UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

Before Administrative Judges:
Ivan W. Smith, Chairperson
Gustave A. Linenberger, Jr.
Dr. Jerry Harbour

In the Matter of PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE, ET AL. (Seabrook Station, Units 1 and 2)	Docket Nos. 50-443-444-OL (Off-site EP) May 3, 1988

CORRECTED TESTIMONY OF ROBERT L. GOBLE, ORTWIN RENN, ROBERT T. ECKERT, AND VICTOR N. EVDOKIMOFF ON BEHALF OF THE ATTORNEY GENERAL FOR THE COMMONWEALTH OF MASSACHUSETTS ON SHELTERING CONTENTIONS

I. IDENTIFICATION OF WITNESSES

Q. Would you each please state your name, and briefly summarize your professional qualifications.

A. (Goble) My name is Robert L. Goble. I received a Ph.D. in physics from the University of Wisconsin in 1967, specializing in high energy elementary particle physics. Since then I have held combined research and teaching posts at Yale University, the University of Minnesota, the University of Utah, Montana State University, and Clark University. My present position at Clark is Research Associate Professor of Physics where I am a member of the program on Environment, Technology, and Society, and part of the Hazards Assessment Group of the Center for Technology, Environment, and Development [CENTED].

I have taught a wide range of physics courses at both the undergraduate and graduate level and a number of courses dealing with the relationship between technologies and society. My current research interest are: (1) emergency planning for nuclear reactor accidents (I am one of the principal researchers in a two year Clark project to write an emergency response plan for the TMI nuclear reactor); (2) risk assessment (I am conducting research on risks from radon exposures in indoor air, and am working with other CENTED group members on reviewing risk assessments for a potential radioactive waste repository in Nevada); (3) air pollution dispersal (I am continuing work on both short and long range pollutant dispersal, including applications to the acid rain problem, as well as the transport of radionuclides from nuclear accidents). My curriculum vitae is included at Attachment 1.

A. (Renn) My name is Ortwin Renn. I received a Ph.D. in Social Psychology from the University of Cologne in 1980 after obtaining a masters degree in economics and sociology in 1977. For ten years, I worked at the Nuclear Research Center of Julich (West Germany), in the beginning as conference manager, then as research associate and from 1981 as head of the research unit "Technology and Society". From 1981 to 1986, I taught "Sociology of Technology" at the Technical University of

Stuttgart. My present position at Clark University is Associate Professor of Environment, Technology, and Society. I am also part of the Hazards Assessment Group of the Center for Technology, Environment and Development. I have taught courses in behavioral aspects of emergency planning, technology assessment, risk perception, decision analysis and other related topics. My major interest lies in the analysis of the interface between society and technology. I am a member of several advisory panels and committees. My publications include three monographs, four coedited books, and numerous scientific articles. My curriculum vitae is included at Attachment 2.

A. (Eckert) My name is Robert T. Eckert. I am Vice President of Salmon Falls Research Associates, Incorporated, and Associate Professor of Forest Resources and Graduate Program Coordinator in the Department of Forest Resources at the University of New Hampshire. I have been employed since September of 1978 at the University of New Hampshire, where my responsibilities have been divided between research and teaching. My research has emphasized the statistical analysis of population data generated from forest surveys. I have received funding from the United States Environmental Protection Agency (EPA) to conduct large-scale studies of the impact of air pollutants on forests. Part of this work has been to develop standard operating procedures and quality assurance protocols for the operation of the project, in addition to statistical analysis of large data sets. I currently supervise sixteen people in the conduct of this research. The daily conduct of this variety of activities, including collection and analysis of repeatable data, at the level of quality imposed by the EPA, and at the professional level required for publishing, qualifies me to collect and assess measurement data. I have taught a variety of forestry courses including forest surveying and measurements, forest biology, and quantitative genetics. I have over twenty published articles and research reports. My curriculum vitae is included at Attachment 3.

(Evdokimoff) My name is Victor N. Evdokimoff. My twenty years of experience as a health physics consultant includes service to industry and hospitals. I received an SCM in Radiological Sciences from Johns Hopkins School of Public Health, and earned "Comprehensive Certification" in Health Physics from the American Board of Health Physics (ABHP) in 1980. Comprehensive Certification by ABHP has been achieved by only about 8% of American health physicists, and requires a broad-based expertise including reactor health physics and environmental impacts of radioactive releases from nuclear power plants. I am a registered expert in radiation protection with the Commonwealth of Massachusetts. I also serve as an adjunct Assistant Professor of Public Health (Environmental

Health) at Boston University's School of Medicine, and I teach a four-credit graduate course in Radiation Protection at Boston University's School of Public Health.

I have been the Radiation Safety Officer at Boston University Medical Center for 10 years. The Center includes a teaching hospital plus a medical and dental school. At the Center, I deal with radioisotopes as part of my duties on a regular basis. I have recently designed a special room in a new addition to our university hospital to protect staff, adjacent patients and visitors from gamma ray exposure from Iodine-131. This involves utilizing shielding characteristics of building materials as well as engineering controls to minimize the volatility of Iodine-131. In industry, I dealt with over 55 different radioisotopes over a six year period in which I was involved in health physics. I have also published a paper on dose assessments to the public from radioactivity released to the environment. A copy of my curriculum vitae is included at Attachment 4.

II. OVERVIEW OF TESTIMONY

Q. **What is the purpose of this testimony?**

A. **(All)** This testimony addresses matters raised in Town of Hampton Contention VIII, SAPL Contention 16 and NECNP Contention RERP-8. In short, it addresses the adequacy of the New Hampshire Radiological Emergency Response Plan, Revision 2, [NHRERP, Rev. 2] with respect to its provisions for sheltering the summer beach population. The testimony is that the NHRERP is grossly inadequate because it contains essentially no provisions for sheltering the summer beach population. Without sheltering, this population would have to remain outdoors or in automobiles virtually unprotected from radiation exposure for many hours while waiting to evacuate.

Our testimony also addresses the feasibility of implementing sheltering for the beach population on an ad hoc basis. We have concluded that an ad hoc sheltering response simply cannot work in this area. We have examined the Stone & Webster "Study to Identify Potential Shelters in the Beach Areas near Seabrook", March, 1986, and the subsequent Revision 1 to that Study, dated August, 1987, provided by the applicants, as an aid in determining if sufficient sheltering capacity exists in the beach area to shelter the entire beach population. We have determined, based on our own examination and measurements of a number of those shelters and on surveys of owners of the shelters, that the capacity does not exist. There is a significant capacity shortfall even if one accepts KLD's estimates of the size of the beach population. Furthermore, this percentage of shelter capacity assumes that all of the shelter space is suitable with respect to shielding and accessibility, an unjustified assumption. Indeed, there are some areas along the beaches where people would have no access at all to shelters. Moreover, there is no indication of how persons on the beach would be instructed to locate shelter or how they could identify it as suitable, and without plans in place to implement sheltering it is highly questionable whether people would choose to shelter, rather than evacuate, and if they did choose to shelter whether that strategy could be implemented quickly enough for it to do any good.

We have also evaluated the shielding potential of many of the buildings in the beach area, both summer cottages and commercial establishments, and have concluded that the bulk of the buildings in the beach areas are old, unwinterized, wood-frame structures, without basements, often with numerous and various holes, windows, or other openings to the outdoors. These buildings are totally unsuitable for sheltering.

For all of these reasons, and others, we have concluded that in comparison to even an ineffective evacuation response an ad hoc sheltering response would much more likely result in an increase in radiation doses to the beach population than it would in any reduction in doses.

III. TESTIMONY

Q. **What is "sheltering" as an emergency response measure for nuclear accidents?**

A. (Goble, Evdokimoff) Radiation exposures from materials released in a nuclear accident can occur initially in three ways: The first is from the cloud of radioactive gases and particles which emit gamma radiation in all directions as it passes over an area, thereby exposing persons beneath the cloud. This is called cloudshine. The second is from radioactive material deposited on the ground and other surfaces which will accumulate and will continue to emit gamma radiation even after passage of the cloud. This is called groundshine. The third, is from radioactive materials that are inhaled and which may be retained in the body and continue to emit radioactivity, particularly exposing the organ in which the material is retained. This is called inhalation.

A person who is sheltered indoors is partially protected from each of these forms of exposure. The walls and roof of a building offer some shielding from the cloud radiation. The amount of shielding depends on the thickness and density of the intervening material. The walls also offer shielding from groundshine, and the building acts to keep the deposited material some distance away from the person. To the extent that there is limited ventilation, so that indoor air is breathed rather than outdoor air, the amount of inhaled radioactivity is reduced.

The degree of protection afforded by a building for each of these forms of exposure is commonly expressed in terms of shielding factors: numbers, between 0 and 1, represent the ratio of the exposure that a person in a building would receive to the exposure that he or she would receive if the building were not there. A shielding factor of 1 indicates that the building offers no protection, while a factor of 0 indicates perfect protection. Because protection from the three forms of exposure involves different aspects of building construction, three shielding factors are usually necessary to characterize the protection offered. It is worth noting that protection against inhaled radioactivity will decline during passage of a radioactive cloud (i.e., the shielding factor will approach one), because the indoor air will become progressively more diluted with outdoor air. Thus, sheltering becomes less effective as a protective response for inhalation as the duration of release increases. On the other hand, for a severe accident in which materials causing groundshine are significant, sheltering can be of increasing importance as the duration of release and deposit of materials is extended.

Q. What is the role of sheltering in emergency response planning?

A. (Goble) Emergency response planning for nuclear accidents is not simply planning for evacuation. Sheltering and evacuation are identified in NUREG-0654 (p.9) as the two principal immediate protective responses that might be recommended to the general public. The choice between these measures, or the particular combination of them, is to be made based on the specific conditions of the accident.

Q. What special characteristics of the Seabrook reactor site bear on the use of sheltering?

A. (Goble) The Seabrook reactor is located less than two miles from one of the most popular beach areas in New England. The reactor site itself is on an inlet which lies between the Seabrook and Hampton beaches and which separates the beach areas from the rest of the two towns. This proximity to the shore strongly influences the meteorological conditions at the site. The combination of beach development with the presence of the inlet and surrounding marsh areas means that there are only a few routes for cars leaving the beach areas. Most importantly, proximity to the beach means proximity to a potentially very large population of beach visitors--up to 70,000 visitors in the emergency planning zone according to the New Hampshire plans (see Vol. 6), and in excess of 100,000 according to more recent documentation (see Testimony of Drs. High, Adler, Befort and Luloff on Contention No. 34.) This combination of inadequate shore roads with large numbers of people means that evacuation times for the area will be excessively long (up to 9 hours or longer according to testimony presented by Dr. Adler), with the result that the need for effective sheltering is especially critical at this site.

Q. Are there any special characteristics of the beach population that would bear on the use of sheltering?

A. (Goble, Renn) The beach population in the Seabrook emergency planning zone (EPZ) is, for the most part, comprised of two types of people: the "day-trippers" meaning those who come to the beach area just for the day (or evening), and the short term visitors, people from out-of-town who are staying in rental cottages, motels or hotels. A small percentage of the beach population are permanent residents of the beach area. (See Beach Survey conducted by Dr. Luloff, Attachment 4 to Dr. Luloff's Testimony). There are a number of characteristics of the beach populations, both day-trippers and short-term visitors, which make their response in an emergency difficult to predict or alter. It is difficult to educate them or prepare them for an emergency and the information that can be reliably communicated to them during an emergency may be quite limited (some of them will not even speak English). Also, they will have had limited or no opportunity to develop confidence in local authorities. Many will not know their way around very well. Their destinations will be uncertain. Some may be separated by a considerable distance from their vehicles and some may even be lost.

These characteristics are likely to increase the vulnerability of the population. Other sources of vulnerability are the high density of the population, the likelihood that many of them will not have direct access to any shelter, and the fact that many with access to apparent shelter will be staying in unwinterized summer cottages and motels which offer very limited protection. A further characteristic of this population is that its members will have a stronger propensity to evacuate than to shelter, as they will have limited possessions with them and will be leaving little or nothing behind.

Q. Are these characteristics that you just mentioned unique to the Seabrook site?

A. (Goble) The combination of factors is unique. I would agree with FEMA's statement, made in response to interrogatories, that "[t]he factors unique at least in magnitude to Seabrook" include:

> the size of the transient ('day tripper') beach population; size of the beach population; number of unwinterized housing/commercial buildings; volume of corridor type road traffic; complexity of road network; [and] number of local governments involved in the emergency planning process.

(See Response of the Federal Emergency Management Agency to Massachusetts Attorney General James M. Shannon's Off-site Emergency Preparedness Interrogatories and Request for Production of Documents to FEMA (Set No. 2), dated June 4, 1987, Answer No. 11, at Attachment 5 of this testimony).

Q. Are there emergency situations in which sheltering, if it were successfully implemented, would be the most effective protective measure for the beach population?

A. (Goble) Yes.

Q. Please describe such situations.

A. (Goble) Except for accidents involving very small radioactive releases, evacuation, when it is feasible, is the preferred protective response. If the population can be removed from the path of the radioactive material before it arrives, then the protective action will avoid exposures rather than merely reduce them. The conditions in which sheltering would be preferred to evacuation are those in which the accident develops rapidly, that is, situations in which exposure would begin in times that are short compared to the times that it would take to complete an evacuation.

Q. The NHRERP, Rev. 2, provides that the beach areas closest to the plant (Hampton and Seabrook beaches) may be closed at an Alert stage of an emergency. Doesn't that mean that people on the beaches would always be gone from the area before plume arrival?

A. (Goble) Certainly not, although it is possible in the case of certain slow developing accidents.

Q. Could you explain your answer?

A. (Goble) NUREG-0654 provides specific guidance on the spectrum of accident conditions which should be considered in emergency planning, including the magnitude and timing of potential releases. It includes core melt sequences as representative of releases of radioactivity to be considered in the development of emergency response plans, and identifies four time periods which are significant for planning. Planning guidance for these times is presented in a table that is reproduced here for convenience.

TABLE (Table 2 of NUREG 0654, p. 17)

GUIDANCE ON INITIATION AND DURATION OF RELEASE

Time from the initiating event to start of atmospheric release	0.5 hrs. to 1 day
Time period over which radioactive material may be continuously released	0.5 hrs. to several days
Time at which major portion of release may occur	0.5 hrs. to 1 day after start of release
Travel time for release to exposure point (time after release)	5 miles - 0.5 to 2 hrs.
	10 miles - 1 to 4 hrs.

In addition, NUREG-0654 specifically observes that potential releases of significant amounts of volatile fission product. such as iodines, cesiums, tellurium, and ruthenium, need to be planned for. In fact, as other NRC guidance documents point out, it is expected that for most major (life-threatening) releases the major portion of the radioactive material will be released very quickly (within 0.5-2 hours) after the start of the release. (See, e.g., NUREG-1210, Vol. 4, at pp. 22, 28 and the Reactor Safety Study, WASH-1400, App. VI, and especially Table VI 2-1).

Based on this guidance, it is clear that one must plan for accident conditions in which there are potentially large releases of radioactive materials and in which visitors to the nearby beaches (1.6 - 5 miles from the plant) may start receiving substantial exposures not much more than an hour after the initiating event. This time must then be compared to the time for evacuation of the beach population. The evacuation time estimates in the New Hampshire plans (NHRERP, Rev. 2, Vol. 6), computed by KLD Associates, give evacuation times (for the summer beach season) which range from 5 to 10 hours including notification time, depending on the number of beach visitors present, the weather, and the time and day of the week. Testimony presented in this proceeding by Dr. Adler indicates that the potential number of beach visitors is considerably underestimated in KLD's analyses and that reasonable evacuation time estimates are much longer. Even using the KLD time estimates, however, it is clear that a significant release of radioactive material could reach the beach hours before an evacuation, even off the beach, could be completed.

Q. In summary, then, given the situation you have just described of early plume arrival, and evacuation time estimates for the beach area ranging from 5 to 10 hours, would sheltering be the preferred protective response?

A. (Goble) Most definitely. In a rapidly developing, severe accident, it clearly would be preferable for the beach population to be temporarily sheltered rather than simply waiting in or outside their cars to evacuate. For a short duration (a few hours) gaseous release of radioactivity, which is also within the planning basis of NUREG-0654, Table 2, sheltering is the only response that would do any good.

Q. Can you explain why it is the only response that will do any good in that latter situation?

A. (Goble) The hypothesized accident involves a puff of radioactive gases released with very little warning. The puff would arrive and depart before the population could evacuate, and if the release were only gases there would be little ground-deposited radioactivity. The only exposure would be during the passage of the radioactive cloud and the only protection available would be from whatever building material could be interposed between the person and the cloud.

Q. Doesn't your conclusion that people would be better off sheltering than waiting in cars in the case of a rapidly, developing severe accident contradict the early evacuation strategy advocated in NUREG-1210?

A. (Goble) No. NUREG-1210 is a generic guidance document intended for training rather than regulatory purposes. Its recommendations for severe accident protective action are based on explicitly stated generic assumptions about nuclear power plant sites. The strategy is premised on the observation that for most nuclear reactor sites only a few hundred people live within the area 2-3 miles from the plant and, therefore, that this immediate area can be evacuated in almost all cases <u>before</u> plume arrival. These assumptions, however, do not hold for the Seabrook site. As I stated earlier, I agree that it would always be better to evacuate if people can do so before plume arrival. That is not the case at the Seabrook site. NUREG-1210, in fact, specifically addresses exceptions to its generic assumptions, including the type of situation we are faced with at the Seabrook site, where due to the high density population evacuation before or shortly after plume release is impossible. NUREG-1210 calls this situation "entrapment." (See, e.g., NUREG-1210, Vol. 4, at p. 19.) In situations of entrapment NUREG-1210 agrees that a shelter would provide better shielding from radiation than a car, so that a preferable strategy would be to shelter the population and then evacuate them after the plume has passed (preferably after monitoring so that the evacuating population can avoid travelling through "hot spots").

Q. When you state that in the case of a rapidly developing severe accident sheltering would certainly be preferable to waiting outside in cars, does that mean that sheltering could actually result in a substantial reduction in exposures and, possibly, in the savings of early injuries and deaths?

A. (Goble) Effective implementation of sheltering, if it could be achieved, might reduce doses by a factor of two or more. (see Aldrich et al., Feb. 1978). Suitable shelters will reduce the exposure to cloudshine by about half, exposure to groundshine by more than one half, and exposure from inhalation by less than one-half. Better shelters would do better: thicker walls and ceilings would provide more protection from cloudshine and groundshine; filtering of incoming air would increase protection from inhalation.

Q. What provisions for sheltering the beach populations are in the New Hampshire emergency plans?

A. (Goble) The clearest statements on sheltering the transient beach population are in the NHRERP, Rev. 2, Vol. 1, Section 2.6. There are general statements concerning transients on page 2.6-6, which provide:

> Transients located indoors or in private homes will be asked to shelter at the locations they are visiting if this is feasible. Transients without access to an indoor location will be advised to evacuate as quickly as possible in their own vehicles . . . If necessary transients without transportation may seek directions to a nearby public building from local emergency workers. Public buildings may be set up and opened as shelters for transients, on an ad hoc basis, if any unforeseen demand for shelter arises during an emergency.

The summer beach population is explicitly mentioned on page 2.6-7. That section provides:

> Sheltering may not be considered a feasible protective action on seacoast beaches during the summer. For this reason, early precautionary beach closures may be implemented. The conditions under which such an action may be taken are described in NHRERP, Vol. 4, NHCDA Procedures, Appendix F.

The decision criteria presented in Figure 2.6-6 (p. 2.6-25) are unambiguous: under all circumstances evacuation of Hampton and Seabrook beaches would be recommended. Further evidence of what would happen comes from the prepared emergency messages in Appendix G to Vol. 4, NHRERP, Rev. 2. These messages are intended to be used as is, when appropriate, in cases such as a fast developing accident in which there is insufficient time to prepare special messages. None of the messages in Appendix G direct people on the beach to find shelter.

Nevertheless, the Applicants' recently filed testimony on sheltering, which includes recently proposed amendments to the NHRERP, does indicate that sheltering of the beach population would be considered by the State in certain limited, unspecified circumstances. It is clear from the testimony, however, that the State of New Hampshire has no present intention of amending the NHRERP to include plans for implementing a sheltering strategy for the beach population (See Applicants' Direct Testimony No. 6, dated 4/15/88).

Q. If an attempt were made to implement sheltering of the beach populations, based on the existing plans, would it be successful?

A. (Goble) No. In my judgment, the attempt would most likely aggravate the conditions of the accident and lengthen the period of exposure for many people.

Q. Why is that?

A. (Goble, Renn) The best way to answer that question is to describe what would be necessary for a successful implementation of a sheltering response for a beach population. We have identified the following set of general conditions that we consider essential. These are very far from being realized in the present plans as is clear from the following list:

> (1) decision criteria which recommend sheltering only when it will be the most effective protective response to the particular accident conditions at hand;
>
> (2) adequate amounts of sheltering space for the population, including a substantial margin to provide for non-uniform distributions of people;
>
> (3) good shielding factors for this sheltering space;
>
> (4) the space must be readily accessible; it must be easy to find, clearly labeled, and the access route must not create bottlenecks;
>
> (5) previous arrangements with the owners or managers of the spaces so that there will not be time-consuming ambiguity about its use during an emergency;
>
> (6) plans and facilities for communicating simple repeated instructions, telling people to take shelter and how to do it; it may be necessary for there to be emergency personnel providing direction;
>
> (7) plans for coping with confusion and panic in the most sensitive locations;
>
> (8) plans and resources for communicating with people in shelters and, in particular, providing information and assistance on decontamination and on preparation for leaving the shelter; and

(9) plans and resources for helping people leave shelters expeditiously, including preparation for conditions with significant radiation contamination.

Q. How do the provisions in the NHRERP relative to sheltering the beach population measure up to these criteria?

A. (Goble, Renn) As we have already explained, the NHRERP does not provide any planning for sheltering the beach population. Thus, the conditions we consider minimally essential for the successful implementation of a sheltering plan are virtually non-existent. The following briefly summarizes the essential ingredients that are lacking:

--decision criteria: there are no decision criteria in the present plans for selecting sheltering for transients on the beach; the criteria for recommending sheltering to short term visitors (which are the same as those for the resident population) are flawed;

--sheltering space: no sheltering space for beach visitors is identified in the plans; including no indication of the shielding factors of sheltering space in the beach area; thus, there is no indication that sufficient shelter space accessible to the public exists or where that space is located;

--notification and direction: there are no provisions in the plans for notifying people on the beach to seek shelter, for assisting them or guiding them to shelter, or for ensuring that sheltering space is accessible and open.

Q. Despite this lack of planning couldn't sheltering of the beach population still be accomplished on an ad hoc basis?

A. (All) No. In our judgment it could not be implemented. We have examined in detail the adequacy of: (1) sheltering capacity; (2) shielding factors; and (3) the capability to notify and direct people to shelters. We have found that any attempt to implement a sheltering response at this site, given the characteristics and size of the beach population, the type of buildings in the beach area, and the present non-level of planning, would likely make matters worse.

Q. Could you explain in more detail how you reached this conclusion?

A. (Goble, Eckert, Evdokimoff) We started by examining the buildings possibly available for sheltering in the beach area to determine whether sufficient sheltering space exists in the beach area, the shielding potential of that sheltering, and its accessibility to the beach population. The buildings can be divided essentially into two groups: private residences, which for Hampton and Seabrook beaches, the beach area closest to the plant, are predominantly summer beach cottages; and public buildings, which includes commercial establishments, such as motels, hotels, restaurants and stores, as well as municipal buildings.

Q. What did you find out about these buildings?

A. (Goble, Evdokimoff) Let's start with the first group, the private residences. We examined only the summer cottages, since permanent residents make up only a very small percentage of the population in the beach area, and it is these cottages which predominate in the Hampton and Seabrook beach areas. Our purpose in examining the cottages was to determine if the many, short-term beach visitors residing in these cottages could use them as shelters in the event of a radiological emergency at the Seabrook plant or if other suitable shelter would have to be found for this population.

Q. What lead you to question the suitability of these cottages as shelters?

A. (Goble, Evdokimoff) For one thing, FEMA raised the issue in early reviews of the NHRERP that "occupants of the many unwinterized cottages, motel rooms, and campgrounds in the Seabrook EPZ" might not be suitably protected. FEMA, in a December, 1985 memorandum to the RAC, noted the possibility that

> the normal assumptions we make about the protective effects of sheltering are not valid for structures which are:(a) not designed to resist air intrusion, and/or (b) which have a very small protective factor because of the slight mass of the structure.

(*See* Memorandum to Regional Assistance Committee (RAC) Radiological Emergency Preparedness Task Force (REP) from Edward A. Thomas, Division Chief, Natural and Technological Hazards, on Seabrook Emergency Plans, dated December 31, 1985, No. R1-TH-85-28. Attachment 6 hereto). More recently, FEMA concluded after its review of this issue that "the protection afforded by sheltering in these structures [unwinterized cottages and motel rooms] will definitely be less than that afforded by a normal wood frame house." (*See* Current FEMA Position on Admitted Contentions on New Hampshire Plans for Seabrook, FEMA Response to Revised Town of Hampton Contention VIII to Revision 2 (of the New Hampshire RERP for Seabrook), SAPL Contention 16, and NECNP Contention RERP-8, dated June 4, 1987, at p. 39, Attachment 7 hereto).

Q. What did you conclude based on your own examination of the summer cottages?

A. (Goble, Evdokimoff) We agree with FEMA's conclusions that the cottages are unsuitable for sheltering.

Q. Did you examine all of the cottages?

A. (Evdokimoff) No. I performed the survey of the cottages and I examined what I considered to be a representative sample of the cottages in the beach area.

Q. What did you do?

A. (Evdokimoff) First, I talked with fire officials, police officials and realtors in Hampton Beach. I learned that in Hampton Beach there are well over 1000 cottages which can house one to three families. While I could not obtain a breakdown of use by season, I determined that the summer season represents the largest use -- close to 100% occupancy. I surveyed cottages in the area of Hampton Beach where the majority of rental cottages are located. This included cottages off Ocean Loulevard, the "lettered" streets between Ashworth and Ocean Boulevard and finally the area off

Ashworth. Most of the streets in the area were surveyed. [See Attachment 8]. I confirmed that this area was representative after discussion with two fire officials, two police officers, and five of the ten realtors in Hampton Beach.

Q. Did you look at all types of buildings in the area?

A. (Evdokimoff) I tried to confine myself to rental cottages since those are the buildings that predominate in this area and because we are focussing on the large transient population. Also, I understood that Dr. Eckert and Dr. Goble were examining the suitability of the commercial establishments in the area. However, I still looked at a number of the commercial buildings while I was in the area.

Q. What was your criteria for consideration of a structure as a rental cottage?

A. (Evdokimoff) Structures were classified as cottages using the following two criteria:

> 1) Location in areas known by local realtors and town officials as having cottages for rent.
>
> 2) Signs out front of the structures advertising cottages and/or apartments for rent.

It is likely that I classified some permanent residences as rental cottages. Structures listed as hotels, inns or condominiums were not counted in this survey.

Q. How many of the cottages did you survey?

A. (Evdokimoff) I surveyed 459 of the estimated 1000 rental cottages in the area. According to town officials, the area that I surveyed represented 90% of the area in which the cottages are located.

Q. Please describe the survey techniques you employed to assess cottages for shelter potential?

A. (Evdokimoff) I walked the streets in the area and observed the cottages. Many times I was able to walk around and look into the cottages. I also surveyed a greater area by automobile to assess the distribution of one and two story cottages by location. I interviewed renters of the cottages to ascertain cottage construction. I also talked with local residents including officers in the fire department, officers in the police department and five real estate companies to get an overview of rental cottages. Through the realtors and renters, I was able to inspect twelve representative cottages.

Q. How did you assess the shielding potential of these cottages?

A. (Evdokimoff) As stated earlier in this testimony, a building can reduce radiation exposure from three pathways. The degree of protection depends on the following factors:

a) building material, for example wood, brick or masonry, and thickness of that material;
b) whether the structure has a basement or not;
c) the number of floors or stories in the structure; and
d) how airtight the structure is (absence or presence of insulated windows, air-conditioning, cracks in the windows, fireplaces, etc.).

Aldrich _et al_. from Sandia National Laboratories have assigned representative shielding factors to estimate the degree of protection for such structures. As explained before, these factors range from 1, meaning no protection within the structure, to almost 0, meaning the structure affords almost perfect protection. Typical values range from 0.9 (10% protection) to 0.1 (90% protection). Aldrich _et al_. present tables allowing one to estimate cloudshine and groundshine shielding factors for various types of buildings, including woodframe year-round housing, with and without basements, and residential and commercial masonry buildings. As regards inhalation, Aldrich states that an individual can reduce the dose up to 35% (factor .65) from inhalation with a structure that is "tight." That is, windows closed, well-insulated windows and doors, plus ventilation systems turned off (Aldrich et al., January, 1978). There is one _caveat_ for use of these factors: occupants may _not_ remain near the windows or doors, but must reside inside preferably near interior walls of the structure until it is safe to leave the shelter.

Q. Please describe what you found from your survey.

A. (Evdokimoff) The cottages with few exceptions are constructed of wood and have no basements. They do have crawlspaces. I was told by the Fire Department and a local resident that the lack of basements is due to this area being classified as a flood plain. It is developed marshland in which flooding of one foot above ground is common. Significantly, most of these cottages are 70-100 years old. A few have storm windows and may be insulated. Some have siding or asphalt shingles on the exterior. Many cottages that I viewed from the outside had broken windows or screens and were in severe disrepair. These appeared to be mainly the one floor, one-family cottages. Many two-family, two story cottages/apartments appeared to be in better condition. All of these cottages are small. Typical dimensions for a one-story dwelling are 10' by 20'. Many two-story dwellings have one room in the attic area. A typical one floor cottage has a porch with or without windows or screens, 10-20 windows, a 3 1/2 foot crawlspace under the wooden floor, 2 bedrooms, a living room, a bathroom and a kitchen.

Q. Please describe the cottages that you went into.

A. (Evdokimoff) All twelve cottages I entered fit the same general profile. They were each about 70-100 year old wood structures without basements. But as a sample group, they displayed a range of both deterioration and improvements. At 17 Epping and 7 Boston, for example, I looked at two one-story cottages that were typical of one end of the spectrum of condition, that is, largely unimproved with considerable visible disrepair in evidence. Both of these were 20' X 12' with crawlspaces underneath. The Epping cottage stood on concrete blocks, and had asphalt shingles. Both had porches.

Each had broken windows and screens; neither had interior ceilings. One could look up at the uninsulated wooden roofs and see spaces which admitted light. They each had about 10 windows, not counting the front and rear door windows, and one sash of the Boston St. cottage could not be closed.

In better condition were two cottages I entered in the Ashworth Street area: a one-story and a two-story near the corner of J. St. The single story was 10' X 20' and sat directly on a brick slab with no crawlspace. It had been improved with siding and storm windows, and had interior ceilings. The two-story cottage was structurally similiar to the one-story units -- wood framed with no basement -- but had storm windows and was in good condition.

Eight of the cottages had interior ceilings, while in the remaining four one could see daylight through the roof openings between boards. There were broken windows or inoperative sashes in three cottages, four had storm windows, and two of the two-story cottages were heated and panelled.

Q. Do you have any data on the relative numbers of the one and two-story cottages in the Hampton Beach area?

A. (Evdokimoff) Yes. Ocean Boulevard had 50 one-story cottages out of 107 cottages. This is indicated as area "A" in the maps which are part of Attachment 8. The "lettered" streets between Ocean Boulevard and Ashworth had 79 two-story cottages out of 89 cottages. This is area "B" on the map. The area off Ashworth Street designated as "C" had 222 one-story cottages out of 263 cottages. Therefore, of the 459 cottages surveyed, 61.4% are one-story and 38.6% are two-story. Two (2) cottages of the 459 had basements and one cottage was constructed of masonry without a basement.

Q. What are your conclusions on these cottages as potential shelters?

A. (Evdokimoff) Based on the predominance of wood structures (99.8%), one-story buildings (61.4%), and no basements (99.6%), it appears these cottages would offer minimal shielding characteristics for cloudshine. These cottages would afford somewhat better shielding against groundshine. Because of the number of windows in the structures, the age of these cottages and the significant number of cottages without storm windows (approximately 70%), there would be minimal protection against inhalation of radioactive material.

The Stone & Webster study of March 1986, in assessing potential shelters in the beach area near Seabrook Station, states on page 3: "Wood frame buildings without basements were not included [in this report] because this type of building usually does not provide sufficient shielding." I agree with this assessment. Ninety-nine percent of the cottages I surveyed fell into this category. Furthermore, the cottages give significantly less effective protection than the average year-round dwelling in this category for the following reasons:

1) they are smaller with less interior wall space; 2) construction materials tend to be lighter; 3) windows occupy a large percentage of the exterior wall space and tend to be poorly sealed; and 4) as noted earlier, in many cases there are openings directly to the outside air through broken or inoperative windows, spaces in the roof boards, vents, etc. Therefore, it is my opinion that overall, these cottages in Hampton Beach are unsuitable for consideration as emergency shelters from an accident resulting in an off-site release of radioactivity from Seabrook Station.

Q. Does the siding on the cottages, the storm windows or the crawlspaces afford extra radiation protection?

A. (Evdokimoff) The siding on the houses is not of sufficient thickness to offer any significant added shielding potential from gamma rays. Aluminum is denser than wood or concrete but not thick enough in siding for added protection. Storm windows would offer additional protection against the inhalation radiation hazard. However the maximum reduction according to Aldrich would only be 35% of the inhalation dose. Most cottages that I saw appeared to be poorly insulated. I estimate in the Ashworth section that 30% of the beach cottages have storm windows. The crawlspaces in my opinion are not suitable for radiation protection for two reasons. First, most are not enclosed. Some crawlspaces are wooden slats under the house. Others are concrete with vent holes. Many of them can be reached by doors from the outside. Many cannot be reached at all. I saw no cottage in which you could enter a crawlspace from inside the house. The primary reason for those crawlspaces, as I previously explained, is to protect the cottage from water since Hampton Beach is built on a flood plain. Secondly, these crawlspaces are at most 4 feet high. It would be impractical to shelter people in them. Also, a number of them are used as storage areas and there would be little, or no, space available in them for sheltering. The floors of the crawlspaces are dirt and they are not continuous solid structures. It would seem imprudent to expect to shelter people on their stomachs on the ground in a dark crawlspace for hours.

Q. How would you compare these cottages to the average wood-frame permanent residence in the Seabrook EPZ?

A. (Evdokimoff) The cottages would offer less protection. Most of the cottages that I viewed are not comparable to a typical wood-frame residential dwelling. A conventional residential house is assumed to have various characteristics, such as: greater dimensions (20' x 40'), ceilings, attics, interior walls, and good insulation with storm windows to prevent air from entering the dwelling. The cottages that I viewed are not comparable because, as explained before: there are significantly less wood and building materials in these dwellings; they are not well insulated; and they have more windows, many of which are cracked. Therefore, these cottages will provide less radiation protection than will a typical residential structure with similar building characteristics (i.e., wood and no basement). Also, it is important to note regarding my earlier mentioned caveat on the use of the Aldrich tables, that these cottages are so small that in many cases it would be impossible to take shelter away from doors, exterior walls and windows.

Q. What do the decision criteria in the NHRERP assume as shielding factors for the decision whether to shelter or evacuate overnight and short-term visitors to the beach areas.

A. (Goble) The decision criteria (NHRERP V.1, p. 2.6-7) assume a whole body shielding factor of .9, combined cloud shielding and ground shielding. They assume inhalation protection that declines over time, with values of .5 for exposure up to one hour, .75 for exposure of two hours, etc.

Q. Can you describe in more detail why inhalation protection is expected to decline over time?

A. (Goble) A building constantly takes in air from the outside and releases inside air to the outdoors. The rate at which outside air is brought in is commonly expressed in terms of numbers of air exchanges per hour.

Q. What are typical air exchanges rates for houses?

A. (Goble) Typical year-round residences have air exchange rates of .5/hour to 2/hour, depending on how energy efficient they are.

Q. Does an air exchange rate of 1 per hour mean that all of the original air of a house will have left the house in an hour?

A. (Goble) No, because the exchange is occurring continuously. A rate of 1 per hour means that 1/60 of the air in a house will leave in a minute, but some of the air exchanged in subsequent minutes will be new air from outside.

Q. How radioactive will the air be in a house after an hour or two?

A. (Goble) If we use the NHRERP figure of 2 air-changes per hour, then 1 hour after the arrival of a cloud of radioactive gases, the air inside will be approximately 85% as radioactive as it is outside. After 2 hours it will be more than 95% as radioactive. The average exposures over those first two hours will be those listed in the decision criteria. However, as the previous testimony has already indicated, the beach cottages provide less protection than the average dwelling which was used to define those criteria, and therefore the air in those cottages could be more radioactive than those percentages just mentioned after comparable periods of time.

Q. Could the people staying in the beach cottages shelter anywhere else in the beach area?

A. (Goble) The New Hampshire plan does not make any provision for this. Nevertheless, we did examine whether there exists other space in the beach area suitable for sheltering.

Since we found the beach cottages to be unsuitable, the necessary sheltering space would have to be found in either commercial buildings, which includes motels, hotels, shops and restaurants or in municipal buildings. Also, the sheltering would have to be able to accommodate essentially the entire beach population. This would include all the day-trippers, short term visitors staying in beach cottages, hotels or motels, and persons working in the beach area, as well as those permanent residents whose homes do not provide suitable shelter. Since permanent residents comprise such a small percentage of the total population in the beach area, and since the size of the beach population is so variable, we considered figures for the entire beach population in calculating sheltering needs.

Q. How many people would the sheltering space in the beach area need to accommodate?

A. (Goble) We estimate the number for the beach areas in the New Hampshire portion of the EPZ to be 70,500. The following indicates the beach area population estimates broken down by town:

Seabrook Beach	11,400
Hampton Beach	43,800
North Hampton Beach	3,200
Rye Beach	12,100
Total New Hampshire Beach Area Population	70,500

Q. On what do you base these population estimates?

A. (Goble) They are based on the testimony of Drs. High, Adler, and Befort. We multiplied the number of estimated parking spaces in each beach area, as provided in Table 1 of that testimony, by the number 2.85, which according to their testimony at page 5, footnote 1, represents the weekend vehicle occupancy rate for the New Hampshire beach areas. This is the same methodology (multiplying parking spaces by vehicle occupancy rate) employed by KLD Associates in calculating the beach area population figures that are provided in Volume 6 of the NHRERP, Rev. 2. We use the parking space and vehicle occupancy rate figures provided by High, Adler and Befort because their figures are based on more recent data than KLD's.

Q. Does the New Hampshire emergency plan indicate whether there is sufficient sheltering space in the beach area to accommodate all these people?

A. (Goble) No, the New Hampshire plan does not provide any indication of where people on the beach could be expected to shelter. However, a study entitled "A Study to Identify Potential Shelters in the Beach Areas near Seabrook Station" (hereinafter "Stone & Webster Study") was performed for the applicants by Stone & Webster Engineering Corporation in March, 1986 (<u>See</u> Attachment 9 to this testimony). According to the applicants, this study identifies the public sheltering capabilities of those public municipal and commercial buildings in the EPZ "that are considered to be suitable for sheltering of the beach population." (See Affidavit of Anthony M. Callendrello [Manager of Emergency Planning for Applicants] on SWEC Shelter Study, dated March 25, 1987, at Attachment 10 to this testimony). We started with this study to determine whether sufficient sheltering capacity exists in the beach area for the indicated population.

Q. Didn't Stone & Webster perform another study of the beach area shelters?

A. (Goble, Eckert) Yes, but that second study, "A Study to Identify Potential Shelters in the Beach Areas Near Seabrook Station, Revision I," dated August, 1987 [hereinafter "Stone & Webster Study, Rev. I."] included virtually all commercial and public buildings in the beach area, including those buildings which the first study rejected as unsuitable for shelter. Therefore, our analysis of shelter space in the beach area begins with the first Stone & Webster Study to determine whether there is sufficient suitable space.

Q. Can you be more specific as to the types of buildings included in the first Stone & Webster Study?

A. (Goble, Eckert) The Stone and Webster Study of potential beach area shelter lists a variety of commercial establishments that could provide shelter to the beach population. These commercial buildings are predominantly motels, rooming houses, and restaurants, but there are also several retail stores and businesses such as food markets, and real estate offices included. Other sheltering spaces in their survey comes from churches and municipal buildings, such as fire and police stations, municipal bathhouses, restrooms, and a post office.

Q. Did Stone & Webster include in their study all the commercial and municipal buildings that are in the beach area?

A. (Goble, Eckert) No. Stone & Webster did not include in its first Study those buildings, or areas of buildings, that it deemed unsuitable for shelter. (See Stone & Webster Study, pp. 1-3).

Q. What criteria did Stone & Webster use for classifying a shelter as suitable or unsuitable?

A. (Goble) According to Stone & Webster, its list of suitable shelters included, as stated at page 3 of the Study, only:

> "masonry buildings and buildings with masonry basements which have the potential for providing representative (typical) shielding factors of 0.4 to 0.6 for airborne radionuclides (clouds) and 0.05 to 0.2 for surface deposited radionuclides (ground) . . . . wood-frame buildings without basements were not included because this type of building usually does not provide sufficient shielding."

Q. Do you agree that wood-frame buildings without basements would not be suitable for shelter?

A. (Goble) Yes, especially in this area where, as FEMA pointed out, even many of the motels in the area are unwinterized, and the protection afforded by sheltering in these buildings "will definitely be less than that afforded by a normal wood-frame house." (See Current FEMA Position on Admitted Contentions, pp. 38-39, Attachment 7 hereto).

Q. How much suitable sheltering space did Stone & Webster find in these public buildings?

A. (Goble, Eckert, Renn) The Stone & Webster Study lists the following total sheltering space and numbers of shelters for each beach area in the New Hampshire EPZ:

Seabrook beach area:	26,550 sq. ft. in 9 shelters
Hampton beach area:	283,580 sq. ft. in 96 shelters
No. Hampton beach area:	1550 sq. ft. in 2 shelters
Rye beach area:	87,330 sq. ft. in 7 shelters

Q. How many people would these spaces accommodate?

A. (Goble, Eckert) The Stone & Webster Study states, at page 6, "the number of people that can be sheltered in a given area for a few hours can be estimated by dividing the potential sheltering area by a factor in the range of 10 to 20 square feet per person". The Study concludes from this that there exists the following short-term public sheltering capacities in the beach area:

Seabrook:	4,500 - 9,000 persons
Hampton:	14,200 - 28,400 persons
N. Hampton:	75-150 persons
Rye:	4,350 - 8,700 persons

It must be borne in mind, however, that while alotting just 10 square feet per person for sheltering space may be suitable for a short period of time, it becomes less suitable for the longer hours we must consider at this site. It is also doubtful whether people, left to their own devices, would be willing to crowd in that tightly.

Q. Is this enough shelter space to accommodate the beach population?

A. (Goble, Eckert) No. The following chart compares estimates of summer weekend beach population figures with Stone & Webster's estimate of sheltering space:

	Stone & Webster <u>shelter capacity</u>	Weekend Population by <u>beach area</u>
Seabrook	1,350 - 2,700 spaces	11,400
Hampton	14,200 - 28,400 spaces	43,800
North Hampton	75 - 150 spaces	3,200
Rye	4,350 - 8,700 spaces	12,100

Q. Can you state whether Stone & Webster's estimates of sheltering space are accurate?

A. (Eckert) Stone & Webster's figures are not accurate. They identify more suitable sheltering space than is actually available in the beach area.

Q. How do you know that?

A. (Eckert) Under my direction, a field investigation of shelter capacity in the beach area was conducted by Salmon Falls Research Associates ["Salmon Falls"] in order to verify whether Stone & Webster's report of shelter capacity was accurate.

Q. What did you find?

A. (Eckert) That the Stone & Webster report over estimates shelter capacity by approximately 40%.

Q. How was that determined?

A. (Eckert) By taking field measurements of a number of the shelters listed in Stone & Webster's Study and then comparing our measurements of each building with Stone & Webster's estimation of sheltering space.

Q. Did you measure all the buildings listed in Stone & Webster's Study?

A. (Eckert) No. We measured twenty percent.

Q. Can you explain exactly how you selected the buildings you measured?

A. (Eckert) Yes. The Stone & Webster report listed 114 potential public shelters in the New Hampshire beach area. A twenty percent sub-sample (23 establishments) was selected from the Stone & Webster Study using a stratified random sample according to within-town square footage size class. Once the buildings were selected, the street numbers of commercial establishments given in the Stone & Webster Study were verified using a telephone directory. If the establishment was not listed, the address indicated by Stone & Webster was visited to determine if the name had changed. Once the current name and address were verified, telephone calls were placed to each owner/manager to ask permission to enter the premises to take measurements and photographs. When the initial random sample failed to yield 23 usable samples due to lack of cooperation from owners or other factors, an additional random selection of establishments was made. A total of 38 randomly chosen establishments had to be contacted in order to gain access to 23. Of the 15 unusable establishments, 10 would not cooperate, 3 had become private residences, 1 had burned down, and 1 was a private residence that was included as a commercial building in the Stone & Webster Study.

Q. Once you selected the buildings, what was the procedure you used for measuring shelter capacity?

A. (Eckert) Teams of 2 to 5 people were involved in taking measurements and photographs. The same field supervisor was present for all data collection to provide quality assurance. A Keson 165 foot fiberglass engineering tape was used for all linear measurements. Prior to taking any measurements, new team members were instructed in its proper use. Care was taken to ensure that the tape was held level, was parallel to the wall being measured, and was pulled tight for each measurement. When a measurement was in doubt or difficult, it was repeated. Complex areas were divided into rectangles and triangles for measurement and calculation. A diagram was made of each shelter area, on a room-by-room basis, while actually standing in the space, and before any measurements were taken. Dimensions, locations of doors, windows, and immovable obstructions were noted on the diagram. Heights of crawlspaces were measured.

Q. Did you include all the measured space in your results?

A. (Eckert) Yes, our results present total square footage and total square footage adjusted by a reduction factor. The "reduction factor" was estimated for the percentage of floor space covered by stored objects and equipment. The most optimistic disposition of stored objects was used. For example, in the Surf Hotel basement, where approximately 1/3 of the space was not high enough to stand in, it was assumed for our calculations that stored items and equipment would be placed in that space rather than covering standing room. The reduction factor was estimated separately by each crew member and, per our protocol, had to be agreed upon by all crew members.

Q. Aside from your diagrams, did you document your observations in any way?

A. (Eckert) Photographs were taken to document the structure and to capture the "quality" of shelter space in most buildings. Black and white Ilford XP1 400 or Kodak Tri-X 35mm film were used for all photography. Points from which photographs were taken were noted with an 'X' on diagrams. Photographs of the exteriors of most buildings were taken to document building materials and window space and to provide information on access to the potential shelter area. Notes on access to the shelter were also made on the diagram. (See, Salmon Falls Research Associates Re-Survey of Potential Shelters, at Attachment 11 to this testimony).

When measurement and photography were complete, a departure interview was held with the owner/manager of the establishment. The owner/manager was shown the information we collected, asked whether he/she had been contacted by New Hampshire Yankee or Stone & Webster regarding the designation of their building as a potential shelter, and asked for a signature to indicate that we had actually taken measurements of their building.

Q. How did you calculate the shelter space?

A. (Eckert) Calculation of shelter area was based on the diagrams drawn on-site. These diagrams were broken up into rectangles and triangles where necessary, and the square footages calculated for each. Square footage taken up by stored items was then deducted from total space. Assessment of the completeness, accuracy, and repeatability of Stone & Webster's data was accomplished by examining Tax Assessor's cards for the buildings in the sub-sample evaluated by Salmon Falls. Attachment 11 to this testimony provides the documentation (diagrams, photographs, summary of measurement data, Stone & Webster shelter survey forms, and property assessment records) for each assessment of an individual potential shelter analyzed by Salmon Falls, as well as our final calculations of the space of each shelter, and a discussion of how we obtained those results.

Q. Did you consider all the interior space you measured as potential shelter space?

A. (Eckert) The objective of our statistical analysis of shelter data from Salmon Falls and Stone & Webster was to determine if the two studies estimated the same amount of shelter space available in the buildings identified by the Stone & Webster report. Therefore, Salmon Falls followed Stone & Webster's explicit guideline that no wood frame structures without basements would be included as potential shelters (See Stone & Webster Study, at p. 3). Buildings found to be in this category during field inspections were assigned a shelter space of zero.

Q. How did you compile your final data?

A. (Eckert) Data from the 20% sub-sample were divided into "Total Square Footage" and "Shelter Square Footage" for analysis. Analysis of "Total Square Footage" i.e. raw measurement data not adjusted for shielding factors (Stone & Webster) or stored items (Salmon Falls), provides an estimate of whether the two studies agree on the amount of pre-adjustment space available as potential shelter in the sample buildings. Thus, by looking at "total square footage," we can ask the question: Do the areas calculated from internal measurements taken by Salmon Falls agree with areas taken from the Tax Assessor's cards by Stone & Webster?

Analysis of "Shelter Square Footage", or post-adjustment square footage, on the other hand, provides a more realistic picture of habitable space available for potential shelters. In calculating this square footage, the space taken up by stored items was deducted from Salmon Falls measurements, and Stone & Webster's data adjusted for shielding factors were used. Shielding factor deductions were not used by Salmon

Falls. Raw unadjusted square footage estimates for Stone & Webster data were obtained from their own worksheets.

Q. What statistical analysis did you use to verify the results obtained from your data?

A. (Eckert) Two statistical tests were applied to the data. We applied a "t test" of the null hypothesis that the average difference between the Salmon Falls space measurements and Stone & Webster space estimates is 0. The Wilcoxin two-sample test of the null hypothesis that the Salmon Falls and Stone & Webster square footage estimates come from populations having the same statistical distribution was also used. In situations where randomization has been performed, as is the case here, these tests are highly appropriate (Box et al. 1978). Confidence limits were calculated for each test.

Q. What were the results of your analysis?

A. (Eckert) The Stone & Webster Study of potential shelter space for coastal New Hampshire overestimates actual space available for sheltering (see Attachment 11, Summary Table of Findings). Of 23 establishments (located in 24 buildings), 4 locations (17%) should not have been included according to Stone & Webster's own guidelines: <u>one</u> is a private residence located in a basement and <u>three</u> are crawl-spaces with ceilings of 4.5' or less and dirt floors. Further, a police station was included by Stone & Webster, even though it is crowded with equipment and would in any case be unavailable as a shelter in the event of an emergency.

Q. What is the bottom line difference in actual shelter space between your survey and Stone & Webster's?

A. (Eckert) Total shelter capacity estimated by Salmon Falls for the 24 buildings is 43% less (32,010 square feet -- or 3,201 fewer people @ 10 square feet each) than that estimated by Stone & Webster (see Attachment 11, Summary Table of Findings). Statistical analysis using the t test indicates we can be more than 99% confident that the difference between Salmon Falls' estimates and Stone & Webster's is greater than zero. The Wilcoxin test results indicate that we can be more than 99% confident that Salmon Falls' and Stone & Webster's samples of potential shelter area differ significantly. These statistical results are the same for both pre-adjusted (Total Square Footage) and adjusted (Shelter Square Footage).

Q. What accounts for this disparity in results?

A. (Eckert) The major reasons for these differences were the inclusion by Stone & Webster of inappropriate wood-frame structures and crawlspaces as potential shelters, the inclusion by Stone & Webster of space obstructed by stored items which were deducted by Salmon Falls, and the inclusion by Stone & Webster of private spaces misidentified as public.

Q. What did your survey show about the suitability of these buildings as shelters?

A. (Eckert) Eleven of the 23 locations failed to meet Stone & Webster's own sheltering structural criterion of "no wood frame structures without basement," or had other structural features or defects (like broken windows and/or holes in the walls) that would compromise at least some of the available space. The Seagate Motel, Cristaldi's Pizza, the Surf Hotel, Connecticut Village and the Shirley Motel all had wood frame or wooden-walled areas and yet were designated as potential shelters. The Hampton Beach Fire Station Garage has six broken windows and holes in the walls; the Hampton Beach Restrooms have open vents in the walls; Kristy's Korner has six foot high windows comprising nearly its entire north wall; the American Spirit has large expanses of glass; the Surf Hotel has gaps in the western wall of its foundation, and part of the basement is above ground with wood walls.

Q. Can you now summarize the available evidence on the amount of suitable sheltering space potentially available in the beach area?

A. (Goble, Eckert) We summarize the results in the Table below showing the corrected estimates of suitable sheltering space, the estimated peak populations, based on current parking space and car occupancy data, and, for reference, the NhRERP peak population estimates. It is noteworthy that for no beach is there sufficient potential sheltering space, even according to the NHRERP population figures. According to the new figures, the gap between the number of spaces and the number of people is enormous.

Beach	Shelter Capacity (Stone & Webster Corrected by Salmon Falls)	Peak Population	(NHRERP Peak Population)
Seabrook	800-1,600 spaces	11,400	6,400
Hampton	8,500-17,000 spaces	43,800	21,800
North Hampton	50 - 100 spaces	3,200	1,400
Rye	2,600 - 5,200 spaces	12,100	5,100
TOTAL	11,950 - 23,900	70,500	35,000

It should be noted with respect to this Table, that even the applicants now assume higher peak population figures than does the NHRERP.

Q. You have characterized this space as "potential sheltering space". Are there other issues that might affect its use as sheltering?

A. (Goble, Renn) Yes. Problems in obtaining access and the inhabitability of the space are as important as the actual physical existence of the space.

Q. Were these issues addressed by either the Stone & Webster or the Salmon Falls surveys?

A. (Eckert) Issues of space taken up by stored items, and public access to shelters from outdoors, were not discussed by Stone & Webster. The importance of these issues became apparent during our field work. We found that on the average, about 25% of motel and restaurant basement areas are obstructed by stored materials, equipment, and in some cases, real junk.

In one case, a large basement was found to be dangerous because of loose boards with protruding nails, wet floors, animal waste, and no lighting.

Q. Can you provide a specific example of these problems and how a beachgoer would confront them.

A. (Eckert) Moulton Hotel epitomizes many of the short-comings of the Stone & Webster Study. First, walled-off areas and large amounts of stored objects and clutter reduce the basement space actually available to 57% of Stone & Webster's calculation. Second, it is unlikely that beachgoers could even find their way into this basement, "since one must either climb a locked chain-link fence in the alley northwest of the building to gain access to the exterior bulkhead door, or enter the hotel through its poorly marked front door (see photo)." (Salmon Falls Re-Survey, at p. 70). The route through the hotel involves locating the single front door between two storefronts, climbing a flight of stairs to the lounge hallway, passing through the reception area, identifying and proceeding down the west hallway (one of three hallways leading from the reception area), exiting through the door to the deck area, crossing the deck and climbing down its rickety stairs, turning 180 degrees around to proceed north down the hotel's back alley, and finally entering the basement through a plywood bulkhead. Once inside, evacuees will discover that five of the six basement rooms are unlit, the floors are dirt, and the entire area is cluttered with old appliances, building materials and other potentially dangerous objects (photos show a free-standing pressurized gas cylinder among the debris). Finally, Salmon Falls found that this basement houses stray cats and the air is saturated with "suffocating, nauseating cat urine odor." It seems improbable that beachgoers would even find this "potential shelter," let alone remain in it for hours.

Q. What does the Salmon Falls Study tell us about access to shelters?

A. (Eckert) We found access to be limited by many factors. For the purposes of this report, we defined access as follows: once on the property, the route to the entry point of the building where the potential shelter is located, and the type of entry point (bulkhead door, locked hatch, etc.). We purposefully excluded distance and route from the beach to the potential shelter in this definition. Access in some cases, we found, is through private residences, and in many cases follows a winding route, and/or has limited or no access from outdoors, and/or is through business work areas. Often the entry point is difficult to locate. Public restrooms and parking garages are generally of unlimited access, and some churches, businesses and the public restrooms are only open seasonally.

Q. How does the Stone & Webster Study, Revision I, differ from the first Stone & Webster Study?

A. (Eckert) Stone and Webster's report, "A Study to Identify Potential Shelters in the Beach Areas Near Seabrook Station," Revision 1, August 1987, expanded their March 1986 report of the same title. Based on Tax Assessor card information, the 1986 report identified potential "suitable" shelter space in 114 basements and masonry buildings in Rye, North Hampton, Hampton, and Seabrook, NH. The 1987 report used tax card information from a total of 249 potential public shelters in these same seacoast towns to identify space available in wood-frame buildings.

Q. Did Salmon Falls evaluate the accuracy of Stone & Webster's Revision I Study?

A. (Eckert) Yes, Salmon Falls examined the methodology and results of Stone & Webster's 1987 revision. We, first, checked the validity of Stone & Webster's work with Tax Assessor's cards by trying to repeat it, i.e., to determine if Salmon Falls could obtain the same information as that recorded on Stone & Webster's shelter survey forms by using the same methods that Stone & Webster claims to have used.

Q. How did you do that?

A. (Eckert) This was done by studying the Tax Assessor's cards for every shelter in Hampton and Seabrook, combined with visual inspection of the exteriors of these shelters by a former real estate appraiser and the Salmon Falls field supervisor (in separate visits).

Q. What was the result of your comparison of Stone & Webster's work with the Tax Assessor information?

A. (Eckert) Several kinds of problems were uncovered in Stone & Webster's work. One of the most pervasive was Stone & Webster's inclusion of private residences in their potential public shelter space. It is quite common in this beach area to find private (year-round) apartments in buildings housing commercial establishments. Often the apartment belongs to the owner or manager of the establishment. Stone & Webster consistently included these private residences in their calculation of public space, even when it was quite obvious from the Tax Assessor's cards that the space should not have been included.

Q. Do you have an estimate of the amount of private apartment space Stone & Webster included in their calculation of potential shelter space?

A. (Eckert) Of the 205 potential shelters in Hampton, at least 6 establishments are in categories that would not have private apartments -- the fire station, police station, beach restrooms, beach storage building, the church, and McDonald's. Of the remaining 199 establishments, 77, or 38.7%, have owner's/manager's/employee's apartments for which Salmon Falls has documentation. These 77 private residences were all included by Stone & Webster in their calculation of public shelter space.

The square footage is given on the Tax Assessor's cards for 49 of the 77 above apartments. The total of these square footages if 69,608 ft^2. The average size of these apartments is 1,421 ft^2. Based on this sample of apartments, the 28 apartments of unknown square footage can be assumed to be roughly the same size as this average, and to total approximately 39,000 ft^2. Based on personal knowledge and information obtained from long-time residents of Hampton, and informed speculation on the part of Salmon Falls, it is likely that there are another 70 owner's/manager's/employee's apartments. If these apartments are of the same average size as those above, they would total over 99,000 ft^2.

The situation is similar for Seabrook. Of the 17 potential public shelters in Seabrook, 3 are in categories that do not have apartments -- the police station, church, and bank. Of the remaining 14 establishments, 5, or 35.7%, have owner's/manager's/employee's apartments for which Salmon Falls has documentation. This percentage is consistent with the equivalent documented percentage for Hampton. These private residences total 4,158 ft^2 and were included by Stone & Webster in their Revision 1 Study.

Q. Did Stone & Webster include any other private residences, besides the type you have just mentioned, in its list of public shelters?

A. (Eckert) Yes. We found 7 cases in which private homes, including condominiums, were submitted as public shelter space. The square footage of these private residences that should not have been included total 33,120 ft^2.

Q. What other types of problems did you find?

A. (Eckert) We found 22 cases (10%) in which square footage that does not exist was included by Stone & Webster. This involved a total of 36,409 ft^2. These errors resulted from:

- Stone & Webster's practice of pacing off buildings to determine square footage when it did not have the Tax Assessor calculations of space. In some cases, Stone & Webster paced off the buildings inaccurately. In other cases, it paced off buildings even when the Tax Assessor's information was available. In a number of these latter cases, the Tax Assessor information showed Stone & Webster's pacing to be inaccurate;
- Stone & Webster's inclusion of several buildings that had been torn down, some of them more than 10 years ago.
- Stone & Webster's practice of multiplying the size of the first floor of a building to get the total square footage, even in those cases where the upper floors were smaller than the first floor.

We also found another case, in which Stone & Webster submitted the same building twice. This came about because Stone & Webster erroneously submitted the establishment's wood-frame building in their first report. They then added its square footage on again in Revision #1.

In at least another 6 cases that Salmon Falls is aware of, establishments or sections of establishments were included by Stone & Webster that have openings to the outdoors. These cases involved large ventilation fan openings that cannot be closed off, parking garages, and buildings with walls of screening. The square footage involved is 38,415 ft^2. It is probable that there are many more buildings with these kinds of openings to the outdoors.

In another 8 cases, porches, decks, and overhangs were included as shelter square footage, totaling 4,324 ft^2, and in 2 cases crawlspaces were included as full basements.

In 3 cases, Stone & Webster made mistakes in arithmetic on the Shelter Survey Forms. In one of these cases, they wrote that "65 x 12 = 7800" (it actually equals 780). This ten-fold increase was doubled and submitted for a building that does not exist as described on the Shelter Survey Form.

We also found another 9 cases in which Stone & Webster did not use the available Tax Assessor information, resulting in inaccurate square footage submissions.

Q. Does that exhaust the types of problems you found?

A. (Eckert) No. We also found a number of cases in which Stone & Webster did not follow its own criteria in reducing the amount of potentially available shelter space. In 4 cases, Stone & Webster did not reduce space for " . . . stored materials, internal structural features, etc." (Stone &

Webster Study, Rev. 1) in accordance with its own criteria because they placed buildings in wrong reduction categories (for example, reducing the potentially available space in a retail store by a third instead of the appropriate two-thirds).

In another 10 cases, Stone & Webster did not deduct for large areas of glass in accordance with Revision 1 which states: "In some cases, structural features of a particular masonry building, mostly large window areas, would prevent use of the entire available floor area. In these cases, the floor areas available for use as a potential shelter were appropriately reduced as described in Section 3."

Also, in 14 cases, Stone & Webster inappropriately, perhaps arbitrarily, upped their shielding factors. For example, in some cases shielding factors of 0.4 and 0.05 were assigned to "tub basements", where the "basement" is 3/4 above-ground and those above-ground portions of the walls are wood. In 12 cases, partially or completely wood-frame buildings were called masonry by Stone & Webster. And in 2 cases, Stone & Webster submitted buildings even they considered "questionable" or "very questionable" according to notes on the Shelter Survey Forms.

Q. Can you summarize the results of your comparison of Stone & Webster's work with the Tax Assessor information?

A. (Eckert) The total square footage submitted in excess by Stone & Webster for which Salmon Falls has documentation is

186,034 ft^2. The adjusted square footage of potential shelter space, after being processed through Stone & Webster's A, B, and C categories for Hampton is 861,000 ft^2. It is 35,800 ft^2 for Seabrook. The total of these two figures is 896,800 ft^2. This figure minus the documented erroneous square footage leaves 710,866 ft^2, most of which is in wood-frame structures.

Q. Did you do anything else to assess the accuracy of the Stone & Webster Revision I Study?

A. (Eckert) Yes, we also closely scrutinized the Tax Assessor's cards for 50% of the potential shelters in Hampton and 100% of the potential shelters in Seabrook to determine the reliability of the Tax Assessor data as a basis for calculating shelter space. This scrutiny involved comparison of the dimensions on the Tax Assessor's sketches with the totals of these dimensions given in the Additions Or Deductions Columns and Computations Columns of the tax cards. We interviewed the current Hampton Tax Assessor (not the one who did the work we were examining) to review some sample discrepancies; he concurred that there are indeed discrepancies in the tax cards we showed him.

Q. What was the result of your scrutiny of the Tax Assessor cards?

A. (Eckert) Close scrutiny of Tax Assessor's cards of 98 establishments (50% of the establishments for which there are Tax Assessor's cards) showed discrepancies in 32 of the sets of cards, or 32.6%.

These discrepancies include:

- the inclusion of porches, decks, and overhangs as interior square footage;
- wrong assumptions, as in the stated assumption that Poore Steve's Ice Cream Parlour has a full basement, when it is a crawlspace;
- errors as to the number of stories in a building;
- assignment of inaccurate square footages;
- inconsistencies in the sketches drawn on the graph paper on the Assessor's cards;
- scale inconsistencies, such as that in one part of a sketch the scale would be 1 square = 2 feet and in another part of the same sketch it would be 1 square = 3 feet;
- missing dimensions;
- physically impossible dimensions, such as a line 1 inch long being assigned a length of 22 feet while a 1/2 inch-long line in the same sketch was assigned a length of 29 feet.

Q. Did you find any other problems with the use of the Tax Assessor information?

A. (Eckert) Yes. The Tax Assessor's cards are a static picture of what the general interior space usage was at the time of his last visit to the building, which in the case of Hampton was at the last town-wide assessment in 1978, or after completion of work for which a building permit was issued.

Therefore, most of the Assessor information for Hampton is ten years old, some is at least five years old, and all is at least two years old, since the Assessor is two years behind in his work.

The information on the Assessor's cards is also limited and not adequate for determining the suitability of buildings as shelter against radiation. The Assessor does not evaluate buildings for their sheltering capacity and adequacy as radiological protection. He evaluates buildings to put a monetary value on them, based on their exterior foundation dimensions and general construction materials. He gives breakdowns of the uses of the interiors of the buildings in only the most general (and vague) sort of way. It often cannot be discerned what space within a building is private residence and what is "public." Even though owners, managers, and/or employees often live in the buildings, it often cannot be told which square footages are their private residences.

The Assessor's office does not attempt to keep track of the names of the businesses in the buildings -- the buildings are indexed by address. There is a rapid turnover of businesses in some of the buildings in Hampton, so any sheltering report using business names will be out of date within a few months. Hampton Beach is also undergoing some "gentrification," so buildings are torn down and replaced, often with condominiums, at an unusually high rate in the current real estate boom.

Q. Do you know anything about the actual availability of these potential shelters in the event of a radiological emergency?

A. (Eckert) We know that no arrangements have been made by the State of New Hampshire with the owners of these buildings for their use in an emergency. To shed further light on this question of shelter availability, we conducted a survey of potential shelter owners asking them 4 questions, the most pertinent of which was whether they would admit people into their establishments during a radiological emergency at Seabrook Station. [The full survey, with responses, is included at Attachment 12 to this testimony].

Q. How did you perform the survey?

A. (Eckert) By mail, we conducted a survey of all the potential shelters identified in Stone & Webster's March 1986 and August 1987 studies. We took the names and addresses of the potential shelters from the two Stone & Webster reports, except for corrections discerned by Salmon Falls from its earlier work.

A total of three waves of mailings of the survey instrument were used to obtain responses. This procedure is standard practice in mail survey research and is generally conceded as the best method for increasing response rate (Dillman 1978). A questionaire was designed to ascertain: (1) if people were informed by either Stone & Webster or NH Yankee that their building was identified as a potential shelter; (2) if people felt that they had space that could be used as shelter; (3) if this shelter space was directly accessible from outdoors; and (4) if people would let beach-goers into their buildings if there was a radiological emergency. [See Attachment 12].

Statistical analysis was conducted in conjunction with Dr. Albert Luloff. The following variables were used in the analysis:

VARIABLE	DESCRIPTION
Town	Town Name
Area	Square footage of each shelter[a]
V1	Ques. 1 -- Were you contacted?
V2	Ques. 2 -- Do you have suitable shelter space?
V3	Ques. 3 -- Is space accessible from outdoors?
V4	Ques. 4 -- Would you let beach-goers in?

[a. Sq. ft. categories: 1=1-2,500; 2=2,501-5,000; 3=5,001-10,000; 4=10,001-high.]

Q. How many people responded to your survey?

A. (Eckert) Surveys were sent to owners of 233 shelters. Of these, 14 surveys were nondeliverable; 6 are actually second buildings of the same establishments, and 2 are private residences. As a result, following the work of Dillman (1978:50) the number of eligible respondents was reduced from 233 to 211. Using the procedures of a modified total design method (Luloff and Ilvento 1981; Christensen 1975; Dillman 1978), a response rate of 70% was achieved.

More than 4 of every 5 responses came from Hampton (124/152) with 28 responses coming from the other towns (4-North Hampton; 15-Rye; 9-Seabrook). Of the 146 potential shelters for which complete data exist, the average size is

7,458 ft^2 with a range from 600 to 109,860 ft^2. About 1 in 5 have less than 2,500 ft^2; 30% range from 2,501 to 5,000 ft^2; 30% range from 5,000 to 10,000 ft^2; and 1 in 5 are over 10,000 ft^2 (with 2 at 19,000; 2 from 22,000-23,000; 2 at approximately 50,000; and 1 at almost 110,000 ft^2).

Q. Can you summarize the responses?

A. (Eckert) Yes, the responses can be summarized as follows:

> QUESTION #1: Almost 9 of every 10 owners were not contacted by anyone about using their buildings as potential shelters.
>
> QUESTION #2: Only 1 in 3 indicated that they felt they had suitable shelter space.
>
> QUESTION #3: Just slightly more than half of the respondents (56.8%) indicated that their space was accessible from outside. Twenty-seven of the 152 possible did not provide a response to this question.
>
> QUESTION #4: Two thirds of the respondents indicated they would not let people into their establishments.

Q. Did you detect any relationships between the towns in which the respondents were located and the responses to the four questions?

A. (Eckert) We analyzed this separately for each question with the following results:

> QUESTION #1: No significant relationship was detected between the town in which respondents were located and whether they were informed that their establishment had been designated as a potential shelter, although proportionately more people in Hampton were contacted (11 of 16 contacted).

QUESTION #2: No relationship was detected between potential shelters with basements, stone or masonry walls suitable for shelter, and the town in which they were located.

QUESTION #3: Significantly more potential shelters are accessible from outdoors in Hampton than in other towns, however there are 3 times as many shelters in Hampton.

QUESTION #4: There is no statistically significant difference among towns regarding whether owners would let people in during a radiological emergency, although in towns other than Hampton owners are almost as likely to let people in as not. This infers that Hampton, which has the most shelters, is also the least likely to allow people in, i.e., is the most adamant against letting people in.

In addition, there were no significant relationships observed for potential shelter size and town, whether one had a basement or masonry walls suitable for sheltering, access from the outside, or whether people would let others in during a radiological emergency.

Q. Did you conduct any other surveys of the shelter owners?

A. (Eckert) Yes. Once the first survey was complete we sent another survey [included at Attachment 12 to this Testimony] to those owners of hotels, motels and cottages who had answered "yes" to Question No.4, that they would admit the people into their establishments during a radiological emergency at Seabrook Station. These owners were surveyed to determine their opinion regarding who has the right to allow the public into a rented room -- the owner/manager of the building or the customer who paid for the room.

Q. Why did you perform this second survey?

A. (Eckert) We wanted to know for those owners who said that they would admit people into their establishments in the event of a radiological emergency whether that meant that they would admit people just into the common public areas (such as lobbies, hallways, basements, etc.) of the building, or whether it meant that they would also admit people into the private rooms of the hotel/motel's guests. This is a significant question, because the vast majority of available public shelter space in Hampton Beach consists of rented rooms in hotels and motels.

Q. How many people were sent this second survey?

A. (Eckert) Nineteen of the original survey responses were positive in answer to question #4: "In the event of an accidental radiation release at the Seabrook Station, would you let people into your building?" All of these people were mailed our motel/hotel owner's survey instrument (at Attachment 12).

Q. What were the results?

A. (Eckert) Ten people responded as follows: One indicated that he questions the welfare of the beachgoing public, insurance liability, and driver availability for busses during an evacuation, and requested FEMA and NRC to remove his name from the list of potential shelters; 3 people indicated that it is the owner's right to determine who is admitted to rooms rented by customers; while 6 indicated that this right belongs to the customer (one of the respondents in this category also requested that her name be taken off the list, and another indicated that she would only let people in if she was the person who determined under what conditions, and who she would let in -- a very qualified yes).

The above responses from the survey of "Yes to entering" are very low in number (10) and therefore do not qualify for statistical analysis. The responses are important, however, because, until now, no one has obtained this type of information from the people closest to the situation.

Q. In summary, what conclusions can you draw about the amount of potentially available suitable sheltering space in the beach area within tne Seabrook EPZ?

A. (Goble, Eckert) There is clearly not enough suitable space available for shelter on summer days. Even considering the amount of additional space included in the Stone & Webster Revision I Study, there is not enough space in Seabrook, North Hampton or Rye to accommodate all the beach-goers in those towns. In Hampton Beach there is also likely to be a significant shortage of space, when one considers the unreliability of Stone & Webster's calculation of shelter space (as evidenced by the significant number of errors we located and the unreliability of the Tax Assessor information on which Stone & Webster's calculations were based) and the fact that two-thirds of the shelter owners who responded to our survey from Hampton stated that they would not allow the general public to shelter in their buildings. On top of that, one must consider that the vast majority of the space identified by Stone & Webster for shelter in all these towns is not suitable for sheltering.

Q. Why is the space not suitable?

A. (Goble) The criteria used in the revised Stone & Webster Study for selecting shelter space is that it provide a .9 cloud shielding factor. Space with only a .9 shielding factor is not suitable for protecting a population exposed to substantial amounts of radiation, and it would not be appropriate for the State of New Hampshire to recommend the use of such shelter in an emergency.

Q. Why do you say a .9 protection factor is insufficient?

A. (Goble) There are several reasons:

i) this is pretty much a consensus view within the expert community. Stone & Webster expressed this view in the 1986 version of its Study when it asserted (at page 3 of the Study) that "wood frame buildings without basements were not included because this type of building usually does not provide adequate shielding." The protection provided by structures with .9 shielding is even less than Aldrich, et al. have assumed would be provided the average person at other sites in the country even if no protective action was recommended. (Aldrich, et al., Feb. 1978)

ii) a ten percent reduction in potential exposure is very small compared to variations in exposure for even slight changes in conditions: as you move from one location to another, around a street corner, or 200 yards toward town from the beach for instance. A simple observation is that 10% of a six hour exposure is only 36 minutes. Any elongation of the time of exposure by more than a half hour because of an implementation of sheltering would use up any of the small benefits provided.

iii) a ten percent reduction in potential exposure is very small, as well, in comparison to the variation between people in their response to radiation. This is particularly pertinent in the case of severe radiation exposures which may cause early injuries or deaths and for which there appear to be relatively sharp thresholds below which such harm is unlikely. A sheltering strategy that is based on 50% or so reductions in exposure is very much more likely to encounter conditions in which a substantial number of people are kept below such thresholds than would be the case for a strategy based on 10% reductions.

Q. Can the use of .9 shielding factor shelters cause harm in an emergency situation?

A. (Goble, Renn) Yes. There can be serious radiological consequences to a person who selects a poor shelter compared to a reasonable shelter. There can also be problems if members of the public substitute their judgment of what constitutes suitable shelter for that of the State: many of the buildings included in the Stone & Webster Study differ strongly from people's perceptions of what a shelter ought to be and individual judgments about what would serve as shelters might seriously limit the implementation of a sheltering strategy. In addition, when it becomes public knowledge that the utility and the State plan to recommend shelters which provide only a 10% reduction in exposures as the emergency response to potential nuclear accidents, it is possible that the credibility of these institutions as sources of information in an emergency will be seriously damaged.

Q. The State of New Hampshire stated in its February 11, 1988, Response to FEMA Supplemental Testimony (Enclosure 1, at p.2) that it did not want to rely on a sheltering strategy for the beach population because it could not be relied upon to be "implemented quickly." Do you agree that this would be a problem?

A. (Goble, Renn) Yes, as we stated earlier in this testimony, the benefit of sheltering as a protective measure versus evacuation is that in most cases sheltering can be implemented quickly -- prior to plume arrival. Any benefits to be derived from sheltering (especially in the poor-quality shelters located in the New Hampshire beach area), however, would be severely undermined if the strategy could not be implemented prior to plume arrival.

Q. Do you agree with the State of New Hampshire that it would be difficult to implement a sheltering strategy in the beach area in a timely manner?

A. (Renn) Yes, we would agree with the State that moving people into shelters in the beach area would be akin to "'evacuating' to a shelter." As the State noted in its Response to FEMA (at page 2),

> "this action would require forming family groups or social units prior to moving, deciding whether to seek shelters or evacuate spontaneously, choosing a mode of transportation (i.e., walk or ride), seeking a destination (i.e., home or shelter), and undertaking the physical movement."

Without any plans in place to implement sheltering in the beach area, we estimate that it could take as long to shelter the beachgoers in the Seabrook EPZ as it would to evacuate the EPZ around most other sites.

Q. What are your time estimates for people to take shelter?

A. (Renn) First, I should explain that the calculation of time estimates is almost impossible to perform, at least based on objective and empirically reliable data. A thorough literature review demonstrated that there is not a single case study where a large non-resident population was ordered to seek shelter in an actual emergency situation caused by a technological hazard. Furthermore, in the absence of specific plans for sheltering the beach population, it is difficult to make direct comparisons with analogous situations. Therefore, our time estimates are based on:

- review of studies of natural hazards;

- Dr. Lulolff's beach survey'

- the behavioral analyses of TMI and other nuclear emergencies;

- general psychometric studies on risk perception; and

- common sense (when all other sources failed);

We tried to use these sources in a complementary way, substituting each source with another when the evidence seemed weak or vague (for example, in drawing conclusions of actual behavior from behavioral intentions). In spite of our effort to make the best use of the given sources, the estimates are still subjective judgments. Our calculations resulted in three time estimates: an optimistic estimate of one hour and forty minutes, a pessimistic estimate of four hours and 35 minutes and an average estimate of two hours and thirty eight minutes.

Q. Even the optimistic estimate appears to be quite high. Why should it take so long to shelter people?

A. (Renn) The main reasons for the time delay are (1) the ambiguity of the messages instructing the population to shelter; (2) the average time-distance between the beach population and available shelters; (3) the lack of labels for shelters; (4) the time required to search for shelters that conform to people's perceived image of a good shelter; and (5) counteracting altruistic behavior.

Q. Could you explain those factors to us? Why do they delay the time it would take to shelter?

A. (Renn) Let's begin with the message. The beach public address shelter message orders the beach population to leave the beach and to go indoors immediately. The corresponding radio message contains hardly any more information. It states: "Go to a nearby building where you can take shelter until advised by this EBS station that instructions have changed." Persons listening only to the public address system (only fifty percent of the beach population take a radio with them to the beach, according to the Luloff Survey) may assume (especially if English is not their native language) that "indoors" may also include inside one's car. Time is needed to ask other people about the meaning of the message.

Even for those who receive the radio information, however, the content of the message is ambiguous. Are there specified buildings designated as shelters? Should I go to the basement or is it sufficient to enter any available house? People in emergencies are not likely to guess, but will communicate with others about the meaning of the messages. This usually consumes a considerable fraction of time.

Q. What about the average distance between the beach population and shelters? The shelters in most areas seem to be rather close to the beach. Why do you think it may take a long time for the beach population to reach shelter?

A. (Renn) Although most shelters are in a walking distance of less than 15 minutes, some shelters are as far as 20 to 30 minutes away from the most remote beach area. One should keep in mind that those shelters nearest to the beach will be filled by the people who arrive first, while the beach population further away will have to find shelter in the buildings that are more remote. Furthermore, these latter people will first try to find space in the nearby, but already filled, buildings and only then will they be advised to find shelter somewhere else.

If we assume trial and error to find shelter and conclude that the best available shelters will be filled first, the average person has a chance of around 1 out of 10 to find shelter on his or her first trial after fifty percent of the beach population has already been placed in one of the shelters. Since a reasonable person will seek shelter closest to the beach and may share the same image of a good shelter as all the other people, the probability of finding available space in a shelter will only gradually improve for each trial.

Q. You also mentioned the image of shelters. In what way do images of shelter impede the process of finding shelter?

A. (Renn) Risk perception studies demonstrate that most people are convinced that a normal house will not provide adequate shelter to protect against radiation. They will look for "bunkers" obviously designed for nuclear emergencies. Hotels and restaurants and, to an even greater degree, private homes will be seen as weak protection. Consequently, either a late spontaneous evacuation or a desperate search for the "real" shelter will occur.

Q. Do you think that labelling shelters would be helpful? How will the fact that the NHRERP makes no provision for labelling shelters affect the beach population's ability to locate shelters?

A. (Renn) It would definitely help to have shelters labelled because this facilitates the process of orientation and distribution among shelters. Even well-informed and calm individuals will have a hard time accepting the fact that any building is as good as any other for protection. In addition to having specific images of shelter, most people will be searching for optimal protection, and thus will concentrate on buildings which seem to offer the best perceived protection. Obviously those buildings will soon be congested and newly-arriving persons will have to be sent to the second-best places. In essence, labels are very important to the implementation of sheltering for the following reasons:

- Labels will enable people to be certain that they have finally reached a shelter and will help reduce their feeling of uncertainty over whether a particular shelter will provide protection. Otherwise, people may decide that better, or other clearly-designated, shelters may still be available and leave the original shelter to search for those better ones.

- Labels will reduce trial and error and will also reduce the likelihood of confusion and panic.

- Labels will increase public confidence that sheltering provides protection and may help overcome the preconceived image of what a shelter should look like.

- Labels will make it less likely that owners or managers of shelters will refuse beachgoers access to their buildings.

Without labels, implementation times and access times will be considerably higher.

Q. You mentioned altruistic behavior as a factor affecting time delay. It would seem to us that the more people behave altruistically, the better and faster sheltering should take place. Could you explain this apparent contradiction?

A. (Renn) As many studies have demonstrated, altruism may be counter-effective if the volunteers do not know how to properly cope with the hazard. Confusion is likely to occur when competing advice and recommendations are given and when the goals of the rescue operation are unclear. Many individuals will perceive the situation as a unique chance to demonstrate their own ability for leadership and heroism and will offer their own guidance to groups of confused people. We expect that those self-appointed leaders will give ambiguous and contradictory advice to others and that they may compete later on with official emergency workers when, and if, they arrive at the scene.

Q. I would like to come back to your time estimates. Could you explain in more detail how you modelled the time estimates?

A. (Renn) Certainly, the most effective approach to modelling time periods for emergency behavior is to subdivide those periods into specific behavioral components. The literature of disaster management contains a wide variety of phase models going back to the classical four phase model by Carr (1932) and including complex three dimensional models such as that of Dombrowski (1983.) A review of models has been compiled by Stoddard (1968). Miletti, in his testimony, does not use a specific model for time estimates, but relies on the simple pre-action sequence of "hear, understand, believe, personalize, decide, response" for which he does not specify time requirements (p. 155).

For our purpose, a modification of the Janis five-stage model is most appropriate (Janis 1954). KLD uses a similar, though less differentiated model in the NHRERP evacuation time estimates. The six stages are:

a. <u>Notification Time</u> -- the time between the decision to order protective action and the actual announcement and the physical recognition by individuals that protective actions are needed. The notification time should not exceed 15 minutes for the five-mile emergency zone but in reality may be longer. (Sorenson and Vogt 1987).

b. Recognition Time -- the time between the announcement and the recognition by individuals that the announcement is meant for them and for them to understand what kind of protective actions they are advised to take. The six step sequence that Miletti proposed may fit well into this category (hear, understand, personalize, decide, respond).

c. Preparation/Securing Time -- the time needed for preparing protective actions, finishing ongoing activities and securing property.

d. Orientation Time -- the time needed to find out what kind of action is required and where to go. Orientation may occur simultaneously with recognition, but before engaging in any activity, individuals tend to reconfirm their action and may ask for additional information.

e. Implementation Time -- the time span between starting the protective action (motion to find shelter, for example) and reaching the desired safety area (arriving at the final shelter)

f. Access Time -- the time between arrival at the designated safety area (shelter) and actual accommodation within it, including the process of entrance and allocation of space.

Taking into account the delay factors that I just mentioned and based upon a set of assumptions, we calculated the following time estimates for each stage of the sheltering procedure:

TIME	MINIMUM	MAXIMUM	MEDIAN
Notification	10	15	12
Recognition	5	10	7
Preparation	15	20	17
Orientation	10	20	12
Implementation	45	180	90
Access	15	30	20
SUM	1:40	4:35	2:38

The sum of the time segments vary between one hour and forty minutes and four hours and thirty-five minutes. The median value is two hours and thirty-eight minutes.

Q. You mentioned a set of assumptions that underly your judgment. Could you please elaborate on those assumptions?

A. (Renn) For our analysis we defined a hypothetical situation at Seabrook which was specified by the following set of assumptions:

- a peak population of 60,000 to 100,000 in the overall beach area need sheltering;
- 25 percent of the population will evacuate spontaneously (conservative estimate);
- adequate sheltering capacity is available at least for 90 percent of the remaining beach population;
- the facilities for notifying people are effective and the messages can be heard by everyone; and
- weather conditions are favorable for locating shelters

We assumed that shelters were not labeled, since the NHRERP makes no provision for labelling shelters in the EPZ around Seabrook. Adequate shelters mean, however, that enough physical space for each individual is available and that the entrances to shelters are open and that owners of shelters do not refuse entrance to persons who seek entrance.

Q. Why did you construct a hypothetical situation and not rely on the actual situation?

A. For our study we assumed that the time estimate comprises the cumulative time period until ninety percent of the shelter-seeking population have actually found shelter. There is considerable doubt as to whether enough shelter space is available for ninety percent of the population, at least on peak beach days, so that our time estimates would be indefinite if more than ten percent of the population were not able to find shelter regardless of how hard they tried. In addition, we are not sure whether the owners of shelters will provide access to their buildings for the beach population. Again, we had to assume that they will provide access in order to fulfill our criterion of complete sheltering.

Q. Is this a real possibility that owners of shelters would refuse to let people into their buildings?

A. It is difficult to predict what the owners of potential shelters will actually do in case of an emergency. In the literature, hardly any assessment can be found for the option of sheltering with respect to technological hazards. Quarantelli collected different case studies of sheltering in a report of the Disaster Research Center (1982), but the conclusions drawn in this report apply to natural hazards and the willingness of residents to offer shelter to disaster stricken neighbors. While the surveys of the beach-area shelter owners may therefore provide the best indication of what these people would do, the general notion is that people may voice a negative opinion in an opinion poll but still not refuse to give shelter to other individuals if a real disaster occurs. Nevertheless, the Seabrook case contains some specific problems that would justify a deviation from this rule.

Q. Could you mention some of the problems?

A. First, the data from Quarantelli and others were collected for natural hazards in which the affected individuals sought help from their neighbors or other local residents. The degree of familiarity with another person strongly influences whether a person will help that other person. In the Seabrook situation, the beach population is not known to the shelter owner and the anonymity of the mass of people may prevent the compassion that is normally found among voluntary assistants.

Second, surveys of the shelter owners revealed an unexpectedly high degree of verbal refusal to grant access to their buildings. More than fifty percent of those surveyed were not willing to host people from the beach in the case of an emergency. Although we know that verbal refusal is not a good predictor of actual behavior and that the refusal to cooperate may also be a symbol for expressing opposition to the Seabrook plant, the surveys do evidence a strong commitment among the owners not to cooperate with the utility and not to participate in any emergency plan and also evidence a lack of trust in the utility. Thus, the moral obligation to help others may be counterbalanced by the moral commitment not to cooperate with an institution that is regarded as detrimental to the community. In addition, this lack of trust indicates that owners may be less willing to trust emergency messages indicating that shelter will provide the best protection and will choose instead to evacuate when instructed to shelter.

Third, the same surveys indicate that around thirty percent of those interviewed stated that they would leave the area immediately if any kind of emergency were to be declared. This is a reasonable response considering the fact that the first ones to leave will be the first ones to be out of the EPZ. It is unrealistic to assume that those shelter owners who choose to evacuate will nevertheless leave their doors open to host the beach population. They would seek instead to protect their property, and the commercially valuable goods stored inside, by locking their doors.

Fourth, because of the pre-conceived image people have of "radiation" shelters, masses of people may try to get into the same shelter. This creates a frightening situation whereby owners may decide to keep their doors closed in order to avoid panic or over-congestion. In the survey, several owners expressed a conflict between protecting their employees and families and opening their doors to the beach population.

Fifth, it is still unclear in what way the perception of radiation will interfere with people's willingness to offer shelter. We know from perception studies that people believe radiation to be contagious if somebody has been exposed to it. Similar to the Aids cases, where help has been refused due to fear of contraction, one may hypothesize that access to shelters will be refused out of fear of becoming contaminated or, perhaps more importantly, out of fear that their own families, children, employees, and patrons of their hotels/motels will become contaminated if they let others in.

Sixth, owners of shelters may have the same preconceived image of what shelters from radiation should look like as most of the rest of the population have and, therefore, they may advise the people seeking shelter to evacuate rather than shelter, based on their own perception that their building does not provide any real protection. This will be particularly the case if the owners plan to leave the area themselves, and also if the owner is aware, as many of them are, apparently, that his or her building will provide only a ten percent reduction in exposure to radiation.

Seventh and last, Miletti and other disaster researchers have pointed out that compliance with emergency roles depends heavily on a clear assignment of this role and clear instructions beforehand of what the demanded role requires. Since the owners of the beach area shelters have not received any official notification, or any description, of their obligations as shelter providers, they will not feel obliged to play this role for which they are not prepared. This alleviates their moral obligation and makes it easier for them to leave the area or keep their indoors closed.

Q. You mentioned people's fear of being contaminated. Do you know of any situations in which people have actually refused to help others because of a fear of radiation?

A. (Renn) The situation that occurred last year in Goiana, Brazil is illustrative of the way people may act as a result of their fear of radiation. People in Brazil showed such a high degree of fear of the radiation-contaminated people that in some neighborhoods roadblocks were set up to prevent contaminated persons from entering, there were instances of persons refusing their own relatives access to their homes and other instances of people refusing to bury or to allow the burial of contaminated bodies in their towns. (Science Magazine, Nov. 1987).

Q. Do you think that, due to the difficulty of finding shelter and other considerations pertinent to the Seabrook beach population, panic reactions will occur that may further impede the sheltering action?

A. (Renn) Contrary to popular belief, natural and technological disasters are not usually accompanied by panic or total confusion. This was observed early on for natural hazards (Wallace 1956, Wolfenstein 1957, Form and Nosow 1958) and verified later for technological hazards (Wenger and Parr 1969, Quarentelli 1979, Tamminga 1980). Two exceptions to this .'e may be important in the case of sheltering the beach population. If people perceive that there is too little time to save themselves, they may lose control over their actions (Tiryakian 1959, and K:ilian 1952). If people are compressed into too small an area, normal concern for other people may totally disappear (Bahne-Behnson 1964, Form and Nosow 1958). This latter situation would pose a serious threat if a bottleneck develops at access points from the beach, or possibly if shelters become seriously overcrowded. The coincidence of a perception that time is running out and of a critical concentration of population at the beaches may well lead to panic resulting in further time delays and unnecessary damage.

Other factors which may promote panic are the lack of visibility of the hazard (Renn 1981, Lifton 1967), separation of family or primary group members (Tiryakian 1959), distrust of rescue organizations (Perry et al. 1981), distrust of authorities (Thompson 1967, Kates et al. 1973, Green 1977), lack of social cohesion (Dombrowski 1983), and uncertainty about the nature of the protective action (Moore 1956). Most of these features are likely to be present in the case of a nuclear emergency and need to be compensated for by planning activities that lead to clear instructions, prior knowledge about protective response in the affected population, and efficiency in the risk managing activities.

In most catastrophic situations, solidarity among potential victims will prevail over selfishness. (Wolfenstein 1957, Parr 1969, Forrest 1974). But, confusion is likely to occur when competing advice and recommendations are given and when the goals are unclear (Clausen 1983, Gray 1981, Drabek et al. 1981).

Emergency actions are more effective the more consistent the orders for them have been and the better prepared are the responding individuals (Form and Nosow 1958, Moore 1964, and especially the discussion of TMI by Martin 1980).

Responses in emergency situations differ considerably depending on the nature of the hazard. The dangers of natural hazards are usually underestimated; the dangers of technological hazards are overestimated (Perry et al. 1980, Grundfest et al. 1978). More important than differences in perception are differences in response; in most cases of natural hazards people have trust in the emergency agencies and evacuation studies have shown that the principal trigger to evacuate was the specific recommendation by public authorities (Perry et al. 1980). The response patterns in TMI revealed a reverse pattern. A similar situation is likely to occur to the beach population at Seabrook.

Q. What then would you expect would happen if there were an attempt to order sheltering on the beaches?

A. (Coble, Renn) The evidence on shelter space shows insufficient sheltering space on most of the beaches, including Seabrook beach, for any population estimates. Those spaces are divided among more than a hundred commercial and public buildings, which are scattered among hundreds of more unsuitable commercial, residential, and public buildings in the "strip" along Hampton Beach. Many of the identified spaces are difficult to enter, with circuitous routes through other non-suitable space. There is little or no indication that any of the owners or managers of the sheltering space are prepared for its use as a shelter or would know what to do about granting people access or where they should be accommodated. No sheltering space is labeled as suitable for shelter, so the public will not be able to tell whether or not it is effectively protected from radiation. Thus, in the event of an order to the beach population to seek shelter, what must be expected is that many people will find themselves in unsuitable sheltering space; many people will be blocked, perhaps several times, from entering shelters because the shelters are already full, because of bottlenecks in the access routes, or because of confusion by managers of the space as to what they should do. The small number of emergency workers who might be present, who have not been prepared for this situation, would be totally overwhelmed, and there will be large crowds of upset and confused people milling around outside unprotected.

Q. Can you summarize your assessment of the adequacy of the New Hampshire plans with respect to sheltering?

A. (Goble) By almost any standard, the performance to be expected under the New Hampshire emergency response plans in the event of a rapidly developing severe accident with a substantial flow of radioactive material toward the beaches on a summer day would be dismal. Attempts to achieve sheltering, either by the authorities, or spontaneously by the affected population, is likely only to make the situation worse.

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In the Matter of	)	
PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE, ET AL. (Seabrook Station, Units 1 and 2)	)	Docket No.(s) 50-443/444-OL

CERTIFICATE OF SERVICE

I, Allan R. Fierce, hereby certify that on May 3, 1988, I made service of the within Errata and Corrected Testimony of Robert L. Goble, Ortwin Renn, Robert T. Echert, and Victor Evdokimoff on Bahalf of the Attorney General for the Commonwealth of Massachusetts on Sheltering Contentions, by mailing copies thereof, postage prepaid, by first class mail, or as indicated by an asterisk, by hand delivery to the NRC Hearings in Concord, New Hampshire:

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