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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

Before Administrative Judges:
Helen F. Hoyt, 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) September 14, 1987

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

Department of the Attorney General
Commonwealth of Massachusetts
One Ashburton Place
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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 circulumum 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 as 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 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, 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 those 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. In comparing sheltering capacity to the documented estimates of the population on peak summer days formulated by other experts' testimony in this proceeding, we estimate that there is space to shelter only 25-30% of the 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. In addition, even if the capacity did exist, there is no indication that the owners of the shelters would allow the public access to their buildings for sheltering. 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.

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 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 DURACTION 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.

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 (2 - 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) puff 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. 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. 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), included for convenience in Attachment 6 to this testimony, 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.

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:

--<u>decision criteria</u>: 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;

--<u>sheltering space</u>: 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;

--<u>notification and direction</u>: 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 7 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 8 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 Boulevard, the "lettered" streets between Ashworth and Ocean Boulevard and finally the area off

Ashworth. Most of the streets in the area were surveyed. <u>See</u> Attachment 10. 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) No. 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.

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, I was able to enter and inspect ten 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 appeared to be in better condition. All of these cottages are small. Typical dimensions 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 ten 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 at 136 Ashworth, and a two-story on 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 on the corner of J. St. was structurally similiar to the one-story units -- wood framed with no basement -- but had storm windows and was in good condition.

Six 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 or four cottages, two had storm windows, and one of the two-story cottages at Ashworth and J Streets was 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 10. 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 catagory 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 inhalationon 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 Hampson 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 occuring 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 would 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 accomodate 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 accomodate?

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 accomodate 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 (See Attachment 11 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 12 to this testimony). We started with this study to determine whether sufficient sheltering capacity exists in the beach area for the indicated population.

Q. Can you be more specific as to the types of buildings included in the 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 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 9 hereto).

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

A. (Goble, Eckert) 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:	4500-9000 persons
Hampton:	14,200-28,400 persons
N. Hampton:	75-150 persons
Rye:	4350-8700 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.

Q. Is this enough shelter space to accomodate 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 shelter capacity	Weekend Population by beach area
Seabrook	4,500 - 9,000 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 report 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) No. A "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, where approximately 1/3 of the space was 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 13 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 13 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 explict 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 estimates, 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 estimates 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 13, 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 footage -- or 3,201 fewer people @ 10 square footage each) than that estimated by Stone & Webster (see Attachment 13, 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 is greater tnan zero. The Wilcoxin test results indicate that we can be more than 99% confident that Salmon Falls and Stone & Webster 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 Surcey Motel all had wood frame or wooden-walled areas 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 sheltering space potentially available in the beach area?

A. (Goble) We summarize the results in the Table below showing the corrected estimates of 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 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	5,400
TOTAL	11,950 - 23,900	70,500	35,000

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, 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" and remain in it for hours.

Q. What does the Salmon Falls survey 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.

The question of whether owners/managers would let people into shelter space in an emergency was not addressed by Stone & Webster. Of the 23 owner/managers, Salmon Falls contacted, only one thought he remembered any contact by Stone & Webster or New Hampshire Yankee regarding use of their space as a potential shelter.

Q. How will people behave if asked to shelter?

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 rule 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 Killian 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. 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 Nowow 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 a attempt to order sheltering on the beaches?

A. (Goble, 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 accomodated. 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 uprotected.

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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