



September 24, 2003

L-MT-03-072  
10 CFR 50, Appendix E  
Section V

U.S. Nuclear Regulatory Commission  
ATTN: Document Control Desk  
Washington, DC 20555

Monticello Nuclear Generating Plant  
Docket 50-263  
License No. DPR-22

Emergency Plan Implementing Procedure

Furnished with this letter is a revision to the Monticello Nuclear Generating Plant Emergency Plan Implementing Procedures. The following procedure is revised:

<u>Procedure</u>	<u>Procedure Title</u>	<u>Revision</u>
A.2-807	Off-Site Dose Assessment and Protective Action Recommendations	10

Please post changes in your copy of the Monticello Nuclear Generating Plant Emergency Plan Implementing Procedures. The superseded procedure should be destroyed.

This revision does not reduce the effectiveness of the Monticello Nuclear Generating Plant Emergency Plan.

Please contact John Fields at (763) 295-1663 if you require further information.

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Enclosure

A045

<b>MONTICELLO NUCLEAR GENERATING PLANT</b>		A.2-807
<b>TITLE:</b>	<b>OFF-SITE DOSE ASSESSMENT AND PROTECTIVE ACTION RECOMMENDATIONS</b>	Revision 10
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Prepared By: <i>B. Peterson</i>	Reviewed By: <i>Charles D. Dixon</i>	
OC Review Req'd: YES	OC Meeting Number: <i>2382 F</i>	Date: <i>9/11/03</i>
Approved By: <i>[Signature]</i>	Date: <i>9/11/03</i>	
<b>FOR ADMINISTRATIVE USE ONLY</b>		
This revision incorporates Volume F Memos: <i>A.2-12</i>		
3087 (DOCUMENT CHANGE, HOLD, AND COMMENT FORM) incorporated: <i>03-1978</i>		
Resp Supv: EP	Assoc Ref: A.2	SR: N
ARMS: A.2-807	Doc Type: 1060	Admin Initials: <i>[Signature]</i>
		Freq: 1 yrs / Date: <i>9/11/03</i>

l/plr

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**1.0 PURPOSE**

This procedure provides instructions and guidance for the conduct of off-site dose assessment and formulation of off-site Protective Action Recommendations at the Monticello EOF.

Steps in this procedure satisfy commitment M90125A.

**2.0 APPLICABILITY**

2.1 An Alert has been declared at the Monticello plant and,

2.2 The EOF has been activated, staffed and has assumed the responsibility for off-site communication, dose assessment and Field Team coordination.

**3.0 ORGANIZATION AND RESPONSIBILITIES**

3.1 The Emergency Manager (EM) is responsible for:

3.1.1 The approval of off-site Protection Action Recommendations prior to their transmittal to the State (or local) authorities.

3.2 The Radiological Protection Support Supervisor (RPSS) is responsible for:

3.2.1 Implementation of this procedure.

3.2.2 Overall direction and coordination of EOF Rad Prot Support group activities including off-site dose projections, dose assessment, and the formulation of off-site protective action recommendations.

§ 3.2.3 Making recommendations regarding off-site Protective Actions to the Emergency Director (ED) and discussing the basis for off-site Protective Action Recommendations with the State Planning Chief and NRC.

3.3 The Assistant RPSS is responsible for:

3.3.1 Assisting the RPSS with the coordination of EOF Radiation Protection Support Group activities including dose projections, assessment and Field Team direction.

3.4 The MIDAS Operator is responsible for:

3.4.1 The conduct of off-site dose projections using the MIDAS (or backup) methods including the generation of periodic Emergency Notification Follow-up Messages for transmittal to the State.

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3.5 The Field Team Coordinator is responsible for:

3.5.1 Direction and coordination of Monticello and Prairie Island Field Teams under the supervision of the RPSS (or Assistant RPSS).

3.6 The Field Team Communicator is responsible for:

3.6.1 The coordination of Monticello and Prairie Island Field Teams via radio under the direction of the Field Team Coordinator.

#### 4.0 DISCUSSION

##### 4.1 Summary

Dose assessment refers to the integrated process of dose projection, collection of field measurements and meteorological data, comparison of projected data to field data, and consideration of plant status to develop a working knowledge of the current and near-term radiological environment resulting from a radioactive release.

The radiological forecast developed in the dose assessment process provides the input for making appropriate recommendations to protect the health and safety of the public.

The responsibility for dose assessment is initially assigned to the TSC. The Radiological Emergency Coordinator (REC) formulates protective action recommendations which are forwarded to State or County officials through the ED. After the EOF is activated, the EM is responsible for dose assessment. At the decision of the EM, the dose assessment function transfers from the TSC to the EOF.

The decision to transfer dose assessment responsibilities from the TSC to the EOF will be based on the emergency situation, the EOF equipment status and staffing of the Radiation Protection Support Group. The transfer is implemented by informing the TSC, directing the RPSS to assume the responsibility and closely coordinating the transfer with the REC.

4.2 For definitions related to PARs, see FIGURE 7.1

4.3 For general discussion of PARs, see FIGURE 7.2

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**5.0 PRECAUTIONS**

- 5.1 Declaration of a General Emergency requires immediate initial protective action recommendations (PARs) to off-site agencies. Under these circumstances, NO dose projections are required for formulating the initial off-site protection action recommendation.
- 5.2 Implementation of protective actions for off-site areas is the responsibility of the State of Minnesota. If it is determined by the EM that immediate protective actions are required, and the State EOC is not activated, the recommendation **SHALL** be made directly to the local authorities (i.e., Wright and Sherburne Counties). Upon activation of the State EOC all off-site protective action recommendations **SHALL** be made to the State.
- 5.3 The protective actions outlined in this procedure are limited to actions for minimizing the exposure of the public to external and internal radiation exposure from plume passage, inhalation of the radioactive plume and from internal exposure from drinking water during the early phase of an emergency. Other protective actions for minimizing public exposure via the ingestion pathway will be determined and implemented by the State.
- 5.4 Exposures of Field Team personnel should be in accordance with administrative control levels. They should have proper dosimetry, which is frequently checked, remain alert to their own exposure and request relief if cumulative exposure approaches administrative control levels. The ED may authorize exposure limit extensions if necessary (refer to EPIP A.2-401 (EMERGENCY EXPOSURE CONTROL)). All exposures should be maintained ALARA.
- 5.5 Monticello Field Teams should not be recalled from field monitoring until Prairie Island teams have relieved them in the field.
- 5.6 The transmission of Off-site Protective Action Recommendations to the State EOC (State Duty Officer and Counties if the State EOC is not activated) **SHALL** be completed within 15 minutes of the PAR authorization.

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## 6.0 INSTRUCTIONS

### **CAUTION**

**No dose projections are required when making initial PAR during GENERAL EMERGENCY CONDITIONS.**

## 6.1 Initial PARs for General Emergency Classification

- 6.1.1 Initiate Form 5790-102-02 (MONTICELLO EMERGENCY NOTIFICATION REPORT FORM).
- A. Complete Section 1.4 recommending an evacuation of a 2 mile radius and 5 miles downwind and advise the remainder of the plume EPZ to go indoors to monitor EAS broadcasts.
  - B. Determine which geopolitical subareas are affected by referring to the Sector-Subarea Conversion Table on Form 5790-102-02.
  - C. Ensure completion of Parts 1.0 and 2.0 of Form 5790-102-02 and submit the completed form to the EM for approval.
- 6.1.2 Ensure transmission of the recommendations, via telephone and telecopy, to the State EOC (State Duty Officer, Wright and Sherburne Counties if the State EOC is not activated) in accordance with EPIP A.2-803 (EMERGENCY COMMUNICATIONS AT THE EOF).
- 6.1.3 Approximately 30 minutes after making the recommendation, contact the State Planning Chief or State Duty Officer if State EOC is not activated to determine what protective actions are actually being implemented. Continue to track the status of the protective action until completely implemented and indicate the completion status on the Radiation Protection Status Board.
- 6.1.4 Update the EM and EOF personnel (if activated and staffed) on the status of off-site Protective Action implementation.
- 6.1.5 After making initial Protective Action Recommendations (at the General Emergency Class) continually assess plant conditions and off-site dose projection results. Make subsequent off-site protective action recommendations based on projected off-site doses using the Protective Action Guidelines (PAGs) listed in FIGURE 7.3.
- 6.1.6 Once a PAR has been implemented by state or local authorities it should not be rescinded or revised because of the potential for changing conditions and causing confusion.

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## 6.2 PARS for Sherco Plant

**NOTE:** To safely shutdown the Sherco Plant requires eight (8) hours after the unit(s) are tripped.

- 6.2.1 Throughout the event the RPSS (or Assistant RPSS) should review off-site projected doses and affected Sectors (Subareas) to determine if the Sherco Plant is or will be in the affected area.

**NOTE:** The Sherco Plant is located in the 5N subarea.

- 6.2.2 Formulate protective action recommendations for the Sherco Plant as follows:

A. Recommendations based on Projected Dose (whole body):

1. > 500 mrem (TEDE) - recommend evacuation of non-essential personnel from the Sherco site and shelter essential plant personnel during plant operation.
2. > 1 Rem (TEDE) - recommend shutdown of the Sherco Plant(s). Immediate evacuation of non-essential personnel and sheltering of essential personnel during normal plant shutdown.
3. > 5 Rem (TEDE) - recommend immediate evacuation of non-essential personnel and sheltering of essential personnel during emergency plant shutdown. Evacuate all personnel immediately after plant shutdown.

B. Recommendations based on General Emergency:

1. If evacuation is implemented (in 5N) recommend evacuation of all non-essential personnel and sheltering of essential Sherco personnel. Recommend immediate initiation of plant shutdown.

- 6.2.3 If protective actions are required for the Sherco Plant, discuss the recommendations with the EM.

**NOTE:** Generation management will implement the required protective actions for Sherco personnel through established management channels.

- 6.2.4 Monitor the progress of protective action implementation (at Sherco) to determine when they are completed.

- 6.2.5 Indicate any PARs recommended (and implemented) for the Sherco Plant on the RP Status Board in the TSC.

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6.2.6 Advise the EM if conditions change (e.g., significant increase in release rate) which could change the protective action recommendations for the Sherco Plant.

**6.3 Off-site PARs Based on Projected Doses**

**CAUTION**

**Do not delay recommending off-site protective actions while waiting for off-site monitoring results to verify the accuracy of the dose projection model. Do not delay recommending off-site protective actions while trying to resolve questionable data (MIDAS Data or Field Team Data).**

- 6.3.1 Continuously review dose projection data (four (4) day integrated maximum TEDE and Thyroid CDE) on Form 5790-102-03 (EMERGENCY NOTIFICATION FOLLOW-UP MESSAGE) and compare with the Protective Action Guidelines in FIGURE 7.3. If an updated PAR, based on dose projections is required, proceed to Step 6.3.2. Continuously review meteorological data (wind direction and wind speed) on Form 5790-102-03 and determine the affected sectors. If an updated PAR, based on meteorological data is required, proceed to Step 6.3.2.
- 6.3.2 Initiate Form 5790-204-01 (MONTICELLO OFF-SITE PROTECTIVE ACTION RECOMMENDATION CHECKLIST) and complete the airborne release section.
- 6.3.3 Using current meteorological data (i.e., wind direction and wind speed), determine the affected Sectors, Geopolitical Subareas (using page 2 of Form 5790-204-01), population centers with in the affected area and estimated plume arrival time in those areas.
- 6.3.4 Based on plant conditions, estimate the duration of the existing release or potential release.
- 6.3.5 Using available weather forecast data, evaluate the potential for wind direction and wind speed changes during the estimated duration of the release (and after). Determine what effect potential wind direction and wind speed changes would have on the affected areas identified in 6.3.3.

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**NOTE 1:** Weather forecast information may be obtained from the National Weather Service. Refer to the Monticello and Prairie Island Nuclear Emergency Preparedness Telephone Directory for telephone numbers.

**NOTE 2:** If data used in the determination of the PAR is/or was questionable, attempt to verify the data. **DO NOT** delay the issuance of the PAR. If after verification of questionable data a PAR revision is necessary, complete Section 6.3 of this procedure.

6.3.6 If based on dose projections or field team data a PAR beyond the 10 mile EPZ is necessary, immediately contact the State Planning Chief to inform them of this condition and document in comments section of Form 5790-204-01. Attach a copy of the supporting Follow-up Message to Form 5790-204-01.

6.3.7 Indicate the recommendations on page 3 of Form 5790-204-01. Indicate the recommendation in terms of Sectors and Subareas by completing and circling the applicable information as follows:

A. Identify the affected keyhole by selecting a 360° out to 2 or 5 miles. Determine the affected Sectors by including both Sectors on either side of the downwind Sector (two Sectors on either side should be included if the downwind direction is on a Sector line). Record the 3 (or 4) affected Sectors on page 3 of the Monticello PAR Checklist.

B. Identify the affected geopolitical subareas using the Sector-Subarea Conversion Chart (page 2 of Form 5790-204-01) and circle the affected subareas on the PAR Checklist.

6.3.8 Submit the completed page 3 of Form 5790-204-01 to the EM for approval. Review and discuss the recommendations with the ED as necessary.

**NOTE:** Prior to activation of the State EOC, protective action recommendations should be made directly to the State Duty Officer and Wright and Sherburne Counties (EOCs if activated). The State Duty Officer will coordinate the EAS message and PANs activation with counties. Once the State EOC is activated, all protective action recommendations **SHALL** be made directly to the State authorities.

6.3.9 The ED (or RPSS) should direct an Emergency Communicator to transmit the approved Off-Site Protective Action Recommendation Checklist, to the State EOC (Wright and Sherburne County EOCs only if the State EOC is not yet activated) in accordance with EPIP A.2-803 (EMERGENCY COMMUNICATIONS AT THE EOF).

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- 6.3.10 When notified by the Emergency Communicator that the transmittal of the protective action recommendation has been made to the State Planning Chief (if State EOC is activated) or the State Duty Officer, Wright County and Sherburne County (if State EOC is not activated) contact either the State Planning Chief or the State Duty Officer, Wright County and Sherburne County. Discuss the recommendations and explain the basis of the recommendations.
- 6.3.11 Approximately 30 minutes after making the recommendation, contact the State Planning Chief or State Duty Officer prior to State EOC activation, to determine what protective actions are actually being implemented. Continue to track the status of the protective action until completely implemented and indicate the completion status on the Radiation Protection Status Board.
- 6.3.12 If, as a result of continuing assessment, dose projection results or meteorological conditions change significantly, re-evaluate the previously implemented protective actions and, if necessary, update the protective actions by issuing another recommendation.

**6.4 Protective Action Recommendation for Liquid Releases**

- 6.4.1 Initiate Form 5790-204-01 and complete the Liquid Release Section.
- 6.4.2 Obtain the isotopic analyses of liquid samples taken at the Discharge Canal or release point.

**NOTE:** During a liquid release, samples may be taken at the discharge structure, mid-canal sample station, canal out-fall to the river, or as near the source of the release as possible. To ensure samples are representative of the material being released to the river, the Canal Sample Station is the preferred sampling location.

- 6.4.3 Determine the present Discharge Canal flow rate and river flow rate at the plant (refer to the applicable plant computer point for flow rates).
- 6.4.4 Determine the river flow rate at either the Coon Rapids Dam or the Minneapolis-St. Paul water intakes by contacting the Minneapolis Water Department (refer to the Monticello and Prairie Island Nuclear Emergency Preparedness Telephone Directory for telephone numbers).
- 6.4.5 Using the curve RIVER FLOW vs TIME curve (FIGURE 7.5) estimate the time of release arrival at the Minneapolis-St. Paul water intakes based on current, actual river flow (if actual river flow is not available, use the monthly average river flow in FIGURE 7.5).
- 6.4.6 Using the MIDAS User Manual Procedures access the MIDAS liquid release model. Enter the isotopic and other applicable release data.

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- 6.4.7 Using the MIDAS Liquid Release Dose Assessment printout, formulate off-site protective action recommendations in accordance with the guidelines in FIGURE 7.6.
- 6.4.8 Indicate the recommendations on page 3 of Form 5790-204-01 and submit the completed form for ED approval.
- 6.4.9 Transmit the recommendations to the State Planning Chief (State EOC if activated) in accordance with EPIP A.2-803.
- 6.4.10 Contact the State Planning Chief (in the State EOC if activated) to explain the basis for the recommendations.
- 6.4.11 Approximately 30 minutes after making the recommendation, contact the State Planning Chief to determine what protective actions are actually being implemented. Continue to track the status of the protective action until completely implemented.

**6.5 Ground Deposition Assessment**

- 6.5.1 IF MIDAS is available,  
THEN determine ground deposition using MIDAS User's Manual, Section 10 and continue to step 6.5.1.C.  
ELSE IF MIDAS is not available,  
THEN perform steps 6.5.1.A. through 6.5.1.C.

**NOTE: The purpose of this step is to obtain a rough estimate of ground deposition. If estimates of curies released are not available, proceed with Field Team deployment.**

- A. Determine the number of microcuries of iodine and particulate material (i.e., not noble gases) that were released.
  - B. Refer to FIGURE 7.7 to calculate the projected ground deposition. Using the guidance in FIGURE 7.7 develop a footprint, or map of the area, that could have ground contamination levels above 1 uCi/m<sup>2</sup>.
  - C. Record Field Team ground deposition survey results on Form 5790-410-03 (GROUND DEPOSITION SAMPLE RESULTS LOG).
- 6.5.2 As exposure rate data is obtained, calculate relocation projected doses using the conversion factor of 5000 mrem per mR/hr (i.e., 5000 mrem relocation projected dose per 1 mR/hr initial gamma exposure rate 1 meter above the ground).

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**NOTE:** This conversion factor may be conservative. The factor depends on the isotopic distribution and decay time of the ground deposition. With actual isotopic data, a better conversion factor can be calculated using the data in FIGURE 7.8.

- 6.5.3 As smear samples are analyzed and isotopic data is obtained use FIGURE 7.8 to refine the relocation projected doses.
- 6.5.4 Plot the relocation projected doses on a map. (Consider using a dedicated map to avoid confusion).
- 6.5.5 Determine the appropriate protective action recommendations in accordance with FIGURE 7.9.

**6.6 Return Dose Assessment**

- 6.6.1 As soon as resources allow, obtain dose rate surveys and smear samples per EPIP A.2-410 (OUT-OF-PLANT SURVEYS) in evacuated areas that are believed to be outside the footprint.
- 6.6.2 As the priority for return to evacuated areas within the known footprint increases (per the States recommendation), obtain dose rate surveys and smear samples within the affected (evacuated) areas in accordance with A.2-410.
- 6.6.3 Use FIGURE 7.8 and calculate relocation projected doses based on known (measured) ground deposition.
- 6.6.4 Plot the relocation projected doses on a map.
- 6.6.5 Refer to FIGURE 7.9 and develop Protective Action Recommendations regarding return to evacuated areas as appropriate.
- 6.6.6 Indicate the recommendation on Form 5790-204-01.
  - A. Submit the completed form to the Emergency/Recovery Manager for approval and processing.

**6.7 General Instructions for Field Team Deployment**

- 6.7.1 Identify the team(s) as Monticello Field Team 1 and 2 and direct the team(s) to establish and maintain radio communication with the Field Team Communicator in the EOF.
- 6.7.2 When the Prairie Island Field Teams arrive identify the PI teams as Field Team 3 and 4.
- 6.7.3 Determine the starting point of the survey based on the release point, source term, magnitude of the release, wind direction, and dose projection data (if available).

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- 6.7.4 Dispatch the team(s) to the selected survey/sample points to conduct surveys/sampling in accordance with EPIP A.2-410.
- 6.7.5 Direct the team(s) to transmit survey/sample results (by radio) to the Field Team Communicator in the EOF.
- 6.7.6 Direct the Field Team Communicator to record survey results on Form 5790-202-01 (OFF-SITE SURVEY RESULTS DATA SHEET) or Form 5790-410-03.
- 6.7.7 Direct the Field Team Communicator to periodically update the team(s) on plant conditions, emergency classification changes, protective actions and meteorological information as it becomes available.
- 6.7.8 Direct the team to check personal dosimetry and request relief if their exposure approaches administrative limits.
- 6.7.9 Direct the team(s) in the use of protective measures (including Anti-C clothing, respiratory protection and exposure control) in accordance with the following guidelines:
  - A. Direct protective clothing and respirator (with GMR-I canisters) use if:
    - 1. Substantial airborne activity and ground contamination is suspected or observed and the affected sectors have been evacuated; or
    - 2. A General Emergency has been declared and measured dose rates are more than 100 mrem/hr True Beta.
  - B. Direct the implementation of ALARA exposure control measures as follows:
    - 1. Field Teams should not linger in areas greater than 100 mrem/hr;
    - 2. Field Teams should not proceed into areas projected to be greater than 1000 mrem/hr unless directed by the REC;
    - 3. Field Teams should not proceed into areas projected to be greater than 10,000 mrem/hr.
- 6.7.10 Based on initial survey results request backup surveys or confirmatory sampling as necessary.
- 6.7.11 Upon completion of Field Team survey operations, direct the team(s) to report to the Emergency Operations Facility for exposure processing, de-briefing and re-assignment.

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**6.8 Field Team Deployment During Airborne Releases**

**NOTE:** For events that do not involve a radioactive release off-site monitoring is required to confirm that a release (above normal limits) is not occurring.

6.8.1 Dispatch the Field Teams in the downwind direction to conduct a search for the plume in accordance with EPIP A.2-410.

**CAUTION**

**Do not allow the Field Team(s) to sit idle. Teams should traverse the projected path of the plume in downwind affected sectors rather than remain in one location awaiting plume arrival.**

6.8.2 When the plume is located (positive meter deflection) instruct the team(s) to perform dose rate surveys in accordance with EPIP A.2-410.

6.8.3 Based on the results of the dose rate survey(s) determine if the team is in the plume (positive beta reading) or if the plume is elevated (gamma only).

6.8.4 When the plume is encountered (i.e., positive beta reading) direct the team(s) to obtain airborne particulate, gaseous and iodine airborne, and ground deposition samples. Instruct the team to analyze the samples (in low background area) and transmit the field analysis results to the EOF.

6.8.5 Upon completion of the field analysis direct the team to retain the samples or deliver them to the EOF Count Room for further analysis.

**NOTE:** A sample courier may be used to transport samples from the team(s) to the applicable Count Room.

6.8.6 Direct the Field Team Communicator to record all survey results on Form 5790-202-01 or Form 5790-410-03.

6.8.7 Track and plot the movement of the plume on the Radiological Survey Point map as follows:

A. Using current meteorological conditions (wind speed, direction, etc.) project the path of the plume;

B. Using available MIDAS data (GAMMA & THYROID PROJECTED DOSE REPORT and PROJECTED DOSE SUMMARY REPORT) project the location of the leading edge and trailing edge (if "puff" release) of the plume;

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- C. Using the team(s), locate the leading edge of the plume;
- D. Using the field team(s), locate the lateral boundaries (sides) of the plume;
- E. Using the team(s), verify that upwind ("backdoor") areas near the site are not affected by the release;
- F. For "puff" releases, direct the team(s) to locate the trailing edge of the plume;

- 6.8.8 Compare off-site monitoring results for consistency with State survey results as applicable. Reconcile inconsistencies in data and/or re-survey areas of concern as necessary.
- 6.8.9 Determine the centerline dose rate by directing a team to traverse through the plume, while monitoring enroute.

**NOTE:** This survey should be coordinated with the MIDAS dose projection run in an attempt to verify the projection by comparing survey results to the projection data.

- 6.8.10 Compare off-site survey results with dose projections for consistency. Reconcile major inconsistencies in data and/or re-survey areas of concern as necessary.

**NOTE:** A factor of < 100 is appropriate to use as the reasonable deviation when comparing model vs. actual field data.

- 6.8.11 Direct the Field Team Communicator to periodically update the team(s) on plant conditions, emergency classification changes, protective actions and meteorological information as it becomes available.

**6.9 Field Team Deployment for Ground Deposition Assessment**

- 6.9.1 Deploy Field Teams to obtain ambient dose rates and collect samples (in accordance with A.2-410) in areas that are not evacuated, but within the footprint.
- 6.9.2 Concentrate first on areas suspected of having the highest deposition.
- 6.9.3 Priority should be given to initially performing dose rate surveys, with more detailed smear surveys to follow. Target areas with dose rates above 0.2 mrem/hr or direct frisker readings above 20,000 cpm for collection of smear samples.

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6.9.4 Enough dose rate surveys/smear samples should be obtained to have confidence that "hot spots" have not been overlooked. Ten survey points per square mile is suggested as a minimum in areas where roads will allow this to be practical.

6.9.5 Ensure that areas not within the projected footprint are surveyed sufficiently to verify that the affected area has been identified completely.

6.9.6 Plot the Field Team results on a map. Compare them to the ground deposition projections, and direct follow-up surveys as appropriate to ensure the affected area is identified.

**6.10 Dose Assessment and Field Team Deployment for Ingestion Pathway**

6.10.1 Contact the EOC of each affected State and see if they have sample collection needs of particular priority that MNGP could satisfy.

**NOTE:** MNGP survey teams have the capability of performing dose rate, smear, liquid, soil/snow and air sampling and analysis. If there is a need for more sophisticated environmental samples, contact Teledyne and implement the letter of agreement. Once notified, Teledyne will dispatch a team to the affected site. They will also make their laboratories available for use should we need to send samples for analysis.

6.10.2 Direct the Field Teams to obtain samples according to the State(s) needs or to collect samples to confirm the results of the State(s) survey team.

6.10.3 Ingestion pathway dose projections should not be performed. Instead concentrate available resources on the collection, analysis, and transmittal of results to the States of smear, liquid, soil and/or snow samples.

6.10.4 Ingestion pathway protective actions will be determined by the State of Minnesota.

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**7.0 FIGURES**

**FIGURE**

**7.1 Definitions Related to Protective Actions Recommendations**

1. Affected Area is any area where radiation emanating from a plume, or from material deposited from the plume, can be detected using field instruments (also known as the footprint).
2. Cloudshine is radiation from radioactive materials in an airborne plume.
3. Committed Dose Equivalent (CDE) refers to the dose received over the 50 year period following an intake of radioactive materials.
4. Committed Effective Dose Equivalent (CEDE) is the sum of the products of the weighted factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissue.
5. Dose equivalent means the product of the absorbed dose in tissue, quality factors, and all other necessary modifying factors at the location of interest.
6. Effective dose equivalent (EDE) is the sum of the product of the absorbed dose in tissue, quality factors, and all other necessary modifying factors at the location of interest.

**NOTE: Deep Dose Equivalent (DDE) is considered equivalent to EDE if the exposure is uniform.**

7. Emergency Planning Zone (EPZ) is a defined area which facilitates emergency planning by State and local authorities to ensure that prompt and effective actions are taken to protect the public in the event of a radioactive release from the plant. The EPZ is defined for two areas:
  - A. Plume Exposure Pathway (10 Mile EPZ) is the 10 mile, 360° radius around the plant in which the primary concern is short-term exposure from the plume. The principal sources of exposure in this area are 1) whole body external exposure to gamma radiation from the plume and deposited material from the plume, and 2) internal exposure from inhaled material from the plume.
  - B. Ingestion Exposure Pathway (50 Mile EPZ) is a 50 mile, 360° radius around the plant in which the principal exposure would be from ingestion of contaminated water or foodstuffs (such as milk or fresh vegetables).
8. Evacuation is the removal of people from an area to avoid or reduce high-level, short term exposure, from a plume or from deposited activity.

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FIGURE

**7.1 Definitions Related to Protective Actions Recommendations (cont'd)**

9. Geopolitical Subareas are subarea within the 10 Mile EPZ that are defined by predetermined geographic and/or political boundaries.
10. Groundshine is radiation exposure caused by radioactive materials deposited on the ground.
11. Ingestion Pathway Projected Dose is the projected CEDE (ICRP-30) from consuming contaminated foodstuffs.
12. Keyhole Area an area within the 10 Mile EPZ defined by a 360° radius out to a specified distance of 2 or 5 miles and continuing in the downwind direction in 3 or 4 Sectors.
13. Plume Projected Dose refers to future calculated doses from plume submersion, plume shine, plume inhalation and 4 days of ground deposition exposure.
14. Protective Action is an action taken to avoid or reduce a projected dose.
15. Protective Action Guide (PAG) refers to a dose (or commensurate dose rate) which warrants protective actions.
16. Public Alert and Notification System (PANS) is the system used to alert the public within the 10 Mile EPZ of an emergency condition at the plant. Once alerted, the public would turn to local commercial media broadcast messages for specific protective action instructions. The PANS consists of the following systems:
  - A. Fixed sirens for 100% coverage throughout the 5 mile EPZ and in population centers between 5 and 10 miles.
  - B. Local law enforcement emergency vehicles with sirens and public address capability driving route alerting in the 5 to 10 mile areas not covered by fixed sirens.
  - C. National Oceanic and Atmospheric Administration (NOAA) alert radios in institutional, educational, and commercial facilities.
  - D. The Emergency Alert System (EAS) which accesses local television and radio stations.
17. Recovery is the process of reducing radiation exposure rates and concentration of radioactive material in the environment to levels acceptable for unconditional occupancy.

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**FIGURE**

**7.1 Definitions Related to Protective Actions Recommendations (cont'd)**

18. **Release** is the release of radioactive material to the environment attributable to the event.
19. **Relocation Projected Dose** is the projected effective committed dose from 1 year of exposure to radioactive material deposited as fallout from a plume, including whole body exposure to gamma radiation (groundshine), and internal dose from inhalation of resuspended material, but excluding internal dose from consuming contaminated foodstuffs.
20. **Return** refers to people permanently reoccupying their normal residence within an area that was evacuated during the emergency condition.
21. **Re-entry** refers to temporary entry into a restricted (evacuated) area under controlled conditions.
22. **Secondary Evacuation** refers to relocating people from areas to avoid or reduce relocation projected dose.
23. **Sector** is one of 16, 22.5° sectors around the plant which compose the 10 Mile EPZ.
24. **Sheltering** provides radiation protection from an airborne plume and/or deposited radioactive materials. Sheltering also ensures effective public notification, via media, should the need for evacuation occur.
25. **Total Effective Dose Equivalent (TEDE)** is the sum of external EDE and CEDE.

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FIGURE

**7.2 Discussion of Protective Action Recommendations**

The following is a discussion of the various Protective Action Recommendations (PARs) that could be made to off-site authorities. The Protective Action Guidelines (PAGs) listed are derived from EPA guidelines (EPA 400).

**1. NO PROTECTIVE ACTIONS**

The recommendation for no protective actions is self-explanatory and is appropriate when projected plume doses do not exceed 1000 mrem (TEDE) or 5000 mrem (CDE) thyroid dose. For liquid releases, no protective actions are warranted if the concentration in raw river water at outflow of discharge canal is less than the concentration listed in 10CFR20.1001-20.2402, Appendix B, Table 2, Column 2 (ODCM-04.01 (LIQUID EFFLUENT CALCULATIONS), Table 1).

**2. EVACUATION**

Evacuation is the movement of a population out of an area in order to reduce or eliminate direct or indirect radiation exposure. Timely evacuation of the population is the most effective protective action.

Initial PARs for a General Emergency involving loss of physical control or core damage are based on NRC Response Technical Manual RTM-93, Vol 1, Rev. 3, Section I. Immediate evacuation of the general public is justified without dose projection.

EPA 400 indicates that evacuation of the general public will usually be justified when the projected dose to an individual is greater or equal to 1000 mrem TEDE (or 5000 Thyroid CDE). At these dose levels, the risk avoided due to the radiation exposure is usually much greater than the risk from evacuation itself.

Using the projected dose criteria stated above, MNGP should recommend evacuation to the State. In turn, they will independently assess and implement protective actions based on our recommendation, their independent assessment, and current off-site evacuation constraints.

**3. CLOSURE OF WATER INTAKES**

Water Intakes PAG: Concentration in raw river water exceeds the value listed in 10CFR20.1001-20.2402, Appendix B, Table 2, Column 2 (ODCM-04.01, Table 1).

Closure of the water intakes is an appropriate recommendation in the case of a liquid release to the river which is expected to result in river water concentrations exceeding the MPC for unrestricted areas.

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FIGURE

**7.2 Discussion of Protective Action Recommendations (Cont'd)**

**4. SECONDARY EVACUATION**

Relocation PAG (in mrem): 2000 (TEDE)

To avoid social and family disruption and the complexity of implementing separate PAGs for individual members of the population, the relocation PAG may be applied for all members of the population. While the relocation PAG is based on projected doses to adults, infant relocation projected doses are not more than two times higher than the adult projected dose.

Based on EPA 400 PAGs, MNGP should recommend relocation of general public from affected areas not previously evacuated when the projected dose is greater or equal to 2000 mrem TEDE from exposure or intake during the first year.

This projected dose includes doses from external radiation, and inhalation of resuspended materials.

**5. RETURN**

Return is allowed at levels below the secondary evacuation PAG (2000 mrem TEDE).

The decision to return segments of the public from previously evacuated areas will be determined by appropriate off-site agencies. Various cautions and dose reduction techniques will be assessed and, if necessary, communicated to the people upon their return.

**6. DESIGNATION OF THE AFFECTED PROTECTIVE ACTION AREA**

The designation of the affected protective action area depends on the nature and extent of the incident and existing meteorological conditions. The area will be described by designating an affected keyhole shaped area and the affected geopolitical subareas within the EPZ.

**a Affected Keyhole Area**

The affected keyhole area should resemble a keyhole consisting of a 360° area surrounding the plant out to a distance of 2 or 5 miles and continuing in the downwind direction out to a distance determined by the PAGs. The affected downwind portion of the keyhole should include 1 sector on either side of the affected sector (i.e., total of 3 sectors). If the downwind direction is on a sector line then 2 sectors on each side of the affected sector should be included (i.e., total of 4 sectors).

**b Affected Geopolitical Subareas**

Geopolitical subareas are subareas of the 10 mile EPZ defined by predetermined geographic and/or political boundaries. The affected geopolitical subareas are defined by any and all subareas that intersect the affected keyhole area.

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FIGURE

**7.2 Discussion of Protective Action Recommendations (Cont'd)**

1. (EXPOSURE PATHWAYS, Incident Phases, and Protective Actions)

POTENTIAL EXPOSURE PATHWAYS AND INCIDENT PHASES	PROTECTIVE ACTIONS	
1. External radiation from facility	Sheltering Evacuation Control of access	
2. External radiation from plume	Sheltering Evacuation Control of access	
3. Inhalation of activity in plume	Sheltering Administration of stable iodine Evacuation Control of access	
4. Contamination of skin and clothes	EARLY	INTERMEDIATE
5. External radiation from ground deposition of activity	LATE	Sheltering Evacuation Decontamination of persons
6. Ingestion of contaminated food and water		Evacuation Relocation Decontamination of land and property
7. Inhalation of resuspended activity		Food and water controls
		Relocation Decontamination of land and property

- NOTE:**
1. Based on EPA 400-R-92-001, May 1992
  2. The use of stored animal feed and uncontaminated water to limit the uptake of radionuclides by domestic animals in food chain can be applicable to any of the phases.

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**FIGURE**

**7.3 Protective Action Guidelines (PAGs)**

	PAG VALUES <sup>1</sup>	RECOMMENDED PROTECTIVE ACTIONS	COMMENTS
WHOLE BODY <sup>2</sup> (TEDE) PROJECTED DOSE	Less than <1 REM (TEDE)	None required	The State may choose to implement sheltering at their discretion. No recommendations are required from MNGP.
	Greater than ≥1 REM (TEDE)	Recommend evacuation of the general public.	The State may choose to implement sheltering of the general public up to 5 REM (TEDE) or special population groups up to 10 REM (TEDE) if immediate evacuation is not practicable due to off-site constraints. No sheltering recommendations are required from MNGP.
THYROID <sup>3</sup> (CDE) PROJECTED DOSE	Less than <5 REM (CDE)	None required	The State may choose to implement sheltering at their discretion. No recommendations are required from MNGP.
	Greater than ≥5 REM (CDE)	Recommend evacuation of the general public.	The State may choose to implement sheltering of the general public if immediate evacuation is not practicable due to off-site constraints. No sheltering recommendations are required from MNGP.

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**FIGURE**

**7.3 Protective Action Guidelines (PAGs) (Cont'd)**

	<b>PAG VALUES<sup>1</sup></b>	<b>RECOMMENDED PROTECTIVE ACTIONS</b>	<b>COMMENTS</b>
<b>SKIN<sup>4</sup> (CDE) PROJECTED DOSE</b>	<b>Less than &lt;50 REM (CDE)</b>	<b>None required</b>	<b>The State may choose to implement simple personal protective actions (washing). No recommendations are required from MNGP.</b>
	<b>Greater than ≥50 REM (CDE)</b>	<b>Recommend evacuation of the general public.</b>	<b>The State may choose to implement sheltering of the general public or simple personal protective actions if immediate evacuation is not practicable.</b>
<b>NOTE 1:</b>	<b>Protective Action Guides are based on EPA 400-R-92-001, May 1992.</b>		
<b>NOTE 2:</b>	<b>TEDE = Total Effective Dose Equivalent; is the sum of the Effective Dose Equivalent from exposure to external source and the Committed Effective Dose Equivalent incurred from all significant inhalation pathways during the Early Phase.</b>		
<b>NOTE 3:</b>	<b>CDE = Committed Dose Equivalent to the Thyroid from radioiodine.</b>		
<b>NOTE 4:</b>	<b>Committed Dose Equivalent to the skin from exposure to beta radiation from radioiodines and particulates.</b>		

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**FIGURE**

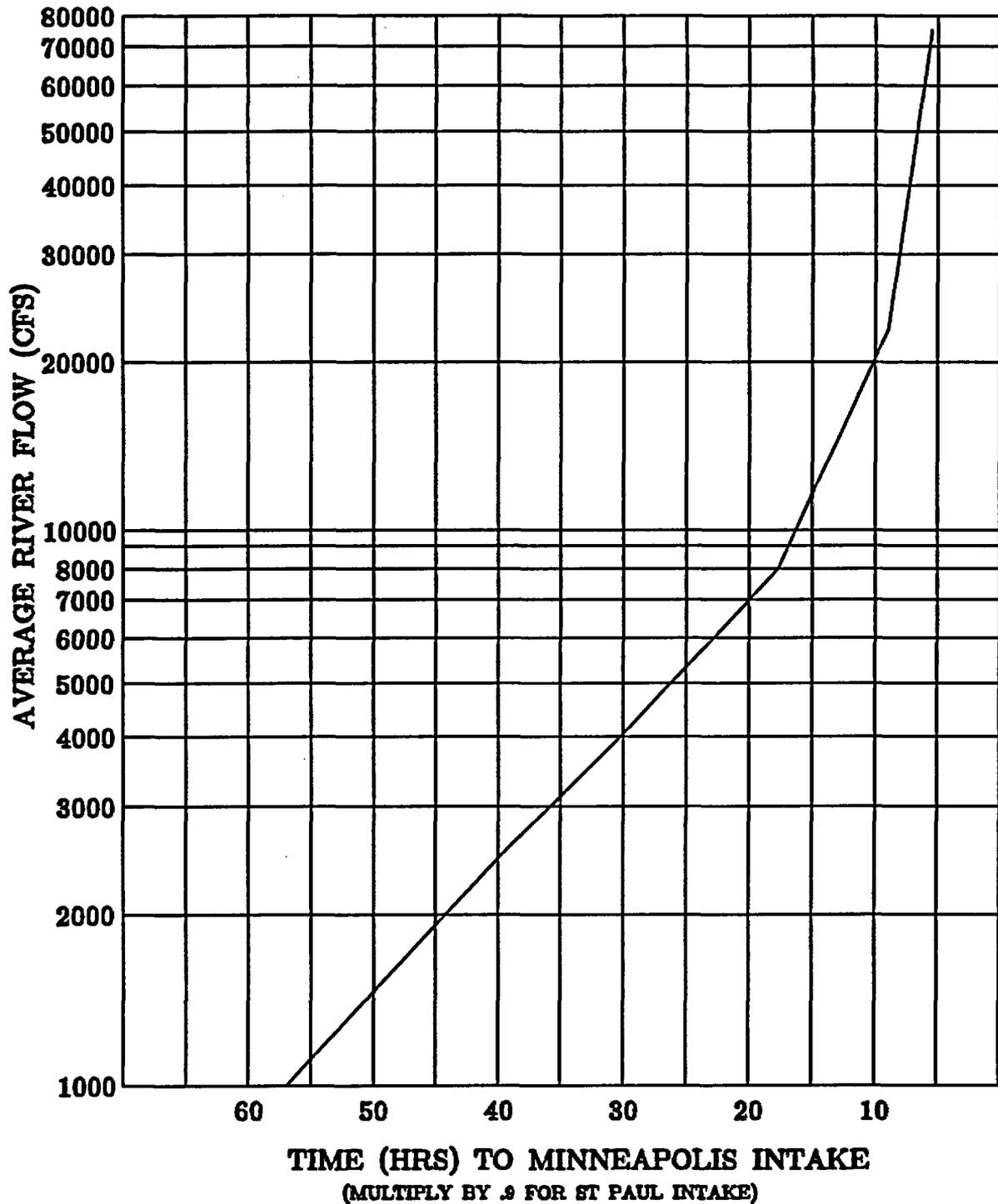
**7.4 Emergency Worker Exposure Limits**

<b>EXPOSURE LIMIT<sup>1</sup></b>	<b>EMERGENCY ACTIVITY<sup>1</sup></b>	<b>COMMENTS</b>
<b>5 REM (TEDE)<sup>(2)(3)</sup></b>	<b>All emergency activities</b>	<b>This dose limit applies when a lower dose is not practicable through application of ALARA practices.</b>
<b>10 REM (TEDE)<sup>(2)(3)</sup></b>	<b>Protection of valuable property</b>	<b>This dose limit applies when a lower dose is not practicable through application of ALARA practices.</b>
<b>≥ 25 REM (TEDE)<sup>(2)(3)</sup></b>	<b>Life saving or protection of large populations</b>	<b>Doses in excess of 25 REM should be on a voluntary basis to persons fully aware of the risks involved.</b>
<b>NOTE 1:</b>	<b>Dose limits for emergency workers and activities are based on EPA 400-92-001, May 1992.</b>	
<b>NOTE 2:</b>	<b>Sum of external effective dose equivalent and committed effective dose equivalent to non-pregnant adults from external exposure and intake during the duration of an emergency.</b>	
<b>NOTE 3:</b>	<b>Exposure to the lens of the eye should be limited to <u>3</u> times the value listed and doses to the skin and/or extremities should be limited to <u>10</u> times the value listed.</b>	

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**FIGURE**

**7.5 Transport Time and Monthly Average Flowrates**



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FIGURE

**7.5 Transport Time and Monthly Average Flowrates (Cont'd)**

<u>MONTH</u>	<u>AVG. RIVER FLOWRATE (CFS)</u>
JANUARY	4663
FEBRUARY	4579
MARCH	6336
APRIL	10890
MAY	10157
JUNE	7369
JULY	5352
AUGUST	3506
SEPTEMBER	3334
OCTOBER	5690
NOVEMBER	5438
DECEMBER	4555

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**FIGURE**

**7.6 Liquid Release Protective Action Criteria**

1. **PROTECTIVE ACTION BASED ON PROJECTED INTERNAL DOSE**
  - a MPC Ratio in Raw River: < 1 MPC - No protective action required.
  - b MPC Ratio in Raw River: > 1 MPC - Recommend closure of water intakes.
  - c Projected Internal (Drinking) Dose:
    - < 250 mrem - No protective action required.
    - > 250 mrem - Implement preventive protective actions.
    - > 1000 mrem - Implement emergency protective actions.
2. **PROTECTIVE ACTION BASED ON PROJECTED EXTERNAL DOSE**
  - a Projected Total External Dose
    - < 250 mrem - No protective action required.
    - > 250 mrem - Preventive protection actions are necessary.
    - > 1000 mrem - Emergency protective actions are necessary.

**NOTE:** Obtain total external projected dose by calculating the swimming, boating and standing projected doses using the following time assumptions for shoreline activities.

Swimming - 3 hrs/day  
Boating - 1 hrs/day  
Standing - 6 hrs/day

**RECOMMENDED PREVENTIVE PROTECTIVE ACTIONS**

1. Close Raw Water Intakes
2. Restrict Intake of Drinking Water, and Foodstuffs obtained from river.
3. Restrict swimming and boating on river.
4. Restrict access to river.
5. Restrict use of river for irrigation and industry.

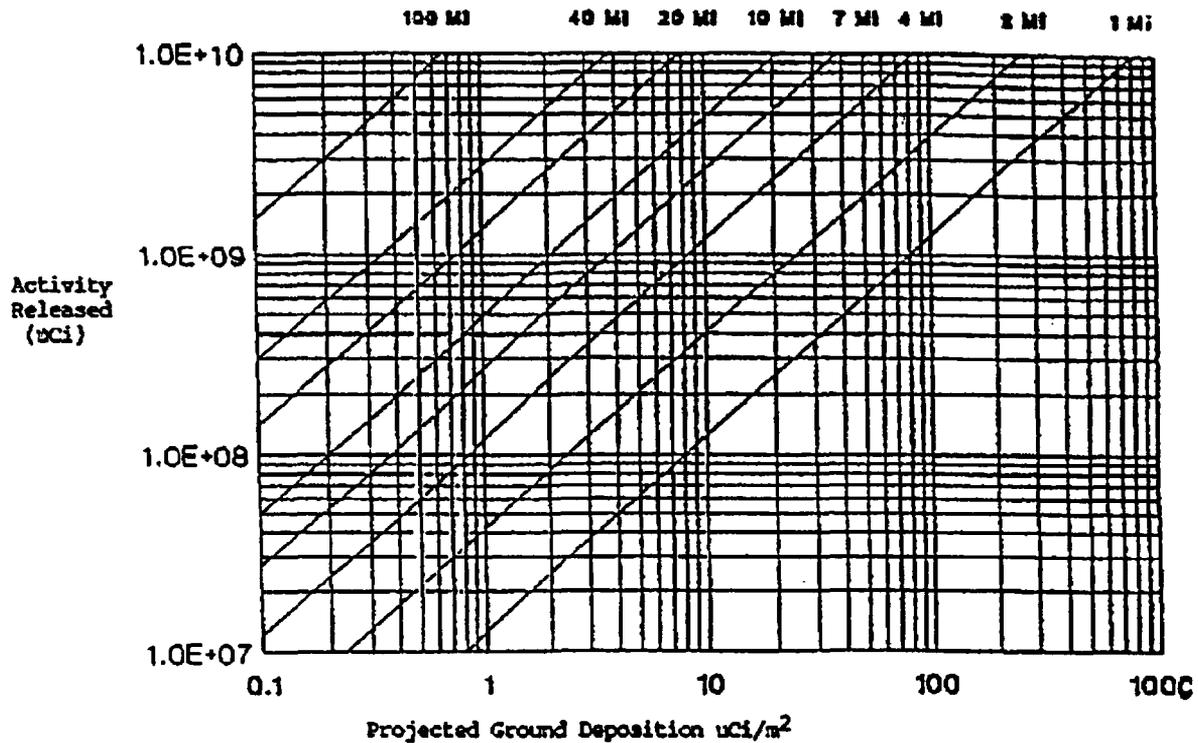
**RECOMMENDED EMERGENCY PROTECTIVE ACTIONS**

1. Close raw water intakes.
2. Condemn drinking water obtained from river.
3. Condemn affected foodstuffs (milk or meat from animals consuming contaminated water or foodstuffs)
4. Prevent access to river.
5. Condemn use of river for irrigation and industry.
6. Substitute uncontaminated water and foodstuffs for contaminated water and foodstuffs.
7. Condemn water usage from river.

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FIGURE

**7.7 Ground Deposition Modeling**



The ground deposition graph was calculated using relations in R.G. 1.109 & R.G. 1.111. The following assumptions pertain to the graph:

1. Unstable (A,B,C) Pasquill stability class. This results in the highest depositions for elevated releases. For ground level releases, the stability class has little effect on calculated deposition rates. For a stable stability class, actual ground deposition could be zero out of many miles from the plant.
2. Elevated (100 meter) release height. For ground level releases, deposition rates will be slightly higher out to 20 miles, and somewhat less beyond 20 miles.

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FIGURE

**7.7 Ground Deposition Modeling (Cont'd)**

3. The plume is deposited uniformly within half-width of a sector arc (about 11 degrees), for constant wind directions. Actual plume widths for unstable stability classes are significantly wider than this. This assumption causes the projected area ground contamination to be at least as high as the highest (centerline) actual deposition that would occur under stable conditions for deposition in accordance with a normal distribution with distance from the centerline.

**NOTE:** If several wind shifts occurred during the release, determine the approximate number of sectors into which the plume deposited material for each release period of interest. Divide this value by 0.5 and divide the result into the ground depositions predicted by the graph, to obtain an estimate of the degree the deposition was "diluted". For example, if the plume was spread out over 2 sectors, the ground deposition values obtained from the graph should be divided by 4. Once ground contamination as a function of distance has been estimated, use MIDAS (plume model) to help predict footprint actual width.

4. Wind speeds and stability classes vary often. The Van der Hoven study concludes there is a 50/50 chance of a significant wind shift within 2-4 hours at any given location. Therefore, the plume could be spread out more than the graph assumes and alter the resulting deposition. Rain showers could increase deposition greatly.

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FIGURE

**7.8 Secondary Evacuation Dose Projection**

Isotope	Ground shine Dose (mrem per uCi/m <sup>2</sup> )	Inhalation Dose (mrem per uCi/ m <sup>2</sup> )	Relocation Proj- ected Dose (mrem per uCi/ m <sup>2</sup> )	Initial Exp. Rate (mr/hr per uCi/ m <sup>2</sup> )	Relocation Proj- ected Dose per Initial Exp. Rate (mrem per mr/hr)
Sr-90	-----	11	11	-----	-----
Zr-95	34	-----	34	0.0162	2100
Ru-103	7.4	-----	7.4	0.0055	1300
Ru-106	14	1.4	15	0.0023	6700
I-131	1.3	-----	1.3	0.0047	280
Cs-134	118	-----	118	0.0183	6400
Cs-137	52	-----	52	0.0072	7200
Ba-140	11	-----	11	0.0279	390
Ce-144	3.3	1.4	4.7	0.0023	2000

**NOTES:**

1. Ground shine is the whole body dose (1 meter above the ground) received after a 1-year exposure to unit ground contamination (uCi/m<sup>2</sup>) as measured at the beginning of the exposure period.
2. Inhalation is the committed effective dose (i.e., corresponding whole body dose) received from the inhalation for 1 year of resuspended unit ground contamination (uCi/m<sup>2</sup>) as measured at the beginning of the exposure period. A re-suspension rate of 1E-6/meter is assumed.
3. The Relocation Projected Dose per Initial Exposure Rate column is the total committed effective dose that would be received after a 1-year exposure to contamination that caused an initial unit exposure rate (mr/hr, i.e., gamma only) at 1 meter above the ground. (The effective mrem per mr/hr for a mixture would be equal to a weighted average of the values in this column, which is computed by multiplying the value in this column times the ratio of the individual isotope to the total.)
4. The projected doses pertain to adults. Infant projected doses are not more than two times higher than the adult doses (other than for iodine which does not contribute greatly to overall dose for infants or adults).
5. Doses could be significantly lowered due to shielding from homes, decontamination, etc.

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FIGURE

**7.8 Secondary Evacuation Dose Projection (Cont'd)**

6. Elimination of the source term due to weathering as well as radioactive decay is assumed.
7. The doses listed include the dose from radioactive daughters.

**SECONDARY EVACUATION DOSE ASSESSMENT**

Isotope	Smear (DPM)	Direct Frisk (CPM)	Ground Contam ( $\mu\text{Ci}/\text{m}^2$ )	Reloc Dose (mrem)	Initial Doses Rate (mrem/hr)
Ru-106	130,000	29,000	67	1000	0.15
Cs-134	17,000	3,700	8.5	1000	0.16
I-131	1,500,000	330,000	770	1000	3.6

Rules of Thumb

1. The most restrictive nuclide in terms of projected relocation dose per measured initial dose rate is Cs-137 (about 7000 mrem per mrem/hr). Cesium-134 is the most restrictive nuclide in terms of projected relocation dose per unit contamination (about 120 mrem per  $\mu\text{Ci}/\text{m}^2$ ).
2. Assuming a 10% smear collection efficiency, 10% counter efficiency, and 20  $\text{cm}^2$  area "seen" by the probe for a direct risk, the following relationships were developed:
  - a  $\text{Direct frisk } \mu\text{Ci}/\text{m}^2 = \frac{\text{net cpm}}{400}$   
Where net CPM is frisker count rate about 1" from surface in question.
  - b  $\text{Smear } \mu\text{Ci}/\text{m}^2 = \frac{\text{smear net cpm}}{200}$   
Where smear net cpm is frisker count rate of 100  $\text{cm}^2$  smear from a smooth surface.
3. Based on assumed radiological characteristics of releases from fuel melt accidents, gamma exposure rates in areas where the projected relocation dose is in the range of 1-5 Rems would be between about 2 and 10 mrem/hr during the first few days after shutdown following an SST-2 accident severity type. Ground deposition values in the range of 200-800  $\mu\text{Ci}/\text{m}^2$  could also be expected.

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FIGURE

**7.9 Relocation Protective Action Guidelines**

Relocation Projected Dose (TEDE)	Recommended Actions
2000 mrem	Relocate General Public

**COMMENTS:**

1. To avoid social and family disruption and the complexity of implementing separate PAGs for individual members of the population, the relocation PAG may be applied for all members of the population. While the relocation PAG is based on projected doses to adults, infant relocation projected doses are not more than two times higher than adult projected doses.
2. Return is allowed at levels below the PAG.

<b>MONTICELLO NUCLEAR GENERATING PLANT</b>		<b>A.2-807</b>
<b>TITLE:</b>	<b>OFF-SITE DOSE ASSESSMENT AND PROTECTIVE ACTION RECOMMENDATIONS</b>	<b>Revision 10</b>
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FIGURE

**7.10 Forms Utilized in Procedure**

<u>NUMBER</u>	<u>TITLE</u>
1. 5790-102-02	MONTICELLO EMERGENCY NOTIFICATION REPORT FORM
2. 5790-102-03	EMERGENCY NOTIFICATION FOLLOW-UP MESSAGE
3. 5790-204-01	MONTICELLO OFF-SITE PROTECTIVE ACTION RECOMMENDATION CHECKLIST
4. 5790-202-01	OFF-SITE SURVEY RESULTS DATA LOG
5. 5790-410-03	GROUND DEPOSITION SAMPLE RESULTS LOG