dpm\ of\ Beta\ Gamma\ Emitters}{dpm\ of\ Transuranic\ Alpha\ Emitters}$$

- If the βγ/α Ratio is less than or equal to 30,000 and the total transuranic alpha activity is greater than or equal to 20 dpm/100 cm^2, verify the smeared location is properly posted as an Alpha Level 2 or 3 Area as required by NISP-RP-04, *Radiological Postings and Labeling*.
  - If the current posting does not sufficiently encompass the hazards from transuranics, immediately take the following actions:
    - Upgrade the posting consistent with NISP-RP-04.
    - Notify RP supervision.

Evaluate Transuranics

- If the βγ/α Ratio is less than or equal to 50 and the total transuranic alpha activity is greater than or equal to 20 dpm/100 cm^2, verify that an alpha frisker is available and the area has been posted to require alpha frisking per NISP-RP-04, *Radiological Postings and Labeling*.
- If the smear was taken on equipment or material removed from an area and the βγ/α Ratio is less than or equal to 300 and the total transuranic alpha activity is greater than or equal to 20 dpm/100 cm^2, take the following actions:
  - Verify the container with the equipment or material is tagged “Level 3 Alpha Area” as required by NISP-RP-04.
    - If the container tag has to be revised, immediately notify RP supervision.
  - Verify the area from which the equipment was removed is posted as an Alpha Level 3 Area as required by NISP-RP-04.
    - If the posting is not for an Alpha Level 3 Area, immediately upgrade the area posting and notify RP supervision.

Evaluate Transuranics

- Method to estimate βγ contamination levels if survey instrument is off scale:
  - Use an ion chamber to measure the activity on a highly contaminated smear by placing the open window as close as possible to the smear without touching it, and observe the readout or meter indication.
  - Apply correction factors as provided by site procedures as needed to convert readings to dpm. (e.g. 75,000 dpm/mR per hour of Cs-137).

Performing Radiation & Contamination Surveys

- Survey Dose Rates in an Area
- Directly Frisk a Surface
- Perform a Smear Survey
- Perform a Large Area Smear Survey
- Survey for Discrete Radioactive Particles
- Analyze Smears
- Evaluate Transuranics
- **Respond to Abnormal Survey Results**
- Document a Radiological Survey
- Radiological Survey Map Symbols & Abbreviations

Describe expected response to abnormal survey results.

- Immediately notify RP supervision for any of the following conditions:
  - Changes in radiological conditions that require changes in postings or RWPs.
  - Dose rates greater than the site limit outside an RCA.
  - Discovery of radioactive material outside the RCA.
- If the criteria in NISP-RP-10, *Radiological Job Coverage,* are met, then <u>stop work</u>.

Performing Radiation & Contamination Surveys

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- Radiological Survey Map Symbols & Abbreviations

Document a Radiological Survey

NOTE

- Programs and software used to document radiological surveys vary among plant sites.
- Surveyors must become accustomed to site expectations for using survey maps and software applications.
- The nomenclature described in Attachment 2 includes accepted industry standards.

Describe survey documentation expectations.

- Document survey results in a timely manner using site-specific forms, maps, and software with the symbols and abbreviations listed in Attachment 2.
- Annotate station unique symbols on surveys as appropriate. Common nuclear accepted acronyms and abbreviations do not need to be defined.
- Ensure the recorded data provides sufficient detail to effectively communicate the radiological conditions within the surveyed area.
- Evaluate the recorded information and posted conditions to ensure compliance with NISP-RP-04, *Radiological Postings and Labeling*.

Describe survey documentation expectations.

- Ensure radiological survey documents meet the following criteria prior to submittal for RP supervision review and approval:
  - Hot Spots as defined in NISP-RP-04, Radiological Posting and Labeling are identified with contact and 30 cm measurements.
  - Radiological postings as defined in NISP-RP-04 are accurately aligned with the radiological measurements recorded on the survey.
  - If a contaminated system was breached during the survey, measurements are provided for:
    - Contact and 30 cm gamma measurements on exposed system internals.
    - Contact and 30 cm beta dose rates if contamination levels exceed 500,000 dpm/100 cm^2.
    - Air sample results during the breach as required by site supervision.
    - Smear results from the exposed internal surface.
    - Smear results from the area around the breached component.

Describe survey documentation expectations.

- Posted boundaries are delineated and labeled with any changes identified and explained.
- Air sample results are provided as required for job coverage.
- Smear surveys are representative of the area to sufficiently assess general area contamination levels.
- The survey date, time, and location are clearly recorded.
- The survey instrument used is identified by a serial number.
- The RWP number is referenced if the survey was performed in support of an RWP.
- The surveyor's printed name and signature are recorded for hand written surveys.
  - Names and approvals for electronic survey systems are entered based on the software application in use.

Performing Radiation & Contamination Surveys

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- Respond to Abnormal Survey Results
- Document a Radiological Survey
- **Radiological Survey Map Symbols & Abbreviations**

Radiological Survey Map Symbols & Abbreviations

- Survey information in the form of maps, signs, radiation work permits (RWPs), or status boards should be readily available via computer or at the RCA access area and, as appropriate, at the entrances to work areas.
- The information should be up to date, clearly written and displayed in format that is easily understandable by workers.
- Radiological survey information should provide workers with a clear understanding of the hazards and low-dose zones in their work areas.
- Date the survey information so radiological protection technicians and workers can evaluate its applicability based on known system changes.
- Workers review this information, attend prejob briefings, or self-brief for low radiological risk activities that include appropriate survey information, and use the information to control their doses.
- Consistent radiological survey symbols enhance the radiation worker's and radiation protection technician's ability to interpret surveys and identify hazards.
- Standardized survey symbols reduce training needs for traveling workers and radiation protection technicians.

Radiological Survey Map Symbols & Abbreviations

Whole Body Dose Rates

- Record chest high dose rates at the approximate locations of the measurements. No additional symbols or annotation is required unless the measurement is for a dose rate gradient.
- Record measurements of a dose rate gradient identifying the source of the gradient, the location of the highest radiation levels, and noting the approximate measurement heights as follows:

Knees

Waist

Chest

Head

Describe survey documentation expectations.

Symbols

Δ – Indicates air sample data. The type of A/S may be designated by placing a letter inside the "Δ" (except for breathing zone air samples it is assumed the others are general area air samples).

- Particulate A/S is designated by placing a "P" inside the "Δ".
- Iodine A/S is designated by placing an "I" inside the "Δ".
- Noble Gas A/S is designated by placing an "G" inside the "Δ".
- Breathing Zone A/S is designated by placing a "BZ" inside the Δ.

O – Indicates contamination data. A number should be placed inside the "O" corresponding to referenced smear location.

__***#**__**/**___#___ – Indicates contact and 30 cm gamma dose rate readings; where the numerical value with the asterisk shall display the contact gamma dose rate and the second numerical value shall display the 30 cm gamma dose rate.

Describe survey documentation expectations.

Symbols

HS – Indicates a hot spot. Contact and 30 cm dose rate (same format as above) of the hot spot may be placed adjacent to the HS.

N – Indicates dose rates due to neutron radiation.

50N indicates 50 mrem/hr general area due to neutron radiation.

B – Indicates the dose rate due to beta radiation, applying a beta correction factor.

50 β indicates 50 mrad/hr corrected beta dose rate; contact and 30 cm readings should be displayed using the same format as above.

XXX or ----- – Designates a radiological area boundary. Used in conjunction with RCA, RA, HRA, LHRA, VHRA, ARA, CA, HCA, RMA, etc.

Describe survey documentation expectations.

Additional Information

- Other information displayed on radiological postings such as "keep out" or a range of gamma dose rates found in the area may be added. Other information should be standardized as follows:
  - "KO" for keep out
  - "NRP" for notify RP prior to entry
  - "LDWA" for low dose waiting area
  - A rectangle with the letters "SOP" shall be placed at the entrance to a contaminated area to designate a step off pad

Describe survey documentation expectations.

Radiological Units

- "mR/hr or mrem/hr," or unit variations, should be used to designate dose rates due to gamma radiation.
- "mrad/hr" should be used to designate dose rates due to beta radiation.
- "N" for dose rates due to neutron radiation in mrem/hr.
  - 50 N indicates 50 mrem/hr general area due to neutron.
- Percent DAC should be used when designating the airborne radioactivity in an area.
- "dpm/100 cm^2" should be used when designating the contamination level in a specific location using a standard disc smear.
- "<1,000 dpm/100 cm^2" should be used to record large area smear results if direct frisking of the smear did not yield ≥ 100 ncpm.

Describe survey documentation expectations.

Radiological Units

- “ncpm / LAS” (large area smear) should be used when designating the contamination level if a direct frisk of the large area smear yielded ≥ 100 ncpm. The abbreviation, LAS, should be spelled out on the survey map.
- “mrad/hr/100 cm^2” should be used when designating the contamination level in a specific area that has been determined using a dose rate meter and a standard disc smear or “mrad/hr/LAS” if an area larger than 100 cm^2 was surveyed.
- “K” should be used for thousands of dpm; for example 1K dpm/100 cm^2 is equal to 1000 dpm/100 cm^2.
- “ND” (non-detectable) or “<ND dpm/100 cm^2” should be used when contamination is below detectable levels.

Must-Know Operating Experience – INPO 12-005

Important Points

- In each event described in this document, personnel could have been prevented from receiving unplanned exposures through implementation of more rigorous radiological protection measures. The following deficiencies pertaining to radiation and contamination surveys were identified as common contributors to these personnel exposure incidents:
  - In several of the events discussed, radiation surveys performed in support of the job were not done in the actual work location, were not done in sufficient detail, or were not done frequently enough to determine the actual work area radiological conditions.
  - Radiological protection technicians were not always aware of the radiological conditions encountered, did not always recognize changes in the radiological conditions, or failed to take the proper actions in response to unusual conditions.
  - In each of the events described, work practices used by one or more individuals indicated a disregard for good radiological protection practices and requirements or demonstrated a lack of knowledge.
- The potential for very high personnel radiation exposures can be present in some areas of a nuclear plant. In many of these areas radiation fields can increase significantly in a short period of time.

Expectations for Radiological Protection

The RP Technician:

- Is expected to be able to accurately develop a survey map and associated products, as these are intended to communicate the radiological hazard(s) to workers.
- Is expected to use human performance tools to reduce errors. Applicable tools are self-verification, questioning attitude and procedure adherence.

Consequences of Inadequate Performance:

- Failure to communicate radiological hazards and properly protect workers (or general public) from ionizing radiation or radiological contamination could result in overexposure of personnel.
- Potential to have a contamination or radioactive material control event, NRC identified finding and / or Technical Specification violation.

Review

<u>Important Points</u>:

- General area dose rates are measured at chest level.
- Threshold levels for background are:
  - Less than 200 cpm to detect with a pancake GM detector.
  - Less than 1 cpm to detect transuranic nuclides.
- Type of instrument to use:
  - For alpha monitoring, you will need to use a zinc sulfide detector or a proportional counter detector.
  - For beta monitoring, you will need to use a pancake GM detector (frisk a surface) or an ion chamber instrument (dose rate).
  - For gamma monitoring, you will need to use a Geiger counter instrument or an ion chamber instrument.
  - For neutron monitoring, you will need to use a Rem meter (such as a Rem ball).
- Immediately notify RP supervision for any of the following conditions:
  - Changes in radiological conditions that require changes in postings or RWPs.
  - Dose rates greater than the site limit outside an RCA.
  - Discovery of radioactive material outside the RCA.

Review

Important Points:

- If dose rates exceed 100 mrem/hour between the knees and the head close to a source of high radiation levels, determine if a dose rate gradient exists that may require relocation of the chest dosimetry or additional dosimetry.
- Measure beta dose rates in known or suspected areas with contamination levels in excess of 500,000 dpm/100 cm^2 (for example, open primary reactor system components or drained radwaste tanks and reactor cavities).
- If the count rate exceeds 50,000 ncpm when frisking with a pancake GM detector, determine if the cause is a discrete radioactive particle (DRP).
- Survey areas greater than 7 feet above the floor only if ladders, scaffolds, or platforms are in place to gain access.
- For large area smears, if an increase above background is not observed, the removable contamination levels are less than the detection threshold of 1,000 dpm/100 cm^2.
- For discrete radioactive particles:
  - An OW/CW ratio less than 10 normally indicates a fuel fragment.
  - An OW/CW ratio greater than 30 normally indicates a corrosion product.

Enabling Objectives

1. Describe the precautions and survey techniques for entering an area in which radiation levels are unknown.
2. Define "general area" and "contact" dose rates.
3. Describe instrument selection criteria.
4. Describe expectations for taking dose rate gradient measurements.
5. Explain how to obtain and record dose rates from mixed radiation fields.
6. Calculate beta dose rates from known or suspected highly contaminated areas.
7. Describe requirements for surveying areas greater than 7 feet above the floor.
8. Identify source of high radiation levels (e.g., overhead piping, floor piping, or highly contaminated surfaces).
9. Explain the purpose and function of area radiation monitors.
10. State the background limits for using contamination survey instruments and counting equipment.
11. Describe actions to estimate contamination levels when contamination survey instruments are off-scale.
12. Describe actions to be taken if count rate exceeds 50,000 ncpm when frisking with a pancake GM detector.

Enabling Objectives

13. Describe actions to be taken if contamination levels in excess of 500,000 dpm / 100 cm^2 are identified.
14. Describe how to perform a large area smear survey.
15. Describe large area smear survey results that would indicate cleaning is required.
16. Describe procedures and limitations for performing special contamination surveys, including radioactive particles on personnel or equipment, radioactive particles in area.
17. Differentiate methods to be selected for analyzing smears.
18. Identify unusual conditions that might affect counting equipment response including high humidity, abnormal background, electronic noise, wet surfaces, oily surfaces, or extreme temperature.
19. Describe the different levels of alpha contamination, including the associated controls with each level, associated dose contribution of each level, and beta, gamma and alpha ratios.
20. Describe expected response to abnormal survey results.
21. Describe survey documentation expectations in accordance with NISP-RP-02.

Performing Radiation & Contamination Surveys Training Conclusion

- Questions: Contact Tom Stroschein, 361-972-7734
- Feedback: Email tmstroschein@stpegs.com
- Conclusions: In our industry it is vitally important to be able to accurately record data obtained from a survey such that other persons can utilize the information from the developed map in order to communicate radiological hazards.

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