NUREG–0654
FEMA–REP–1
Rev. 1
Supp. 3

Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants

Criteria for Protective Action Recommendations for Severe Accidents

Draft Report for Interim Use and Comment

Manuscript Completed: July 1996
Date Published: July 1996

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ABSTRACT

The Nuclear Regulatory Commission (NRC) and the Federal Emergency Management Agency (FEMA) have added Supplement 3 to NUREG-0654/FEMA-REP-1, Revision 1, which provides guidance for the development of protective action recommendations for the public for severe reactor accidents involving actual or projected core damage with the potential for loss of containment. Studies of severe reactor accidents and their consequences since the issuance of NUREG-0654/FEMA-REP-1, Revision 1, have led the NRC staff to conclude that the preferred initial protective action for a severe (core damage) accident is to evacuate promptly rather than to shelter the population near the plant, barring any constraints to evacuation. The guidance in this document is intended to update and simplify the decisionmaking process for protective actions for severe reactor accidents given in Appendix 1 to NUREG-0654/FEMA-REP-1, Revision 1.

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I. INTRODUCTION

A. Purpose and Use of Document

The Nuclear Regulatory Commission (NRC) and the Federal Emergency Management Agency (FEMA) have added Supplement 3 to NUREG-0654/FEMA-REP-1, Revision 1, to provide updated guidance for the development of protective action recommendations for severe reactor accidents involving actual or projected core damage with the potential for loss of containment. Since the publication of the original guidance in NUREG-0654, extensive studies of severe reactor accidents have been performed. These studies clearly indicate that for all but a very limited set of conditions, prompt evacuation of the area near the plant is much more effective in reducing the risk of early health effects than sheltering the population in the event of severe accidents. Therefore, the NRC staff concludes that in the event of a severe (core damage) accident, the preferred initial protective action is to evacuate the population promptly rather than to shelter the population near the plant, barring any constraints to evacuation. Experience gained in reviewing emergency plans and in evaluating numerous emergency preparedness exercises has shown that not all emergency response organizations fully understand the impact of these insights on protective action decisionmaking. Thus, the guidance in this document is being issued to give these organizations the benefit of the insights gained as a result of severe accident studies and to assist them in improving their emergency response capabilities.

Nuclear power plant licensees and State and local emergency response organizations may use the updated and simplified guidance in this document or, alternately, they may continue to follow the original guidance in Appendix 1 to NUREG-0654 to develop appropriate protective actions for the public for severe reactor accidents based on the insights provided by the NRC's severe reactor accident studies.

The guidance in this supplement is consistent with the guidance on protective actions for the public issued by the U.S. Environmental Protection Agency (EPA) in its "Manual of Protective Action Guides and Protective Actions for Nuclear Incidents," EPA 400-R-92-001, May 1992, and is also consistent with the protective action guidance followed by the NRC's Protective Measures Team as documented in the NRC manual for emergency responders, "RTM-96, Response Technical Manual," NUREG/BR-0150, Vol. 1, Rev. 4, March 1996.

B. Background

During the first few hours of an accident at a nuclear power plant, critical decisions may be necessary concerning actions to protect the public. Plant conditions are the major determining factors in developing early protective action recommendations. The licensee is responsible for mitigating the consequences of an accident and for recommending to offsite officials protective actions commensurate with the severity of the accident. State and local governments are responsible for making decisions on the actions necessary to protect the public and for transmitting these decisions to the public. The NRC monitors the actions of the licensee and may provide recommendations and advice to the licensee and State and local officials concerning the protective actions recommended by the licensee.

The guidance for determining protective actions for severe reactor accidents is supported by the conclusions derived from severe accident studies on the effectiveness of protective actions, including NUREG-1150, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," issued December 1990. These conclusions are as follows:

1. To be most effective, protective actions (evacuation or shelter) must be taken before or shortly after the start of a major radioactive release to the atmosphere.

2. If a severe core damage accident occurs, people should immediately evacuate areas near the plant and remain in shelter elsewhere for the immediate future.

3. Following a major radioactive release, the dose from ground contamination may become very significant in a few hours requiring prompt radiological monitoring to locate high levels of ground contamination.

Guidance for licensees and offsite emergency response organizations on protective actions to be recommended to State and local governmental officials under General Emergency conditions was originally provided in Appendix 1 to NUREG-0654 in November 1980. The guidance in Appendix 1 to NUREG-0654 was clarified and illustrated in a flow diagram in NRC Information Notice (IN) 83-28, "Criteria for Protective Action Recommendations for General Emergencies," issued in May 1983. Licensees as well as State and local governments have used the protective action guidance in NUREG-0654 and IN 83-28 as the basis for determining protective action recommendations and directives in their emergency plans and implementing procedures. However, the NRC staff position and internal guidance for developing protective actions for severe reactor accidents has evolved from the guidance in NUREG-0654 based primarily on the results of severe accident studies. Experience gained in reviewing emergency plans and in evaluating numerous nuclear power plant emergency preparedness exercises has shown that not all emergency response organizations are fully aware of how the NRC's improved understanding of severe accidents affects the application of the guidance on protective action decision making.

The guidance in Appendix 1 to NUREG-0654 indicates that the initial protective action for a General Emergency is to shelter the population close to the plant while considering the advisability of evacuation. This initial guidance to shelter the population was intended to apply only until a determination was made that substantial core damage sequences were in progress or were projected. The guidance in Appendix 1 further indicates that if core damage was in progress and containment failure was judged to be imminent, shelter should be recommended for people in those areas that could not be evacuated before the plume arrived. Although the original guidance in NUREG-0654 was never intended to imply that the appropriate initial protective action for severe accidents was to only shelter the population that is near the plant, the guidance was not explicit on this point. Having people seek shelter if they cannot evacuate before the plume arrives was considered to apply only for a short-term (puff) release of known duration. More recent studies have shown that for other than containment venting, this type of release is not predictable, and most of the release and accompanying dose for a long-duration release can be avoided by evacuating early. In addition, studies have shown that except for very limited conditions, evacuation in a plume is still more

effective in reducing health risks than prolonged sheltering near the plant. Therefore, the NRC and FEMA recommend that the population near the plant should be evacuated if possible for actual or projected severe core damage accidents.

The basic premise is that in the unlikely event of a severe core damage event, plant operators cannot predict with certainty the occurrence of a radiological release, the magnitude and duration of any such release, or the radiological consequences of the release. The staff has considered these uncertainties and has recognized that sheltering people in most structures close to a nuclear plant, where plume concentrations and dose consequences are likely to be highest, will not prevent early adverse health effects during a major radioactive release. Accordingly, the staff has concluded that it is better to evacuate promptly near the plant for a serious reactor accident as a precautionary measure rather than to wait for additional information that may only become available after a release occurs. Plant conditions, that is, the status of the core and systems intended to protect the core, should be used as the basis for determining the initial protective actions for severe accidents. Evacuating the areas near a plant early, using information on conditions in the plant, provides the best assurance that early health effects will be prevented or minimized in the event of a severe reactor accident. After performing the initial early protective actions near the plant, the licensee and State and local officials should continue assessing the situation, including the development of dose projections and performing field monitoring. These assessments should be used to determine if the protective actions should be expanded with field monitoring data being the preferred basis on which to determine if people should be relocated from sheltered areas.

II. SIMPLIFIED GUIDANCE ON PROTECTIVE ACTIONS FOR SEVERE REACTOR ACCIDENTS

The guidance in this supplement updates and simplifies the decisionmaking process for determining protective actions for the public for severe reactor (core damage) accidents. The guidance emphasizes that the preferred initial action to protect the public from a severe reactor accident is to evacuate immediately about 2 miles in all directions from the plant and about 5 miles downwind from the plant, unless other conditions make evacuation dangerous. Persons in the remainder of the plume exposure pathway emergency planning zone (EPZ) should be directed to go indoors and listen to Emergency Alert Stations while the situation is further assessed. By doing so, they will be able to receive additional instructions, if necessary.

Travel conditions that would present an extreme hazard may prompt offsite officials to initially shelter rather than evacuate the nearby population until conditions improve. Shelter may also be the appropriate initial protective action for transit-dependent persons, who should be advised to remain indoors until transportation resources arrive, if possible. In addition, shelter may be the appropriate protective action for controlled releases of radioactive material from the containment if there is assurance that the release is short term (puff release) and the area near the plant cannot be evacuated before the plume arrives.

Plant and offsite officials should continue assessment actions based on additional plant information, dose projections, and field monitoring results. After performing the initial early evacuation actions near the plant, licensee

and offsite officials should modify the protective action recommendations as necessary based on (1) field monitoring to locate areas with high levels of contamination (hot spots) and (2) dose projections which indicate that EPA protective action guide doses may be exceeded in areas beyond those that have been evacuated. On the basis of this information, plant and offsite officials may expand the evacuations to encompass other areas in the plume EPZ and, for the worst-case accidents, protective actions may be required beyond the plume EPZ.

A. Flow Chart on Protective Actions

The simplified guidance on protective actions for severe reactor accidents is illustrated in a flow diagram in Figure 1.

B. Revision to Appendix 1 of NUREG-0654/FEMA-REP-1, Revision 1

Guidance on protective actions for severe reactor accidents is given in Appendix 1 of NUREG-0654/FEMA-REP-1, Rev. 1. The simplified guidance in this supplement on protective actions for severe reactor accidents involving actual or projected core damage or loss of control of the plant is given in the form of revised pages to Appendix 1 of NUREG-0654. Change bars are used to denote where the changes have been made in the original text. This supplement also contains other minor revisions to the text of Appendix 1 of NUREG-0654 including an update of the example initiating conditions for a General Emergency.

III. CONTINUED USE OF EARLIER GUIDANCE ON PROTECTIVE ACTIONS FOR SEVERE REACTOR ACCIDENTS

The earlier guidance on protective actions for severe reactor accidents in Appendix 1 to NUREG-0654, as illustrated in a flow chart in IN 83-28, can continue to be used to determine the appropriate protective actions with the proper understanding of the concepts underlying the development of the guidance and with the proper application of the insights gained from more recent severe accident studies. The earlier guidance to shelter the population close to the plant while assessing the need to evacuate does not apply to situations in which plant operators have detected that substantial core damage is in progress or is projected. Shelter, however, may be considered the appropriate initial protective action for some accident conditions that do not involve actual or projected core damage.

Upon detection of core damage sequences in which containment failure is judged imminent, the earlier guidance in NUREG-0654 indicates that evacuation should not be recommended for situations in which evacuation cannot be completed before the plume arrives. The recommendation to shelter the population in these cases only applies to core damage sequences in which there is assurance that the release from the containment will be a short-term (puff) release of predictable duration. For all other cases, the preferred protective action is to evacuate the population close to the plant rather than to shelter the population unless other conditions such as hazardous weather increase the risk of evacuation.

APPENDIX 1

U.S. Nuclear Regulatory Commission

EMERGENCY ACTION LEVEL GUIDELINES

FOR NUCLEAR POWER PLANTS

(Simplified Guidance on Protective Action Recommendations for Severe Reactor Accidents)

The simplified guidance in this supplement is given in the form of revised pages to Appendix 1 of NUREG-0654/FEMA-REP-1, Revision 1. Change bars are used to denote where changes have been made in the original text. For consistency, the page numbers are the same as in the original Appendix 1.

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BASIS FOR EMERGENCY ACTION LEVELS FOR NUCLEAR POWER FACILITIES

Four Emergency Classification Levels are established, each with associated examples of initiating conditions. The classes are:

Notification of Unusual Event

Alert

Site Area Emergency

General Emergency

The rationale for the notification and alert classes is to provide early and prompt notification of minor events which could lead to more serious consequences given operator error or equipment failure or which might be indicative of more serious conditions which are not yet fully realized. A gradation is provided to assure fuller response preparations for more serious indicators. The site area emergency class reflects conditions where major failures of plant functions needed for protection of the public have occurred or are likely. In this situation full mobilization of emergency personnel in the near site environs is indicated as well as dispatch of monitoring teams and associated communications. The general emergency class involves actual or imminent substantial core degradation or melting with the potential for loss of containment. The preferred initial protective action for this class is to evacuate immediately about 2 miles in all directions from the plant and about 5 miles downwind, unless other conditions make evacuation dangerous.

The example initiating conditions listed after the immediate actions for each class are to form the basis for establishment by each licensee of the specific plant instrumentation readings (as applicable) which, if exceeded, will initiate the emergency class.

Potential NRC actions during various emergency classes are given in NUREG-0728, Report to Congress: NRC Incident Response Plan. The NRC response to any notification from a licensee will be related to, but not limited by, the licensee estimate of severity; NRC will consider such other factors as the degree of uncertainty and the lead times required to position NRC response personnel should something more serious develop.

Prompt notification of offsite authorities is intended to begin within about 15 minutes for the unusual event class and sooner (consistent with the need for other emergency actions) for other classes. The time is measured from the time at which operators recognize that events have occurred which make declaration of an emergency class appropriate.

Class	Licensee Actions	State and/or Local Offsite Authority Actions
GENERAL EMERGENCY **Class Description** Events are in process or have occurred which involve actual or imminent substantial core degradation or melting with potential for loss of containment integrity. Releases can be reasonably expected to exceed EPA Protective Action Guideline exposure levels offsite for more than the immediate area. **Purpose** Purpose of the general emergency declaration is to (1) initiate predetermined protective actions for the public, (2) provide continuous assessment of information from licensee and offsite organization measurements, (3) initiate additional measures as indicated by actual or potential releases, (4) provide consultation with offsite authorities, and (5) provide updates for the public through offsite authorities.	1. Promptly inform State and local offsite authorities of general emergency status and reason for emergency as soon as discovered (Parallel notification of State/local) 2. Augment resources by activating on-site Technical Support Center, on-site operational center, and near-site Emergency Operations Facility (EOF) 3. Assess and respond 4. Dispatch on-site and offsite monitoring teams and associated communications 5. Dedicate an individual for plant status updates to offsite authorities and periodic press briefings (perhaps joint with offsite authorities) 6. Make senior technical management staff onsite available for consultation with NRC and State on a periodic basis 7. Provide meteorological and dose estimates to offsite authorities for actual releases via a dedicated individual or automated data transmission 8. Provide release and dose projections based on available plant condition information and foreseeable contingencies 9. Close out or recommend reduction of emergency class by briefing of offsite authorities at EOF and by phone followed by written summary within 8 hours of closeout or class reduction	1. Provide any assistance requested 2. Activate immediate public notification of emergency status and provide public periodic updates 3. For actual or projected severe core damage accidents or loss of control of facility, recommend evacuation for 2 mile radius and 5 miles downwind (unless conditions make evacuation dangerous) and assess need to extend distances. Advise the remainder of plume EPZ to go indoors and listen to Emergency Alert System (EAS) messages. 4. Augment resources by activating primary response centers 5. Dispatch key emergency personnel, including monitoring teams and associated communications 6. Dispatch other emergency personnel to duty stations within 5 mile radius and alert all others to standby status 7. Provide offsite monitoring results to licensee, DOE, and others and jointly assess them 8. Continuously assess information from licensee and offsite monitoring with regard to changes to protective actions already initiated for public and mobilizing evacuation resources 9. Recommend placing milk animals within 10 miles on stored feed and assess need to extend distance 10. Provide press briefings, perhaps with licensee 11. Maintain general emergency status until closeout or reduction of emergency class

EXAMPLE INITIATING CONDITIONS: GENERAL EMERGENCY

1. a. Effluent monitors detect levels corresponding to 1 rem TEDE or 5 rem CDE thyroid based on a one hour exposure at the site boundary under actual meteorological conditions.

   b. These dose rates are projected based on other plant parameters (e.g., radiation levels in containment with leak rate appropriate for existing containment pressure with some confirmation from effluent monitors) or are measured in the environs.

2. Loss of 2 of three fission product barriers with a potential loss of 3rd barrier (e.g., loss of primary coolant boundary, clad failure, and high potential for loss of containment).

3. Loss of physical control of the facility.

4. Other plant conditions exist, from whatever source, that make release of large amounts of radioactivity in a short time period possible; e.g., any core melt situation. See the specific PWR and BWR sequences below.

   Note:
   a. For sequences with actual or projected severe core damage or loss of control of facility, recommend 2 mile evacuation in all directions and 5 miles downwind (45° to 90° sector), unless conditions make evacuation dangerous, and assess need to extend distances. Advise the other parts of the plume exposure Emergency Planning Zone to go indoors and listen to Emergency Alert System (EAS) messages.

   b. As additional plant and field monitoring information becomes available adjust these actions as necessary. For large releases, consider the need to evacuate local areas with high levels of contamination.

5. Example PWR Sequences

   a. Small and large LOCAs with failure of ECCS to perform leading to severe core degradation or melt in from minutes to hours. Ultimate failure of containment possible for melt sequences. (Several hours likely to be available to complete protective actions unless containment is not isolated.)

   b. Transient initiated by loss of feedwater and condensate systems (principal heat removal system) followed by failure of emergency feedwater system for extended period. Core melting possible in several hours. Ultimate failure of containment possible if core melts.

   c. Transient requiring operation of shutdown systems with failure to scram which results in core damage or additional failure of core cooling and makeup systems (which could lead to core melt).

d. Failure of offsite and onsite power along with total loss of emergency feedwater makeup and capability for several hours. Would lead to eventual core melt and likely failure of containment.

e. Small LOCA and initially successful ECCS. Subsequent failure of containment heat removal systems over several hours could lead to core melt and possible failure of containment.

6. Example BWR Sequences

a. Transient (e.g., loss of offsite power) plus failure of requisite core shut down systems (e.g., scram). Could lead to core melt in several hours with significant potential for containment failure. More severe consequences if pumps trip does not function.

b. Small or large LOCA's with failure of ECCS to perform leading to core melt degradation or melt in minutes to hours with significant potential for loss of containment integrity.

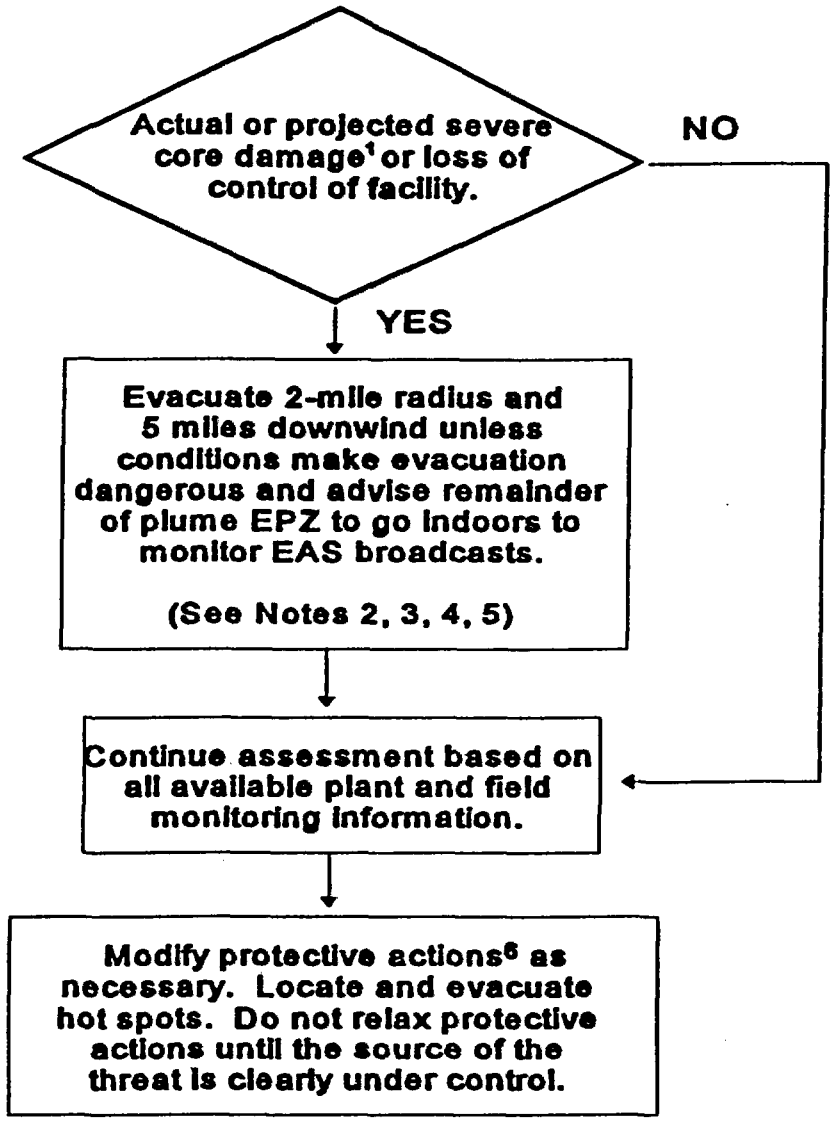
c. Small or large LOCA occurs and containment performance is unsuccessful affecting longer term success of the ECCS. Could lead to core degradation or melt in several hours without containment boundary.

d. Shutdown occurs but requisite decay heat removal systems (e.g., RHR) or non-safety systems heat removal means are rendered unavailable. Core degradation or melt could occur in about ten hours with subsequent containment failure.

7. Any major internal or external events (e.g., fires, earthquakes, substantially beyond design basis) which could cause massive common damage to plant systems resulting in any of the above.

NOTE: Estimates of containment performance under severe accident conditions are based on the information in Chapter 9 of NUREG-1150, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," December 1990.

Figure 1 SEVERE CORE DAMAGE OR LOSS OF CONTROL OF FACILITY PUBLIC PROTECTIVE ACTIONS



[1] Severe core damage is indicated by (1) loss of critical functions required for core protection (e.g., loss of injection combined with a LOCA); (2) high core temperatures(PWR) or partially covered core (BWR); (3) very high radiation levels in area or process monitors.

[2] Distances are approximate - actual distances will be determined by the size of the preplanned sub-areas that are based on local geopolitical boundaries.

[3] If there are very dangerous travel conditions initially shelter rather than evacuate the population until conditions improve.

[4] Transit-dependent persons should be advised to remain indoors until transportation resources arrive if possible.

[5] Shelter may be the appropriate action for controlled releases of radioactive material from the containment if there is assurance that the release is short term (puff release) and the area near the plant cannot be evacuated before plume arrives.

[6] Consider EPA PAGs in modifying initial protective actions.

NRC FORM 335 (2-89) NRCM 1102, 3201, 3202

U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

(See instructions on the reverse)

1. REPORT NUMBER (Assigned by NRC, Add Vol., Supp., Rev., and Addendum Numbers, If any.)
NUREG-0654
FEMA-REP-1, Rev. 1
Supp. 3

2. TITLE AND SUBTITLE

Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants

Criteria for Protective Action Recommendations for Severe Accidents

Draft Report for Interim Use and Comment

3. DATE REPORT PUBLISHED

MONTH	YEAR
July	1996

4. FIN OR GRANT NUMBER

5. AUTHOR(S)

F. Congel, F. Kantor, T. McKenna, A Mohseni /NRC
M. Hepler, V. L. Wingert/FEMA

6. TYPE OF REPORT
Technical

7. PERIOD COVERED (Inclusive Dates)

8. PERFORMING ORGANIZATION - NAME AND ADDRESS (If NRC, provide Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address; If contractor, provide name and mailing address.)

Division of Reactor Program Management
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
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Federal Emergency Management Agency
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Washington, DC 20472

9. SPONSORING ORGANIZATION - NAME AND ADDRESS (If NRC, type "Same as above"; If contractor, provide NRC Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address.)

Same as 8. above

10. SUPPLEMENTARY NOTES

11. ABSTRACT (200 words or less)

The Nuclear Regulatory Commission (NRC) and the Federal Emergency Management Agency (FEMA) have added Supplement 3 to NUREG-0654/FEMA-REP-1, Revision 1, which provides guidance for development of protective action recommendations for the public for severe reactor accidents involving actual or projected core damage with the potential for loss of containment. Studies of severe reactor accidents and their consequences since the issuance of NUREG-0654/FEMA-REP-1, Revision 1, have led the NRC staff to conclude that the preferred initial protective action for a severe (core damage) accident is to evacuate promptly rather than to shelter the population near the plant, barring any constraints to evacuation. The guidance in this document is intended to update and simplify the decisionmaking process for protective actions for severe reactor accidents given in Appendix 1 to NUREG-0654/FEMA-REP-1, Revision 1.

12. KEY WORDS/DESCRIPTORS (List words or phrases that will assist researchers in locating the report.)

emergency planning
emergency preparedness
radiological emergency planning
radiological emergency preparedness
radiological emergency response plans
emergency plans
emergency planning for early site permit
early site permit

13. AVAILABILITY STATEMENT
Unlimited

14. SECURITY CLASSIFICATION
(This Page)
Unclassified
(This Report)
Unclassified

15. NUMBER OF PAGES

16. PRICE