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## State of the Art in Evacuation Time Estimate Studies for Nuclear Power Plants

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## ABSTRACT

In the event of a major accident at a commercial nuclear power station, exposure of the public to airborne radioactive materials can be prevented or greatly reduced by evacuating the area immediately surrounding the reactor site. Reactor licensees are required to conduct studies to estimate the time needed to evacuate the public from the area surrounding each nuclear power station. The results of such studies are used by regulatory personnel and emergency planners to assess the potential effectiveness of protective responses for the public. The time required to evacuate the public from a 10-mile emergency planning radius is estimated by analyzing the available transportation facilities and other relevant conditions within this radius. To support the analysis, data must be collected and assumptions must be made regarding the transportation facilities, the size and characteristics of the population and other conditions in the planning zone. This report describes standard approaches and provides recommendations regarding the relevant information, assumptions and methods to be used in performing evacuation time estimate studies.

desirable for the evacuation time estimate study to provide a range of evacuation times based on the likely ranges of conditions. The evacuation time for any set of conditions not specifically analyzed in the study can be inferred, based on an understanding of how evacuation time is affected by each of the variables.

For a given geographic area, the population to be evacuated is highly time-dependent. For example, scenarios to be analyzed should reflect different seasons of the year, days of the week, and times of day. Likewise, roadway capacity is highly dependent on weather conditions. Weather conditions to be considered should include both good conditions (clear) and adverse conditions (rain, fog, or snow). Adverse weather reduces vehicle speeds. (See page 5, below.)

The purpose of formulating several different scenarios is to determine if certain combinations of conditions cause evacuation demand to exceed roadway capacity. A range of possible combinations should be considered; however, it is not useful to analyze illogical or mutually exclusive combinations of conditions, such as a large daytime beach population and snow-covered roads. The analyst should attempt to identify that combination of conditions likely to generate the highest typical demand on a recurring basis. Scenarios to be analyzed should also include periodic events or conditions that generate a large, temporary population in the EPZ.

There is a relationship between evacuation time and the advisability of certain protective action decisions. Overestimating evacuation time, for instance, is not desirable because such an estimate might lead the decision-maker not to order evacuation as a protective action when it is actually the best alternative. It is also not necessary or desirable to determine a "worst case" evacuation time. The worst case would nearly always be one in which evacuation is simply not possible.

## Demand Estimation

One of the key aspects of the methodology is to define the number of evacuees. Although the object of evacuation is to remove people from the EPZ, it is the number of evacuating *vehicles* that determine if any transportation-related delays are likely. An estimate of the number of evacuating vehicles can be based on several possible data sources. In most cases, the number is estimated *after* estimating the number of evacuees. Occasionally, it is more appropriate to estimate the number of evacuating vehicles directly. For example, it may be more accurate to determine the number of vehicles at a beach by counting them in the parking lots than to count or estimate the number of individuals on the beach.

Databases may be used to estimate of the number of evacuating vehicles. The evacuating population is typically subdivided into three groups: permanent residents, transients and special facility populations. Some individuals may be members of more than one group.

Permanent residents are those persons who live in the EPZ year-round. The permanent resident population is typically estimated from census data (often updated for local growth).

Transients are visitors, including tourists and daily employees, who live outside the EPZ. Transient populations are usually derived from other local sources of data. In some cases, special field studies, such as counting the numbers of tourists' vehicles, may be conducted in specific areas in order to develop better estimates of those areas' transient populations.

Special facility populations, including school and prison populations, are estimated on a facility-by-facility basis because the transportation needs are determined by individual facility characteristics. Some special-facility populations may require buses, and others ambulances. Therefore, consideration of individual facilities is necessary