

**NEI Guidance**  
**Range of Protective Actions for Nuclear Power Plant Incidents**  
**April 2005**

**1.0 Purpose:**

To detail the range of early phase (EPA 400 section 2.1.3) protective actions that may be used for nuclear power plant incidents.

It is intended that licensees who incorporate the "Industry Positions" detailed below would be compliant with the early phase protective action guidance. This paper does not develop new guidance for protective actions; rather, it establishes an industry position using existing guidance. It is not the intention of this paper to provide implementation instructions for protective actions for the public.

**2.0 Discussion:**

**2.1 History**

The range of protective actions that would be used to protect the public during a nuclear power plant incident has been based on a strategy of evacuation and sheltering since the development of emergency plans for nuclear power plants. This paper will not attempt to recount past strategies or their associated bases, but will examine the protective actions detailed in current guidance.

**2.2 Current Guidance**

10 CFR 50.47(b) (10) (Ref 1) contains the requirement for a licensee's emergency plan to contain a range of protective actions. Guidance related to the implementation of a range of protective actions was revised in the mid 1990's in NUREG 0654 Supplement 3 (Ref 2) and EPA 400 (Ref 3).

Each of the subject guidance documents contains the same basic concepts of evacuation and sheltering as protective actions. However, sufficient diversity exists within the guidance to have resulted in divergent protective action schemes within the industry. Specifically, the indications for, and implementation of each protective action differs among licensees. The remainder of this section examines the features of each guidance document.

**2.2.1 EPA 400**

EPA 400 (Ref 3) retained the concepts of evacuation and sheltering as protective actions from previous guidance. EPA 400 revised the Protective Action Guidelines (PAG) (Ref 3 Table 2-1) and provided a basis for those guidelines (Ref 3 Appendices B and C). That document is applicable to a broad range of nuclear-related incidents and therefore did not utilize some of the terminology germane to nuclear power plant licensees, such as emergency action levels or emergency classification levels.

Evacuation is defined as the urgent removal of people from an area to avoid or reduce high-level, short-term exposure, usually from the plume or from deposited activity (Ref 3 Appendix A). EPA 400 recommends evacuation as the principle method of protecting the public and provided an analysis of the benefit of evacuation versus health effects from radiation (Ref 3 Appendix C). The document provides specific details regarding when evacuation should be recommended.

**2.2.1 (continued)**

Sheltering is defined as the use of a structure for radiation protection from an airborne plume and/or deposited radioactive materials (Ref 3 Appendix A). EPA 400 recommends sheltering as an alternative during certain conditions such as short-duration releases or in the presence of evacuation hazards such as weather or road conditions, or for special populations (Ref 3 section 2.3.1). The reference notes that the effectiveness of sheltering

varies widely due to protection factor as a function of building construction, varying effectiveness of air infiltration blocking methods, and air exchange with a structure.

EPA 400 notes multiple mechanisms that would cause sheltering to not provide a large protection factor (Ref 3 section C.2.4) and notes that the process of evaluating and implementing evacuation or sheltering is "far from an exact science". (Ref 3 section 5.5.3)

### 2.2.2 NUREG 0654 Supplement 3

This document was issued after EPA 400 and was intended to simplify and clarify previously issued guidance. This guidance references the dose-based protective action concepts in EPA 400, but relies primarily on plant conditions as an indication for protective actions. NUREG 0654 is aligned with EPA 400 with respect to sheltering, recommending it as an alternative to evacuation for short term releases or when impediments to evacuation exist.

Protective action guidance is summarized in Figure 1 of that document and calls for immediate evacuation of parts of the EPZ in the event of "Actual or projected severe core damage or loss of control of facility". Such conditions are considered to exist coincident with a General Emergency classification level. The subject figure also recommends "Sheltering...for controlled releases of radioactive material...if there is assurance that the release is short term..." In addition, Figure 1 implies sheltering for populations that should be evacuated "...unless conditions make evacuation dangerous..."

Figure 1 also updates the concept introduced in earlier guidance for EPZ populations not evacuated or sheltered by recommending that "...advise remainder of plume EPZ to go indoors to monitor EAS broadcasts." The subject document states that this is done so that the public "...will be able to receive additional instructions, if necessary". This action prepares the public for an evacuation, if necessary, and improves the efficacy of the evacuation process. The action itself does not provide protection to the public, and is not considered a protective action, though licensees may include this action under recommended protective actions.

Section III of that document discusses the use of previous guidance (Appendix 1 to NUREG 0654 (Ref 2) and the subsequent Information Notice 83-28). That section states that the referenced schemes "...can continue to be used with the proper understanding of the concepts underlying the development." The older guidance recommends the evacuation of approximately a 5-10 mile downwind sector under certain severe accidents.

### 2.2.3 10 CFR 50.47(b)(10):

This regulation was amended in 2001 to include "...the prophylactic use of potassium iodide (KI), as appropriate".. It required states to formally consider the inclusion of potassium iodine (KI) as a thyroid blocking agent and incorporate it into their emergency plans as appropriate. Given this, KI would only be included in the licensees' range of protective actions if the affected State(s) decided to include it.

### 2.2.4 Recent Guidance

Regulatory Issue Summary 2004-13 (Ref 6) was issued in 2004 for the purpose of clarifying to licensees the NRC position that protective action schemes must include the consideration of sheltering. The RIS did not introduce any new protective action concepts or guidance.

## 2.3 Industry issues

***NOTE: The industry positions are not meant to preclude pre-planned actions developed to accommodate special circumstances at individual sites. In such cases, actions may have been developed that are more conservative than the industry positions. Those pre-planned actions should be retained in the licensee emergency plan.***

### 2.3.1 Evacuation

#### Issue 1: Evacuation Decision Points

EPA 400 (Ref 3) utilizes dose limits as a decision point for evacuation. NUREG 0654 (Ref 2) uses plant conditions as a decision point for evacuation, stating that evacuation should take place when, "...Actual or projected severe core damage or loss of control of facility" exists, and advises the use of EPA PAG's to modify protective actions. Most licensees have interpreted the above guidance to mean: evacuate 2 miles around and five miles downwind at a General Emergency (actions based on plant conditions), then evacuate if EPA protective action guidelines are met (actions based on dose). This interpretation is consistent with the definition of a General Emergency (Ref 4 and 5) and the guidance in NUREG 0654 (Ref 2) that suggests consideration of EPA PAG's.

Coincident with evacuation, or where appropriate, the sheltering of the population, the remainder of the plume EPZ should be advised to go indoors and monitor EAS broadcasts. (Ref 2)

#### *Industry position:*

*The minimum recommendation that shall be made at a General Emergency is to evacuate approximately 2 miles around and 5 miles downwind from the plant. Subsequent recommendations should be based on the EPA PAG's, changing plant conditions, field data or changes in meteorological conditions.. In addition, the remainder of the plume EPZ should be advised to go indoors and monitor EAS broadcasts.*

### 2.3.2 Sheltering

#### Issue 2: Use of sheltering as an alternative to evacuation for short term releases.

Both NUREG 0654 (Ref 2) and EPA 400 (Ref 3) suggest that sheltering be performed for short term (puff) releases or when it provides a benefit greater than evacuation. In the context of emergency conditions, prediction of release duration is difficult. Continuous and rapidly changing conditions, lack of or inaccurate instrumentation and uncertainty of the timeliness and effectiveness of mitigative actions make such a prediction inherently inaccurate. Moreover, choosing to shelter a population rather than evacuate based on erroneous release duration estimation can result in significant health effects on that population. As such, it is appropriate to identify likely sources of short term releases in the planning process, so that considered protective actions can be developed. For example, controlled evolutions such as containment venting are characterized by definitive actions that provide some measure of certainty regarding release duration and resultant doses. On the other hand, releases from unmonitored release paths would result in highly uncertain assessments of source term.

#### *Industry position:*

*A licensee shall integrate the use of sheltering for short term releases into their protective action recommendation scheme. If a licensee cannot readily or accurately determine release duration, and dose or plant conditions warrant, then evacuation should be recommended.*

#### Issue 3: Use of sheltering for impediments

EPA 400 (Ref 3) provides guidance to shelter when EPA protective action guidelines are met, but evacuation is impractical due to impediments. It lists impediments such as severe weather, long mobilization times (such as medical patients or prisoners and guards) or traffic issues (inadequate roads). Similarly, NUREG 0654 (Ref 2) suggests sheltering when conditions exist that make evacuation dangerous or for transit dependent persons awaiting transportation. During an emergency, licensees typically are unaware of emergent impediments to evacuation, as that information is obtained and acted upon by offsite agencies.

However, the use of sheltering for populations that cannot be expeditiously evacuated due to impediments is required to be accommodated in licensee emergency plans (Ref 6). The industry position accommodates this requirement but acknowledges that typically offsite agencies as the information source for evacuation impediments during an emergency. It is not intended that licensees solicit impediments during an emergency.

In some instances, licensees have developed alternate plans for special circumstances, in coordination with state and local officials. For example: a licensee plan that recommends evacuation at a Site Area Emergency due to impediments that would be created by an evacuation of the public at a General Emergency. In such cases, these alternate plans should continue to be part of the emergency plan.

***Industry position:***

***Licensee emergency plans shall include the use of sheltering for populations that cannot be evacuated due to impediments. A licensee is responsible for ensuring that the development of a protective action recommendation (PAR) be an informed process that does not exclude the consideration of impediments recognizing off-site agencies are ultimately responsible for making protective action decisions necessary to protect health and using a licensee's PAR as appropriate to off-site conditions. In special circumstances, the licensee may incorporate pre-planned actions more conservative than the industry position, such as evacuating at emergency classification levels other than a General Emergency.***

**Issue 4: Effectiveness of sheltering**

EPA 400 (Ref 3) contains a significant range of guidance regarding the effectiveness of sheltering (“...almost 100 percent to zero...”). That guidance also contains diverse practical suggestions regarding maximizing the effectiveness of sheltering. In addition, circumstances are detailed as to when sheltering is ineffective. The diversity of this guidance, likely issues of public compliance with detailed sheltering instructions and time constraints on protective action decision processes lead to a large number of possible implementation schemes and instructions of varying usefulness. The industry favors a qualitative approach to sheltering that utilizes simple instructions to the public for implementation. However, in accordance with RIS 2004-13, regardless of any understanding the licensee may have with state and local authorities, licensees shall recommend sheltering, consistent with existing guidance and the Industry Positions detailed in this paper.

***Industry Position:***

***Licensee may opt to utilize a range of sheltering implementation schemes, including:***

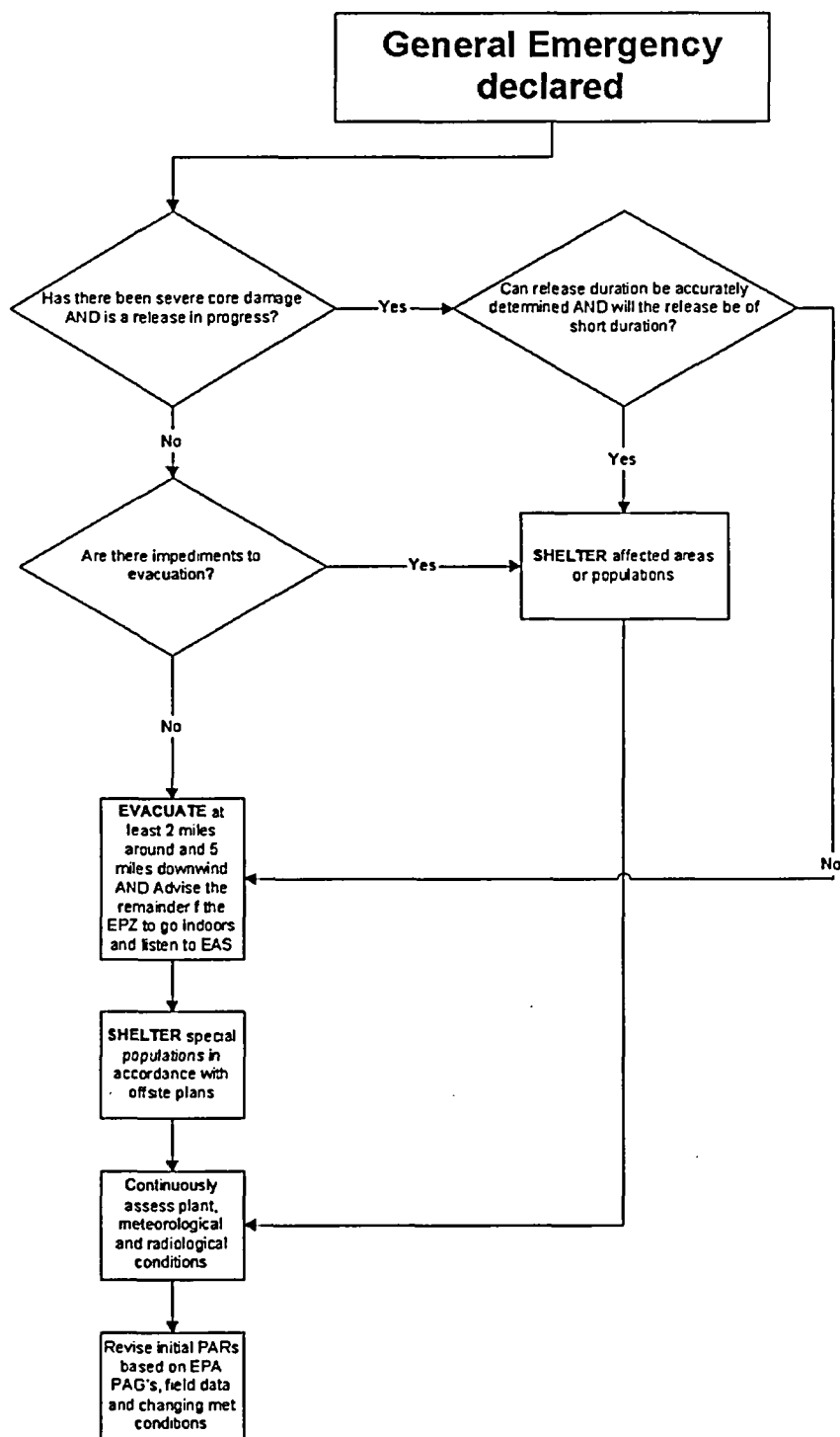
- ***The use of qualitative methods for determining the effectiveness of sheltering. Example, if certain plant or radiological conditions exist, then shelter, OR***
- ***The use of quantitative methods for determining the effectiveness of sheltering. Example, the comparison of sheltering versus evacuation doses.***

**2.3.3 Use of KI for the General Public**

No industry issues associated with the implementation of this protective action

### 3.0 Summary

The following flowchart summarizes the Industry Positions detailed in this paper:



#### **4.0 References**

(Ref 1) 10 CFR 50.47(b)(10): A range of protective actions including sheltering, evacuation and prophylactic use of iodine have been developed for the plume exposure pathway EPZ for emergency workers and the public. Guidelines for the choice of protective actions during and emergency, consistent with Federal guidance, are developed and in place and protective actions for ingestion pathway EPZ appropriate to the locale have been developed (66 FR 5440, Jan 19,2001)

(Ref 2) NUREG 0654 FEMA REP 1 Supplement 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 (July 1996)

(Ref 3) EPA 400-R-92-001: Manual of Protective Action Guides and Protective Actions for Nuclear Incidents (October 1991)

(Ref 4) NUREG 0654 FEMA REP 1: 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, Appendix 1 Emergency Action Level Guidelines. (November 1980)

(Ref 5) NEI 99-01: Methodology for Development of Emergency Action Levels (September 2002)

(Ref 6) NRC Regulatory Information Summary RIS 2004-13: Consideration of Sheltering in Licensees Range of Protective Action Recommendations (August 2004)