which account for regional differences in the frequency of brick and wood homes and of homes with basements, and temporal differences in building occupancy. Sheltering in regions such as the Northeast, where a large fraction of homes have basements, offers the greatest protection, and is represented by average shielding factors of 0.5 and 0.08 for airborne and ground deposited radionuclides, respectively. Sheltering in areas where most homes do not have basements (i.e., Southwest or Pacific Coast) offers the least protection, and is characterized by corresponding average shielding factors of 0.75 and 0.33.*

To estimate the potential effectiveness of sheltering in reducing the quantity of radionuclides inhaled, a multicompartment ventilation model was developed for the calculation of airborne radioactive material concentrations inside of structures [8]. Using "best estimate" values for all parameters, the model indicates that sheltered individuals would inhale roughly 35 percent less radioactive material than if they were outside during the passage of the cloud. Larger reductions would be possible if the ventilation rate (air turnover rate) could be reduced either by tighter building construction or by the sealing of openings in the structure. Further analysis indicated that the strategy of opening doors and windows, turning on ventilating systems, etc., in an attempt to "air-out" the structure after the cloud of radioactive material has passed would most likely not contribute significantly to reducing the amount of inhaled radionuclides unless very low ventilation rates are achieved during cloud passage.

Sheltering effectiveness was evaluated using the range of average shielding factors described above. Sheltering of the public was assumed to be completed prior to the arrival of the cloud of radioactive material, and persons were assumed to remain sheltered until relocated. In an actual accident situation, sheltered individuals might be exposed to ground contamination while sheltered and while being relocated. However, to simplify this analysis, exposure to ground contamination was presented in terms of effective exposure durations assumed to occur only while sheltered. For example, an effective exposure time of 6 hours while sheltered (with SF for ground contamination = 0.2) might, in fact, be due to 4 hours of exposure while sheltered (with SF = 0.2) and 1/2 hour exposure while relocating (with SF = 0.8). Because some exposure would be received while relocating (with little shielding), and it would take some time to determine affected areas and initiate a relocation, 6 hours

*Note that the use of average shielding factors for the assessment of radiological consequences results in the assignment of average doses to all individuals within a given area rather than the distribution of doses that would actually occur due to the variation in shielding protection afforded individuals. The adequacy of this simplification is discussed in reference [7].

NUCLEAR REGULATORY COMMISSION

Docket No. 50-352/353 Official Exh. No. Ap-141

In the matter of Philadelphia Electric

Staff

Applicant ✓ IDENTIFIED ✓

Intervenor RECEIVED

Cont'g Off'r REJECTED

Contractor DATE 5/22/84

Other Witness

Reporter Ann Riley

was chosen as a practical lower limit for effective exposure time.

The modeling of public evacuation as a protective measure for reactor accidents is discussed in reference [9]. A simple evacuation model, based upon a statistical analysis of evacuation data gathered by the U.S. Environmental Protection Agency (EPA) [10], was included in the RSS consequence model for use in the estimation of public risk from reactor accidents. However, for reasons which are discussed in reference [9], that model is inappropriate for use in evaluating evacuation as a radiological emergency response. Therefore, a revised model of public evacuation was developed for this purpose. The revised treatment incorporates a delay time before public movement, followed by evacuation radially away from the reactor at a higher constant speed than previously assumed in the RSS evacuation model. Both the delay time and evacuation speed are required as input to the model, and different shielding factors are allowed while persons are stationary and in transit. As detailed in reference [9], the revised model also calculates more realistic exposure durations to airborne and ground deposited radionuclides than the RSS evacuation model. Persons within the designated evacuation area are assumed to move as a group with the same delay time and speed, and all people in the area are assumed to evacuate. This latter assumption results in upper bound estimates of evacuation effectiveness, given a specific delay time and speed.

The evacuation data gathered by the EPA contains sufficient information for the estimation of delay times before evacuation if a specific speed while evacuating is assumed. Transit speeds of 10 miles per hour and greater have been recorded during actual evacuation events [9], and do seem reasonable given the low population density surrounding reactor sites. Therefore, the speed of evacuation was assumed to be a constant 10 miles per hour throughout this analysis. The EPA data was analyzed to estimate representative evacuation delay times. The mean delay time was shown to be approximately 3 hours, and the 15*-85 percent level range of delays was shown to be approximately 1 to 5 hours.

To evaluate the effectiveness of iodine prophylaxis, reduction factors were applied to the thyroid dose from inhaled radioiodines. For example, if stable iodine was administered shortly before or immediately after the release of radioactive material begins, reduction factors of 0.01 or less might be appropriate (99% or greater dose reductions) [6]. The dose to the thyroid from external radiation sources, radioiodines in organs other than the thyroid, and other inhaled radionuclides are unaffected by these factors.

*15% of evacuations for which data is available had estimated delay times of approximately 1 hour or less.