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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

September 2, 1983

MEMORANDUM FOR: R. C. DeYoung, Director/IE
H. R. Denton, Director/NRR

FROM: William J. Dircks
Executive Director for Operations

SUBJECT: SHOREHAM COMMISSION REPORT

Attached is a first cut suggested draft of the introduction to the report of the Shoreham Commission established by Governor Cuomo. It was prepared by John Marburger, the Chairman of the Commission. Dr. Marburger frankly admits that it reflects his point of view.

Please review the report quickly to identify any factual errors.

I would appreciate you getting a marked up copy of it back to me by mid-day next Tuesday, September 6. Please don't feel you have to provide detailed comments. Brief comments and corrections are all I need.

Bill
William J. Dircks
Executive Director
for Operations

Enclosure
As stated

D/8

DRAFT

DRAFT INTRODUCTION TO SHOREHAM REPORT

John Marburger......................... August 1983

The Shoreham Nuclear Power facility is the focus of an extraordinary and debilitating controversy in the two eastern counties of Long Island. Of the hundreds of questions raised about it during the fifteen years since it was first conceived by the Long Island Lighting Company, there are three basic ones that now demand resolution.

1. Should the Shoreham facility, now essentially complete, be allowed to operate?

2. Whether it operates or not, who should pay for it?

3. How will these questions be answered?

That such questions should be voiced at all is extraordinary. There is no precedent for the abandonment of a $3.4 billion facility that produces a useful commodity. There is usually no doubt in the utility industry about who should pay for what. And the decision-making structure for deciding these issues has seemed until now very well defined.

The reason these questions are being taken seriously is that those asking them know that they will suffer financially as a result of the usual decision making process, and many of them believe in addition that their health and that of their descendants will be endangered if the facility operates. They see the Shoreham plant as having been thrust upon them unnecessarily by a profit seeking entity, and they are attempting to deflect its consequences through the power that they believe they should have in a democratic society. They believe that their elected leaders should heed their concerns and alter the normal processes, if necessary, to abort the certain financial impact and the possible health impact to which those processes appear to be leading.

The governor's fact finding panel was formed to disentangle and clarify the issues contributing to the Shoreham controversy, and thus to assist the governor in choosing a course of action for the State of New York. In performing this task, the Panel must attempt to distinguish between what the various parties assert, and what is actually the case. That is unfortunately not an easy task. It is complicated, first of all, by the universal tendency of those who seek an end to advance all possible arguments toward that end, regardless of the quality of the argument, and secondly by the fact that, while most assertions are about what will happen in the future, the future is very difficult to predict.

It was certainly the difficulty of predicting the future that lead LILCO to embark upon and then pursue the course that will lead to the highest electricity rates in the country for its consumers. No one anticipated the oil crises of the '70s and the rapid global realignments of industrial activity that brought regional growth to a halt while the power plant that was to serve it was under construction. And no one predicted either the fact or the consequences of the accident at the Three Mile Island nuclear facility, an incident that contributed enormously to the direct costs of the Shoreham plant and to the uneasiness of its neighbors.

The difficulty of predicting the future weakens the usefulness of the most common criterion for public action: choose the course that brings the most benefit to the most people. Utility planning extends over such long periods of time that benefit assessments are unreliable in the extreme. All that can be done is to assume that the future will be much like the present and the immediate past and make the best guesses that one can.

In the natural sciences, prediction is more reliable and better defined than in economics, but it is also a more technical concept. Scientific prediction is nearly always statistical prediction, whose accuracy depends upon the weight of experience and the completeness of the predictive model. And yet there are great laws of science, exceptions to which have never been observed. The mix of certainty and uncertainty in science is a source of confusion to a public whose view of science is idealized. Much of the debate over the safety of nuclear power plants in general, and Shoreham in particular, centers upon the significance of a wide variety of statistical predictions.

The broad issues of economics and safety affect each other to some extent, but can be analyzed separately. The time of the Panel was divided between these topics, and our report will also treat them separately.

DRAFT SHOREHAM REPORT: INTRODUCTION ON SAFETY

John Marburger........................August 1983

BASIC FACTS ABOUT NUCLEAR POWER

The nuclei of all atoms heavier than hydrogen are held together by a strong force that overpowers the electrical repulsion between the charged protons within the nucleus. The electrical repulsion is greater in heavier nuclei, and causes the heaviest of them to be unstable: they can fall apart, or fission. Adding an extra neutron to such a nucleus induces it to fission faster than it would by itself. Among the products of the fission are two large pieces, which become the nuclei of two lighter atoms, and two neutrons, which can induce more fission in neighboring heavy nuclei. (Figure 1)

The whole process releases radiation, and expels the fission products forcefully. This is the primary source of the heat energy that is used in all applications of nuclear fission. Fission occurs naturally, and is responsible for some of the internal heat of the earth. It is not the process that creates the heat of the sun, that being derived from the opposite process of fusion wherein small nuclei are crushed together under the sun's immense force of gravity.

Nuclear reactors use the energy released by fission to make steam which then drives a conventional turbine to make electricity. The reactor thus simulates the much larger furnace of the earth in geothermal power generation. A boiling water reactor consists of an array of tubes containing the very heavy element uranium interspersed with control rods containing a light material (boron) that is known to absorb neutrons. When the control rods are fully in place, they inhibit neutrons arising from spontaneous radioactivity from inducing fission, and the core of rods and tubes is cool (before the reactor starts for the first time). As the rods are withdrawn, fission occurs in the region of fuel they leave behind, and the fuel heats up. (Figure 2) Water circulating among the rods and tubes boils and turns to steam which is then used to make electricity.

Before the fuel tubes are stacked in close array and the control rods withdrawn, the fuel is not very radioactive. If it were, it would not have been available in geological formations to mine from the earth. (It would have decayed through radioactivity to less active elements.) In the reactor core, the fission process is accelerated by the presence of the neutrons emitted from nearby fuel. As they leave a fissioning nucleus, however, the neutrons go too fast to be trapped efficiently by surrounding uranium nuclei, and must be slowed down, or "moderated". This is accomplished in the Shoreham reactor by the water that circulates through the core, the same water that also cools the core and boils into the steam that turns the generator. The hydrogen atoms in the water are very light and bounce away when they are struck by neutrons, so the neutrons go more slowly after a collision. The important consequence is that the induced fission process shuts down automatically if the water leaves the core.

The fission fragments are much stronger radioactive emitters than the fuel itself, and are an important source of heat (called "decay heat") in the region of the fuel that has been exposed by withdrawing the control rods. They cause the recently spent fuel to remain hot, and would generate about 6%, or 150 MW, of the 2500 MW of heat that the Shoreham core would produce in full operation. Because this heat is generated even when the induced fission is turned off by the control rods, it is necessary to keep the coolant water circulating when the core is shut down. Otherwise the heat would build up and damage the components of the core. This is why it is essential to have emergency power available when the plant is shut down: the coolant water must be pumped through the core to carry away the ever-present residual heat from the fission fragments.

The neutrons emitted during fission act not only upon the fuel, but upon other surrounding matter as well, sometimes rendering its nuclei radioactive. The fuel comes in pellets of very pure uranium oxide stacked in sealed tubes of zircalloy. The uranium comes predominantly in two species (isotopes) differing only in the number of neutrons in their nuclei. The lighter isotope, U-235, is the one that participates in the induced fission process. It is very rare compared with the heavier U-238 and must be enriched from its natural fraction of about 0.8% to about 2% for the Shoreham reactor. The nuclei of U-238 do fission, however, when exposed to the fast neutrons from the U-235 fission and their fragments contribute to the inventory of substances in the spent fuel. U-238 can also be converted to plutonium-239, which could be used in nuclear weapons. The oxygen in the uranium oxide is also transformed temporarily into the intense radioactive emitter nitrogen-16, but half the nuclei so transformed become normal oxygen again after about 7 seconds. The fission fragments within the spent fuel are very diverse, but can be grouped as shown in Table 1.

Outside the fuel rods, the neutrons can interact with microscopic traces of uranium which might still cling to invisible pores and crevasses on the surfaces of the zircalloy tubes where it escaped the cleaning processes during manufacture. Such small amounts could not ordinarily be detected. Only their radiation reveals their presence. But this material can be induced to fission, and a portion of it, virtually undetectable, could escape into the cooling water. The water itself has oxygen atoms whose nuclei can be turned for a few seconds into nitrogen-16. Water also has small amounts of an isotope of hydrogen (deuterium) which can absorb a neutron to become tritium, a radioactive form of hydrogen with a half-life of 12 years. The usual hydrogen isotope can absorb a neutron to become deuterium, which is not radioactive.

Some reactors use water with artificially enhanced concentrations of deuterium (heavy water) because it is a poor neutron absorber and moderates well without removing neutrons from the core. Because fewer neutrons are lost to the water, the fuel requires less enrichment. And since it is much easier to make heavy water than to make enriched uranium, heavy water reactors can be economical. In operation, however, their primary coolant water contains much more tritium than in light water reactors, whose water contains only trace amounts of tritium.

The circulating water can also carry traces of metals from within the core structure that have been rendered radioactive by the neutrons from fission within the core. Metals are not very soluble in water, so the concentrations are very small, but the solubility is greater at high temperatures so whatever is dissolved in the core will "plate out" on cooler surfaces that the water touches outside the core. This serves to transfer traces of radioactive metal isotopes from the core region. One such metal, cobalt, has a radioactive form with a half life of 5 years. It is present in the water only in trace amounts, but can build up on turbine parts, for example, making its removal necessary before hands-on maintenance.

The coolant water also contains air which is sucked into the primary circulation system through inevitable microscopic pores in the low pressure part of the system. Air contains trace amounts of the chemically inert (noble) gas argon which can be made radioactive by exposure to neutrons. The radioactive form, argon-41, has a half-life of about 2 hours. This air must be removed from the system because it changes the hydraulic and thermodynamic properties of the water and reduces the efficiency of the generation process.

All the processes described above are well understood because the emissions of radioactive substances are easily detected. This situation is in contrast to the study of chemical reactions where the effects of active compounds are often difficult to unravel because the chemicals are so difficult to detect in trace amounts. In fact radioactive tracers are widely used in manufacturing and medical applications to tag chemicals so their actions can be followed more easily.

NUCLEAR HEALTH EFFECTS

Safety concerns arise because emissions from radioactive materials adjacent to living things can penetrate cells and disrupt the complicated molecules that regulate cell functions including replication. If a cell manages to replicate itself with a damaged structure, it may form a cancer. Observation of survivors exposed to radioactive°fallout from the nuclear fission weapons employed against Nagasake and Hiroshima indicate that there is a relationship between exposure to radioactive materials and incidence of cancer. Compared with chemical effects, radoactive emissions affect living cells in a crude way. The penetrating forms of radiation simply zip through tissue disrupting the cell material. If a single cell gets bombarded often enough this way, it will die. If it gets bombarded just once, it will usually survive. Very large doses of radiation can damage enough cells to impair body functions, whether the cells replicate or not, causing short term radiation sickness and perhaps death.

Radiation doses in units of rems (Radiation Equivalent Man) associated with general health effects are shown in Table 2. No harmful effects have been observed from whole body exposures less than 10 rem. Naturally occurring background radiation is about 0.08 rem per year. The average United States citizen receives about 0.18 rem per year. Because there is always a chance that the trajectory of even a single particle expelled in a radioactive decay can pass through a critical component of a critical cell, it seems reasonable to suppose that some fraction of naturally occurring cancers and genetic defects are initiated by background radiation. Thus, although no direct health effects have been observed for very low levels of irradiation, one might infer their existence by extrapolation from the effects seen at higher levels. There is controversy about how to do this, some suggesting that the effect is proportional to the dose, others suggesting that it is proportional to the square of the dose. The latter gives much smaller effects for low doses, and would be appropriate if two radiation events in sequence rather than one were required to lead to a health effect. Using either approach, one may infer a health effect from existing background levels, and from even small increases in background.

It is important to realize that radiation is not a particularly efficient cause of cancer. If it were, life as we know it could not have evolved on earth. Naturally occuring radiation like that emitted by radioactive materials bathes the earth with a "background" that varies with location and time. The background radiation penetrates about one third of the cells in our bodies each year. Our cell mechanisms are known to have a high degree of redundancy and systems for repairing various forms of damage, and these presumably evolved to stabilize cell reproduction against such disruption. Many of those concerned about the safety of nuclear reactors, however, believe that even small additions to the background radiation are unacceptable. Those who do believe small additions are acceptable compare the added risk with risks of other life threatening events and processes that our society currently accepts, many of which are very much greater than the low level radiation risk from normally operating nuclear power plants. Their opponents respond that many of those risks, such as driving, smoking and airplane travel are elective risks, whereas low level emissions from nuclear power plants, small as they may be, cannot be avoided by personal choice.

The great concern is that an accident will release significant amounts of radioactive material into the environment. Because the fission products remain radioactive for very long times, from seconds to hundreds of years, they can have effects disproportionately large for their relatively small amounts. Before they cease to emit radiation, they can be concentrated through biological mechanisms to lodge in organs of the body that then receive much larger quantities of radiation than the average for the entire body. Two such organs are the thyroid gland, which concentrates iodine, and bones, which concentrate strontium and whose marrow generates components of the blood.[o] Radioactive elements that are not concentrated in this way, such as the so called noble gases, have a much smaller effect on living things. In our subsequent discussion, we will focus first on the dispersal of the highly radioactive fission fragments, and then on other radioactive materials associated with nuclear power plant operation.

ACCIDENTS RELEASING RADIOACTIVE MATERIALS

Since health hazards are caused by radioactive substances originating in well-defined places within nuclear reactors, we must ask how they can get out from their usual places in the interior of the sealed containment building into the human environment. One way, certainly, is for them to be removed deliberately when the fuel within a tube is spent. The handling of this "nuclear waste" requires great care, and is a major focus of concern about nuclear power. It is necessary to unload, transport and store this material without releasing it into the environment. Elaborate procedures have been devised to accomplish this, but it is not an area that the Panel investigated extensively. The consequences of an accident in handling spent fuel would seem to be far less severe than one during reactor operation. The fuel is not transported until the most active fission fragments have decayed. The residual decay heat is generated at a low enough rate that relatively simple means can remove it. The spent fuel rods would not be transported all at once, so the total amount of radioactive material is much smaller than that in the core of an operating power plant. The material being transported is solid so that even if by some extraordinary accident its massive steel transport case were to rupture, no spent fuel could spill and disperse. Most importantly, the waste does not carry with it any inherent mechanism to damage its containment similar to that of the decay heat in the reactor core material. Of much greater concern are accidents that release fission products as vapor to be dispersed over the vicinity of the plant.

Another process in which radioactive material is deliberately released from nuclear power plants is the venting of air that has been inadvertantly sucked into the primary coolant system. As described above, this air contains trace amounts of argon, some of which gets transformed into the radioactive noble gas argon-41 by neutron bombardment within the core. Any other gas in the coolant water is also vented in this process, including any gaseous fission products that may have escaped through microscopic pinholes in the tubes containing the fuel pellets. The only gaseous fission fragments that are radioactive are the noble gases krypton and xenon, which do not react chemically with other elements, and iodine, which reacts very strongly and is therefore easy to filter out. When this unwanted air is released at other plants, it is very weakly but measurably radioactive as it leaves the vent. Repeated efforts to measure radiation increases on the ground in the environment outside the plant, however, have failed. That is, the contribution of this radiation to the background is so small as to be undetectable. Because the noble gases do not combine with other elements to make chemical compounds, their health impact is not enhanced by biological concentration. The amount of radiation added to the natural background by allowing these gases to escape is extremely small, and it appears to be unreasonable to describe it as a health hazard.

Nuclear power plants in the United States operate under regulations that strictly limit the release of radioactive substances into the environment. That means if a large release were to occur, it would be as the result of an accident. Two kinds of accident should be distinguished: those releasing substances made radioactive by exposure to radiation (usually neutrons) from the core, and those releasing fission products. The substance that could escape most easily to the environment is the water that circulates between the core and the steam turbines. This water contains nitrogen-16 which decays very rapidly (within seconds) and is one of the principle radioactive substances limiting the ability to do hands-on maintenance of the reactor while it is running. Other longer lived radioactive isotopes in the water would occur only in very sm ll amounts in the Shoreham reactor. An accident involving leakage of the primary coolant to the environment would seem to contribute only very small amounts of long-lived radioactive materials. The Panel did not consider accidents of this type at length.

ACCIDENT SCENARIOS FOR THE RELEASE OF CORE MATERIALS

In considering accidents that disperse fission products, it is important to understand that nuclear reactors cannot explode like nuclear weapons. This is not an assertion based on confidence that the design will work as expected, but is a fact deriving from the very special materials and design of nuclear explosive weapons. Features of nuclear weapons that allow them to explode violently are not present in nuclear reactors. Nuclear reactor cores could get hot enough to melt themselves, but they could not explode like a bomb.

If reactors could not explode, then how could the fission products get out? One possibility is catastrophic damage to the plant by an earthquake or another natural or man-made disaster such as impact by a large airplane. The probabilities of fuel releases by such events have been estimated and found to be less than the probability that a failure within the plant would cause a release. The reason for this is that the most radioactive material remains in the fuel pellets inside their tubes. The only way for it to get out is to melt the tubes. That means the cooling water must be prevented from getting to the core. Most attention to risk assessment and to safety design has therefore focussed upon accidents in which the ability to cool the core is lost.

Because core cooling is so important, there is an emergency core cooling system to back up the regular system, and each system has a variety of features that reduce its vulnerability to failures of components. Even if all these features failed and the core were to heat up and melt, as it nearly did in the Three Mil Island accident, most accident scenarios do not result in a dispersal of radioactive material to the environment. It is necessary to invoke some mechanism that breaks through the containment building and sprays contaminated steam to the outside.

Scenarios that accomplish this have a somewhat Rube Goldbergian quality, which explains why the estimated probabilities are so low. Power reactor design places obstacles in the various failure paths, so many systems must fail simultaneously for massive radiation releases to occur.

In the Shoreham facility, the core is contained within a steel and concrete vessel with walls from four to seven feet thick (the primary containment). The core plus all cooling systems are housed in a steel lined containment building with walls two feet thick (secondary containment. In the Shoreham reactor the primary coolant fluid goes outside the containment building where the generators are located). Under the core is a large pool of water designed to cool steam that might be expelled suddenly from the core in a loss of coolant accident (LOCA). This pool has its own cooling system, and there is also an emergency core cooling system °For an accident to occur that would forcibly expel steam from the containment building, all three systems would have to fail simultaneously, and for relatively long periods of time.

If none of these cooling systems were working, the mass of core material, heated continually by the decay heat, could first expel steam from the core which would vent as designed to the pool, heating up the uncooled pool. When, hours later, the core metals were to melt through the primary containment and drop into the pool, the pool would have no further ability to absorb energy without turning to steam. If all the parameters were just right, the steam could force open pathways through the secondary containment to the outside world.

Scenarios that result in core melts and radiation releases have two important features in common: First, there would always be a long period of time between the onset of an accident (loss of primary coolant) and the expulsion of radioactive steam, associated for example with the time it takes for the core metals to melt through several layers of steel and concrete. Second, multiple systems must fail simultaneously, and loss of electrical power could be a cause of such failures. That is why so much emphasis is placed on the reliability of backup generators. Under ordinary circuumstances, of course, the plant would get power either from itself, or through transmission lines from other plants.

Once the radioactive material escapes from containment, what would happen to it? In most cases,°it would disperse in the atmosphere until it is so diluted that its radioactivity is indistinguishable from the background. If there is only a small breeze, the material remains dense and may settle out near the plant, suggesting evacuation of the zone close to the facility, perhaps within a few miles. In general the radiation decreases rapidly with distance from the plant. The important exception is if the material remains concentrated in a plume that subsequently moves through rain or snow. The precipitation could bring the radioactive material to earth before it has dispersed. The worst case is when the precipitation occurs over a population center. In any case it appears advisable to notify people over whom the plume would pass°regarding appropriate measures to limit their exposure to radiation.

Because some fission products are so radioactive, nuclear reactors are designed to contain them even in the event of an accident. At the Shoreham plant, many different systems are provided to supply the core with coolant to keep it from melting at all. If it were to melt anyway as a result of an unlikely accident, the fuel must make its way through several thick layers of steel and concrete. The important question is: With all these built in safety and containment systems, is any core material ever likely to get out? The answer is: No, it is very unlikely that any core material will get out. Everyone who has studied the problem agrees on this. The point is that if it ever does get out it may cause a major health problem, and therefore, despite the small chance of ever needing them, precautions should be taken to deal with a release of core material.

IS SHOREHAM DIFFERENT?

Our panel heard repeatedly from persons who said that they were not opposed to nuclear power in general, but were opposed to Shoreham on safety grounds because, to summarize their arguments, they had no confidence that the plant was built correctly, and failures contributing to radioactive substance release would therefore be more likely. A related argument urges that the record of mishaps in construction is so bad that LILCO management should not be allowed to operate the facility, if it opens, because they probably could not operate it safely.

There is no doubt that LILCO has been unlucky with Shoreham. It was the first plant licensed after the passage of t.e 1970 Environmental Protection Act. Its early public announcements of siting choices were public relations disasters. It was the first of a new model of General Electric boiling reactors, the Mark III, to be built. Massive design changes were required in mid construction, first as a result of safety tests on the new GE design, then as a wide variety of changes in regulations were promulgated by the Nuclear Regulatory Commission. During its construction, astonishing increases in oil prices slowed the development that Shoreham and other plants were designed to serve, and caused the highest inflation in the postwar period. Construction on Long Island is dominated by heavily organized labor, creating an additional degree of complexity to construction management on a job whose quality control requirements alone created a major logistical problem for work scheduling. The list could be made much longer.

The question is, did all these problems lead to a plant that is significantly less safe than other nuclear power plants? Representatives from the Nuclear Regulatory Commission, including the NRC resident inspector at Shoreham say they see no evidence that they did. And yet there are many instances of workers and construction supervisors who claim to have observed improper construction and quality control practices. We understand that all items brought to the attention of the NRC have been followed up, and that none of them individually or together according to NRC officials suggests a breakdown in the quality control system in place during construction. The situation today is that many such concerns have not been brought to the attention of the NRC because those who are aware of them fear to lose their jobs if they reveal their knowledge. The Panel cannot pass judgment on the validity and significance of these claims. We urge those who make them to bring their knowledge to the attention of the NRC for investigation.

In this connection, the NRC itself has been criticized for failing to catch serious design weaknesses in the Diablo Canyon plant in California. Many people on Long Island have lost confidence in NRC's ability to assure the safety of the plant. That is why the issue of inspections became so sensitive last year. It seemed reasonable to bring in an independent inspection to examine the plant and render a judgment on the construction quality. Initially the Suffolk County Government and LILCO were cooperating to this end, but cooperation ceased when they could not agree on the level of participation of an outside consultant for the county in the inspction process. The lack of agreement seems to have had its source in a mutual lack of confidence that each party had the other's best interest at heart. In any case, an inspection proceeded under LILCO's sponsorship. It basically gave Shoreham good marks, but the results have been attacked on the grounds that LILCO was paying the piper and calling the tune.

The Panel heard presentations on LILCO's Quality Control and Quality Assurance programs from both LILCO and Suffolk County representatives. Their differences seemed technical, and there did not appear to be a basic flaw in the LILCO testing methodology. Large numbers of construction flaws seem to have been detected and corrected routinely during construction, and at least part of a serious worker productivity problem at the site had its origin in the pervasive in-progress inspection programs.

All large construction projects are subject to a variety of problems and defects associated with human behavior. No formal checking process works well if the front line workforce does not support it. These factors are reflected to some extent in the probabilistic risk assessment studies through the statistics on failure rates of components and systems. The statistics used included cases where failure was due to construction imperfections.

At this time, the only evidence that suggests that Shoreham may contain construction flaws that render it less safe than other nuclear reactors is the remaining stories of incidents that have not yet been transmitted to the NRC. No study has suggested a systematic breakdown of the routine quality assessment and quality assurance programs. And yet there is enormous public skepticism and mistrust of the plant. The situation has not been helped by the failure of critical components of all three diesel engines for generating emergency power to the plant. Despite the fact that the equipment failed in testing, where it is supposed to if it is to fail at all, the public interprets the incident as confirming the basic unsoundness of the plant. Would additional studies and inspections help? It is easy to criticise any inspection as incomplete, but additional examination of several systems that have not yet been inspected (except for the normal on-going inspection during construction) with special attention to whether LILCO's quality control programs were adequate, might be of value. It is worth mentioning that such inspections are not carried out on other nuclear power plants, the in-progress process being deemed adequately rigorous.

EMERGENCY PREPAREDNESS FOR THE SHOREHAM FACILITY

Now the problem becomes more difficult. What kind of accident should be prepared for? In general, the bigger the source term, the more people who are likely to be affected, the more severe the health effects, the more expensive the emergency preparation, and the smaller the probability of the incident ever happening in the first place. The people who predict source terms also estimate the probability of the accident that causes them. It is also possible to estimate the probability of meteorological conditions that would lead to public health hazards with such a source term, and to predict the overall probability of a hazardous event. Some of the probabilities predicted this way are very small, such as one hundred millionth (one such accident every year if there were a hundred million identical reactors operating). Should one prepare for such rare accidents? In the Shoreham matter, Suffolk County officials examined just such a rare case and declared that preparations should be made to ensure the public safety in the event it occured, whether it was estimated to be rare or not.

This action by Suffolk County is unusual in the history of nuclear reactor emergency planning. Prior to 1979, the federal government had totally preempted the responsibility for emergency planning. Emergency preparedness was confined to the reactor site and its immediate vicinity, and the licensee was required to be prepared to take responsive measures appropriate to the nature of an accident if one occurred. In response to confusion about off-site emergency response in the Three Mile Island incident, the President ordered The Federal Emergency Management Agency to assume a leadership role in off-site emergency preparedness. On August 19,1982, FEMA published a proposed rule, 44 CFR 350, entitled Review and Approval of State and Local Radiological Emergency Plans and Preparedness. This rule has not yet been finally adopted, but FEMA has followed it since its publication, and has said it plans to continue to do so.

The rule requires reasonable assurance that appropriate protective measures can and will be taken in the event of a radiological emergency caused by an accident at a nuclear power plant. Off-site plans must be prepared, reviewed, exercised and approved as a condition of licensure. The plans must provide a coordinated response by local governmental and utility personnel. FEMA and Nuclear Regulatory Commission personnel have said that they did not expect local governments to perform their own risk assessments and analyses to determine the nature of the appropriate responses, but to follow generally the agency guidelines.

Suffolk County retained experts in the various fields relevant to the estimation of risks and emergency response planning and then decided on the basis of the findings of these consultants that the response they (the officials) believed to be acceptable to at least one possible accident scenario was beyond the means of the County or anyone else to carry out. Consequently the county believes that the plant should not receive a license to operate. It is important to distinguish the reports prepared by the county's consultants from the determinations of the county officials. It was clearly the county government who determined that evacuation in Suffolk County is impoosible. Upon comparison of the findings of the county consultants with the federal guidelines and the response plans of other nuclear reactors in the State of New York, it is clear that the consultants had chosen to analyse more severe (and therefore presumably less likely) accident scenarios than those which other plans normally address. The county reports also assume the necessity for a greater response effort than usually assumed as a result of certain sociological factors not apparently included in other plans.

LILCO also performed an analysis of risk and developed an emergency response plan adhering closely to the pattern suggested by the FEMA guidelines. The LILCO plan is more similar to other plans throughout the state, and is criticized by the county primarily for understating the difficulty of evacuation in the region. The methodologies of the LILCO and county studies were quite similar, and a detailed comparison is possible. The response of the Nuclear Regulatory Commission to Suffolk County's criticism of LILCO's proposal to deal with off-site emergency planning has been the dismissal of some of the more conservative claims advanced by the county, including the notion that the emergency plans would have to address evacuation of residents within a 20 mile radius of the plant.