



NUREG/CR-7002
SAND2010-0016P

Criteria for Development of Evacuation Time Estimate Studies

Manuscript Completed: September 2011

Date Published: November 2011

Prepared by
J. Jones and F. Walton
Sandia National Laboratories

B. Wolshon
Louisiana State University

Sandia National Laboratories
Albuquerque, NM 87185
Operated by
Sandia Corporation
for the U.S. Department of Energy

J. Laughlin, NRC Technical Lead

NRC Job Code R-3139

Office of Nuclear Security and Incident Response

ABSTRACT

The evacuation time estimate (ETE) is a calculation of the time to evacuate the plume exposure pathway emergency planning zone (EPZ), which is an area with a radius of about 10 miles (16 km) around a nuclear power plant. The ETE is primarily used to inform protective action decision-making and may also be used to assist in development of traffic management plans to support an evacuation. The ETE should be developed to provide the time to evacuate 90 percent and 100 percent of the total population of the EPZ. The 90 percent ETE provides the time value that would typically be used to support protective action decisions. This document provides guidance for the development of ETEs, including those associated with staged evacuation protective actions. The document also identifies the importance of using approved emergency response plans and existing traffic control information to reflect the expected response actions during an emergency. Guidance on the review and update of ETEs is also included. The format and guidance provided herein will support consistent application of the ETE methodology, and can serve as a template for the development of ETE studies. Applicants and licensees may propose an alternative method for complying with the associated relevant portions of the emergency preparedness regulations, which the NRC would need to deem acceptable if they provide the basis for the findings required for the issuance or continuance of a permit or license by the Commission.

Paperwork Reduction Act Statement

The information collections contained in this NUREG are subject to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 et seq.), which were approved by the Office of Management and Budget, approval numbers 3150-0011 and 3150-0151.

Public Protection Notification

The Nuclear Regulatory Commission (NRC) may not conduct or sponsor, and a person is not required to respond to, a request for information or an information collection requirement unless the requesting document displays a currently valid OMB control number.

2.0 DEMAND ESTIMATION

The objective of this section is to detail the process for developing an estimate of the number of people to be evacuated. The NRC's regulations in 10 CFR 50.47(b)(10) require that "a range of protective actions has been developed for the plume exposure pathway EPZ for emergency workers and the public." The public includes all persons located within the EPZ, including residents, transients, people with disabilities and those with access and functional needs, and any other member of the public. Demographic data, together with information and assumptions on population groups support an estimate of the public and corresponding vehicles that will be evacuating the area. Demand estimation for the following four population segments should be developed:

1. Permanent Residents and Transient Population – Permanent residents include all people having a residence in the area. The transient population includes tourists, shoppers, employees, etc., who visit but do not reside in the area.
2. Transit Dependent Permanent Residents – Permanent residents who do not have access to a vehicle or are dependent upon help from outside the home to evacuate.
3. Special Facility Residents – Residents of nursing homes, assisted living centers, and those confined to hospitals, jails, prisons, etc.
4. Schools – All private and public educational facilities within the EPZ. Colleges and universities should be assessed on a case-by-case basis, recognizing that college students typically have access to a vehicle.

Demand estimates for these four population groups are developed separately to account for all of the public within the EPZ.

2.1 Permanent Residents and Transient Population

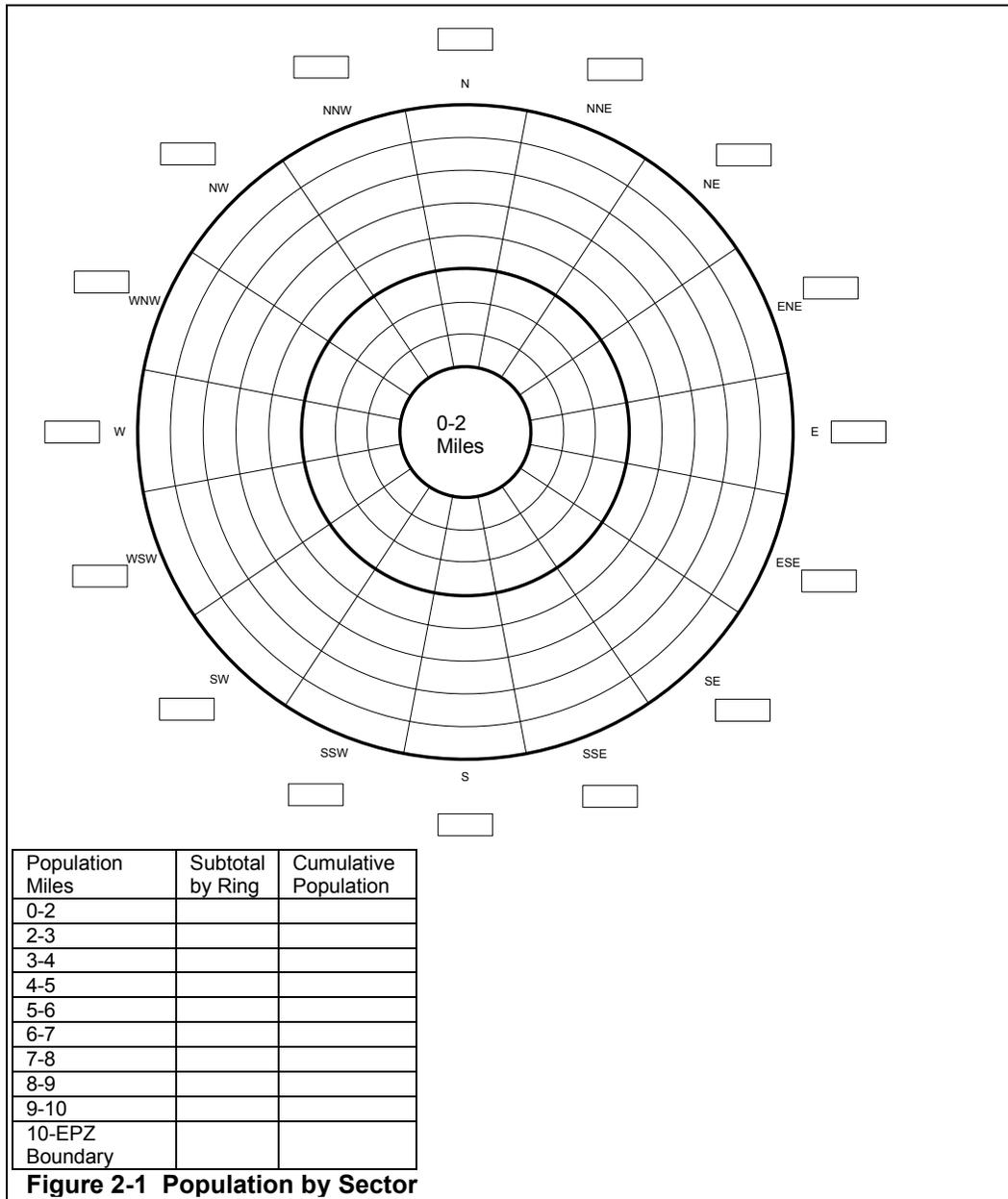
The number of permanent residents should be estimated using U.S. Census Bureau data adjusted as necessary for growth. Along with census data, local data may be used for population estimates. The population values used in the ETE should be developed for the year the ETE is prepared. The permanent resident population group is divided into two subgroups including:

1. Residents having available private transportation.
2. Transit dependent residents (dependent on others for transportation).

The distribution of permanent resident and transient populations should be provided in a format similar to Figure 2-1 with total populations provided for each sector. The rings and sectors of this figure may be extended to 15 miles to show the shadow populations.

2.1.1 Permanent Residents with Vehicles

An estimate of persons per vehicle should be provided. An estimate of 1 to 2 people per vehicle is typical. Values within this range should be used for the permanent population, unless site specific information supports the use of lower or higher values.



2.1.2 Transient Population

The transient population includes people temporarily visiting the area such as tourists, shoppers, employees who do not reside within the EPZ, etc. A list of facilities that attract transient populations should be developed, and peak and average attendance for these facilities should be listed. The use of average attendance values, by season, is generally acceptable. For example, the summer average weekday population for beach areas would be used for summer weekday scenarios, and average weekend population would be used for weekend scenarios.

The transient population should be itemized and totaled as appropriate for each scenario. For example, motel capacities may be full for evening scenarios, but empty during daytime

scenarios when tourists are visiting parks or other areas. The distribution of the transient population should be provided in a format similar to Figure 2-1. Care should be taken not to double-count transient populations. To avoid double-counting transients and permanent residents, indicate the percent of permanent residents of the EPZ assumed to be at parks, shopping, or other locations. The number of people per vehicle should be identified. A value of 2.5 people per vehicle is typical, but this may vary by type of facility or location. A basis should be provided if higher vehicle occupancy rates are used. Large employers, defined as those with 50 or more employees working a single shift, should be listed and include the number of people per vehicle.

2.2 Transit Dependent Permanent Residents

An estimate is needed for the time to evacuate those residents that do not have access to a vehicle. Special services that may be needed to support the evacuation of these residents must be considered (NRC, 1980) and identified within the ETE study. Surveys are helpful in identifying the site specific demographics of this population group, including the number of individuals and specialized transport needs. This population group may include:

- Households with no vehicles;
- Households with unsupervised latchkey children;
- Households with one vehicle that is at work and would not return;
- Households where residents have limitations on driving (e.g., elderly who do not drive at night or do not drive distances of more than a few miles); and
- Households dependent on specialized transportation such as wheelchair vans or ambulances.

Local and county emergency plans should be reviewed to identify if plans are in place to provide transportation to transit dependent residents during an evacuation. Where local plans exist, these should be used in developing the ETE. Data from local and county emergency planning registration programs should be used as a first order planning tool to support the demand estimate, but should not be used as the only source of data.

Previous research (NRC, 2008b) and data reviewed on existing ETEs indicate a range of about 3 to 10 percent of EPZ permanent resident populations may be transit dependent. It is recognized that a portion of the population will rideshare during an evacuation, leaving the area with friends, neighbors, or relatives, and it is acceptable to assume that up to 50 percent of residents without vehicles will rideshare. This value is based on results of a national telephone survey conducted of EPZ residents (NRC, 2008b) which indicated more than 50 percent of residents would offer a ride to individuals waiting for transportation. Empirical data obtained from the widely studied Mississauga, Canada evacuation in 1979 (IES, 1981) also supports a value of 50 percent. If a higher value is used, a basis should be provided. Assuming that 50 percent of transit dependent persons rideshare suggests that 1.5 percent to 5 percent of the EPZ permanent resident population may require transportation. A basis should be provided for use of values lower than 1.5 percent.

The capacity of municipal buses is based on adults, and the capacity of school buses is based on children. Considering that residents are evacuating with their belongings, including clothing, medicines, pets, etc., a reasonable estimate for buses is 50 percent of the stated seating capacity (NRC, 2008a) with no credit taken for standing room capacity. The capacities assumed for buses and other transportation should be identified and if an estimate higher than