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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

BEFORE ADMINISTRATIVE JUDGES:

Lawrence Brenner, Chairman
Dr. Richard F. Cole
Dr. Peter A. Morris

In the Matter of	Docket Nos. 50-352-OL and 50-353-OL
PHILADELPHIA ELECTRIC COMPANY	(ASLBP No. 81-465-07 OL)
(Limerick Generating Station, Units 1 and 2)	LBP-84-31
	August 29, 1984

SECOND PARTIAL INITIAL DECISION

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APPEARANCES

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I. INTRODUCTION

This is the Second Partial Initial Decision (P.I.D.) issued by this Atomic Safety and Licensing Board in this proceeding. The first "Partial Initial Decision (on Supplementary Cooling Water System Contentions)," was issued on March 8, 1983, and resolved the captioned issues in favor of the Applicant (Philadelphia Electric Company or PECo), subject to certain conditions. LBP-83-11, 17 NRC 413 (1983), appeal pending.

This second P.I.D. decides all other issues in controversy in favor of the Applicant which are prerequisite for authorization of the low power operating licenses requested by the Applicant for testing and operation up to five percent of rated power, pursuant to 10 C.F.R. § 50.57(c), as limited by 10 C.F.R. § 50.47(d). These issues are listed in the table of contents of the P.I.D. Offsite emergency planning issues, which must be resolved in favor of the Applicant as a prerequisite for authorization of operating licenses for power levels in excess of five percent of rated power, are pending for litigation in this proceeding. When and if the low power operating licenses authorized by this P.I.D. are issued is determined by the NRC Staff, based on its review of the many other NRC requirements not in controversy before us, and the certification of completion, in turn, of each of the two reactor units comprising the Limerick Generating Station.

The Limerick Generating Station, Units 1 and 2 is located in Limerick Township of Montgomery County, Pennsylvania. It is on the east bank of the Schuylkill River, approximately four miles downriver from Pottstown. Licenses are sought to operate two boiling water nuclear reactors, each with a rated core power level of 3,293 megawatts thermal and a net electrical output of 1,055 megawatts electric. Final Safety Analysis Report (FSAR) at 1.1-1.

In addition to the Applicant and the NRC Staff (Staff), the parties participating in one or more issues decided in this P.I.D. are: Intervenors Limerick Ecology Action (LEA), Friends of the Earth in the Delaware Valley and Mr. Robert L. Anthony (as a joint party and referred to as FOE), and the Air and Water Pollution Patrol and Mr. Frank R. Romano (as a joint party and referred to as AWPP). The City of Philadelphia and the Commonwealth of Pennsylvania also participated in the hearing as interested governments pursuant to 10 C.F.R. § 2.715(c). The City also litigated some of its own issues. Each party filed proposed findings of fact on issues of interest to them.

There were approximately 40 days of evidentiary hearings held on the issues decided in this P.I.D., between December 12, 1983 and June 20, 1984, in Philadelphia, Pennsylvania.

The Board's Findings of Fact follow in numbered paragraphs, keyed to the lettered subsections, in Section II. The Conclusions of Law and the Order (including procedures for appeal) follow in Sections III and IV, respectively.

II. FINDINGS OF FACT

A. AWPP Contention V-4: Aircraft Carburetor Icing

1. Summary

A-1. This Air and Water Pollution Patrol (AWPP) contention arises under the National Environmental Policy Act (NEPA), and alleges that there will be increased icing in airplane carburetors due to emissions from the two Limerick large, natural draft cooling towers. The contention states:

> Neither the Applicant no, the Staff have adequately considered the potential for and the impact of carburetor icing on aircraft flying into the airspace that may be affected by emissions from the Limerick cooling towers.

A-2. We conclude that this contention lacks merit. The Applicant, supported by the Staff, has demonstrated that there will be no hazards to aircraft due to carburetor icing caused by the Limerick cooling tower plumes. Carburetor icing is a well recognized hazard to carburetor equipped aircraft. It is caused by water vapor freezing in the carburetor (in which the temperature can drop markedly due to the expansion of the air flow through the throttling valve). If permitted to accumulate, the ice can cause degrading engine performance to the point of failure.

A-3. The proof before us has clearly demonstrated that beyond the short distance from the cooling towers of about a quarter of a mile, the temperature and humidity differences between the plume and the ambient air are insignificant. The plumes would not present a potential carburetor icing hazard different from the naturally occurring atmosphere, because an airplane could not remain in such a small region of the plume for more than a few seconds -- too short a time for carburetor icing to present a hazard. Furthermore, in the alternative, and contrary to the evidence, even if conditions in the entire plume (up to about 10 miles long) were significantly different from the surrounding air, it would be highly unlikely that an airplane would, or even could, remain in the plume long enough for sufficient carburetor ice to accumulate to cause engine failure. The plume behavior would not result in "socked in" conditions in the local airport traffic pattern so as to cause airplanes to remain in the plume for long time periods.

A-4. In any event, the above considerations are unrealistically conservative. They do not take into account the fact that normal pilot procedure is to use the required carburetor heat system to prevent ice accumulation. If carburetor ice begins to accumulate, whether caused by a plume or ambient air, there is ample timely notice to the pilot due to symptoms of the degraded engine performance, and gauges, that ice is accumulating and therefore carburetor heat should be applied to melt the ice. Pilots must face normal variations in temperature and humidity conditions over relatively small changes in airspace location of greater magnitude than variations which would be presented by cooling tower plumes.

A-5. The Applicant's witness panel included two meteorologists, Messrs. Smith and Seymour, with impressive credentials and experience in studying cooling tower plumes (including from aircraft). Mr. Seymour is also an experienced pilot and flight instructor with a commercial license. See professional qualifications, ff. Tr. 6234. Likewise, the Staff presented an excellently qualified witness panel consisting of an experienced meteorologist, Mr. Markee, and an FAA official, Mr. Geier, who serves as manager of the General Aviation and Commercial Division of the Flight Operations office. Mr. Geier has been a certified pilot for over 40 years, and has been a flight instructor. The Staff's panel also included a Staff nuclear engineer, Mr. Krug, because of his expertise as an instrument rated commercial pilot. See professional qualifications, ff. Tr. 6883. As might be expected from their qualifications, these witnesses, both in the written direct testimony and under extensive questioning at the hearing, displayed thorough knowledge and understanding and strong, thoughtful support for their conclusions. Indeed, they tried valiantly in response to sometimes confusing, repetitive questions, to explain their analyses and bases so that AWPP's lay cross-examiner, Mr. Romano, would understand the situation.

A-6. In contrast to Applicant's and Staff's witness, AWPP's representative (who also testified on behalf of AWPP), displayed insufficient knowledge and expertise to be relied upon. He is a chemist with science degrees. However, he had no knowledge of the meteorology involved in plume behavior. He has been a licensed pilot of small planes with ten years of flying experience, much of it in the local Limerick area. However, although he is rightfully concerned, as a pilot of a small airplane, with carburetor icing, his premises of the behavior and effect of plumes were proved incorrect, as was his unlikely postulation that inexperienced, imprudent pilots might not use carburetor heat to prevent, or if necessary, remove an accumulation of carburetor ice. Romano (qualifications and testimony), ff. Tr. 6725.

A-7. The evidentiary hearing sessions on this contention were held on January 11-13 and 17-18, 1984.

2. <u>Behavior of Cooling Tower Plumes</u>

A-8. In our unpublished memorandum and order of November 8, 1983, we denied Applicant's motion for summary disposition of this contention. In doing so, we held that if Applicant had established, as an indisputable fact, its proposition that temperature and moisture conditions in cooling tower plumes beyond a distance of one quarter mile from the tower were insignificantly different from those in the ambient air, summary disposition would have been warranted. We would have so ruled because aircraft would not, indeed could not, reasonably remain within the influence of a plume within a quarter of a mile of the cooling tower for more than a few seconds 1/ -- too short a time period for carburetor icing to affect the aircraft. November 8, 1983 ("Summary Disposition") Order, at 3-4.

A-9. At the summary disposition stage, we found that there could be a question about the applicability to Limerick of the 1981 Thomson Pennsylvania State University study relied on for Applicant's "one quarter mile from tower significance proposition," because the design of the cooling towers of the Keystone Plant used in the study were different. Id. at 4. Based on the facts established at the evidentiary hearing, as set forth below, we find that the Applicant, without any reasonable contradiction, has established by the overwhelming preponderance of the evidence that the Limerick cooling tower plumes will not have temperature and moisture conditions significantly different from the ambient air beyond a quarter mile from the tower.

1/ For example, assuming both a slow air speed of 90 mph, and an airplane flown through the long axis of the plume within a quarter mile of the tower, a plane would traverse the quarter mile in 10 seconds. Any other flight path would expose the airplane to potential icing conditions for an even shorter time.

A-10. To dissipate the waste heat from the operation of the facility, the Limerick Generating Station will employ two large natural draft hyperbolic cooling towers 507.5 feet in height. Markee, ff. Tr. 6883, at D-5.

A-11. The operation of towers of the type used at Limerick creates visible plumes of water vapor under certain atmospheric conditions. The plume emitted by the Limerick towers will always have a higher temperature and greater water content than the ambient air. Excess water vapor will condense to form a visible plume approximately 50 to 80 percent of the time. The plume will always be less dense than the ambient air and will rise due to buoyancy. Id. at 3-13; Tr. 6296, 6298-99, 6320, 6324 (Smith). The exact temperature and humidity content of the plume as it exits the tower will depend on the temperature of the ambient inlet air drawn into the tower and the amount of heat being dissipated from the plant (at different plant operating levels). Tr. 6317, 6322 (Smith).

A-12. As the plume rises it will be cooled by expansion, evaporation, radiation and mixing with the ambient air. Markee, ff. Tr. 6883 at 3-13 to 3-14; Tr. 6290, 6293 (Smith). The rate of heat dilution and consequent plume behavior is affected by the natural turbulence in the atmosphere, the vigor with which the plume exits the tower (1,100 to 1,600 feet per minute at full power operation), and the humidity and temperature of the ambient air relative to the humidity and temperature of the plume. Tr. 6292, 6296, 6407 (Smith); Tr. 6630 (Boyer). Very rapid mixing occurs in the immediate vicinity of the tower. Tr. 6291-93 (Smith).

A-13. A temperature differential of as little as tenths of a degree (Fahrenheit) over the ambient air will result in a buoyant plume. Tr. 6631 (Smith). As they exit from the cooling towers, the plumes will be very close to or at saturation. Tr. 6639 (Smith). Strong winds expedite the mixing process and reduce the plume's buoyancy as its warmer, wetter air is dispersed. Tr. 6299 (Smith). On the other hand, if the atmosphere is relatively still, plumes will rise almost vertically to greater heights and will continue to rise, usually until it reaches a layer in which temperature increases with height, i.e., an inversion layer. Tr. 6299-300, 6407 (Smith). Normally, as a plume rises under nearly calm conditions it generates its own turbulence and mixing and either dissipates while rising vertically or reaches a layer in which there is transport wind and is carried away. Tr. 6302-03 (Smith). A plume rising into air that is already saturated and therefore has a cloud deck will blend into and become part of the ambient cloud deck. Tr. 6408-10 (Smith).

A-14. As testified to by both the Applicant and Staff, it is extremely rare for cooling tower plumes to assume a lateral orientation before reaching an altitude of 1,000 feet. Tr. 6894, 6908-09 (Markee);

Tr. 6298 (Smith). In their studies of natural draft cooling tower plumes, Applicant's witnesses did not find a single plume whose rise leveled off below 1,000 feet. They found only one bent over plume between 1,000 and 1,200 feet. Tr. 6298, 6334, 6619 (Smith). Additionally, the Staff testified that there is only an extremely small probability that a plume waft might reach the ground in the vicinity of Limerick. Such an event could only occur as a result of very turbulent, hurricane-type conditions, which would be conducive to plume dispersion in any event. Tr. 6894-95 (Markee).

3. Studies of Cooling Tower Plumes

A-15. Applicant's witnesses relied upon two cooling tower plume studies as part of the bases for their testimony that plumes will not affect carburetor icing in the Limerick area. Smith and Seymour, ff. Tr. 6234, at 5-7; Tr. 6423 (Smith). One of these studies, the Thomson (Pennsylvania State University) study of the Keystone cooling towers in Western Pennsylvania (App. Ex. 13), was conducted expressly to determine conditions inside and outside visible and invisible plumes. Tr. 6259, 6279, 6405, 6418 (Smith). The visible plume was tested by making airplane flights at right-angle cross-sections at various altitudes from top to bottom and at various distances along the length of the plume. Tr. 6259-60, 6419, 6458 (Smith). When the visible plume terminated, those procedures were employed downwind at the same altitudes and at increasing distances out to ten miles to test the invisible plume.

Tr. 6419, 6458, 6460-61 (Smith). This technique enabled the researchers to intersect the so-called invisible portion of the plume with great regularity. Tr. 6262, 6279, 6419-20, 6459 (Smith).

A-16. The Thomson study results indicate that in-plume temperature and humidity conditions vary sharply within one quarter-mile of the tower, with both quantities significantly exceeding ambient levels for very short periods. Smith and Seymour, ff. Tr. 6234, at 5-6. Beyond a quarter-mile, however, in-plume temperatures were found to be almost indistinguishable from those of the external air, and the humidity difference dropped to 0.25 gm/kg or less. This is a very small excess as the natural atmosphere, when saturated, contains about 3.5 gm/kg of water vapor at 30° F. This figure increases to 22 gm/kg at 80° F. Smith and Seymour, ff. Tr. 6234, at 5-6 and Figs. 1 and 2; Tr. 7094, 7106-07 (Markee).

A-17. Contrary to AWPP's unsupported claims, the results of the Thomson Keystone study are valid for Limerick. The key climatic conditions applicable to carburetor icing are nearly identical at Keystone and Limerick. Smith and Seymour, ff. Tr. 6234, at 6; Tr. 6423-24 (Smith); Tr. 7033-34 (Markee). The plume and weather conditions at Keystone are not affected by the modest ridges located 40 miles away. Tr. 6444-45 (Smith).

A-18. As noted in our order denying summary disposition, the Keystone towers are smaller than the Limerick towers -- 325 feet and 507 feet, respectively. However, the expert witnesses for the Applicant and Staff testified that based on American Electric Power data, there is little difference in comparative behavior of plumes from cooling towers from plants that are about 500 megawatts and larger. Tr. 6424-25 (Smith); Tr. 7033 (Markee). This was not contradicted by either other testimony or under cross-examination.

A-19. We agree with the Applicant's conclusion, supported by Staff's meteorologist (Tr. 7033, 7086-87, 7106-07 (Markee)), that as a result of the plume and ambient air mixing processes described above, the distance would not exceed one quarter mile from the tower within which temperature and humidity in the plume could reasonably vary enough from the ambient air to cause or exacerbate carburetor icing. This is well supported by their expert knowledge of plume phenomena, their review of the literature, and the Thomson Keystone study. See e.g., Smith and Seymour, ff. Tr. 6234, at 5-6 and Figs. 1 and 2; 6267, 6286, 6312-13 (Smith); Tr. 6286, 6350-51 (Seymour).

4. AWPP's Disagreements Regarding Plume Behavior

A-20. AWPP's disagreements with the information and conclusions regarding plume behavior testified to by the Applicant's and Staff's experts are insubstantial and without foundation. The arguments by AWPP's representative show an unfortunate apparent inability to understand the testimony. Indeed, the arguments illustrate why the testimony of AWPP's representative is entitled to no weight. For example, AWPP seems to believe that the testimony that plumes will not affect carburetor icing beyond a quarter mile from the tower means that Applicant and Staff believe that plumes longer than a quarter mile will not exist. This is not correct. The testimony is that longer plumes will exist, at times as much as five or ten miles long. Tr. 6264-65 (Smith). On rare occasions, the Applicant postulated that, based on American Electric Power studies performed by Mr. Smith, and a computer modeling run for Limerick, the Limerick plumes may even exceed 10 miles. Smith and Seymour, ff. Tr. 6234, at 7-8. This is not inconsistent with the well-supported, uncontradicted, and often repeated testimony at the hearing, regarding the lack of significant temperature and humidity deltas of the plume over the ambient air at distances greater than one quarter mile from the tower.

A-21. Similarly, AWPP's argument (proposed finding 6) that the velocity of the plume as it exits the tower of 1,100 to 1,600 feet per minute contradicts the testimony of lack of significance beyond a quarter of a mile. This argument is a non sequitur. In the first instance, even if that velocity continued, we fail to see how a high velocity plume could contradict the testimony and data of lack of significance of the conditions within the plume beyond a quarter mile.

To the contrary, if such velocity continued it would appear to promote even more rapid mixing of the plume with the ambient air. In any event, the testimony was only that these velocities occurred at the point of exit of the plume from the tower, not that it persisted. See our Finding A-12.

A-22. AWPP postulated that saturated, stagnant ambient conditions could cause the cooling tower plumes to remain near the ground and concentrate in an inversion condition, causing a carburetor icing threat. This was unsupported by AWPP, and was authoritatively discredited by the expert testimony of the Applicant and the Staff. As noted above, (Finding A-13), when the ambient air is saturated, the plume will rise into the atmosphere, continue to mix with the ambient air, merge with the cloud deck, and then be transported away over the course of about an hour. Tr. 6408-10 (Smith). Further, during stagnant ambient conditions, plumes would rise to greater heights than normal and would not cause a significant humidity increase in the airspace close to the tower or the ground. Smith and Seymour, ff. Tr. 6234, at 14; Tr. 6407, 6712-13 (Smith). There is no such thing as completely stagnant air -- air always moves, although at slower rates in stagnant conditions. Tr. 7050-51 (Markee).

A-23. The plume phenomena described above show that even when ambient dispersion conditions are poor (i.e., stagnant), plumes will rise to heights of several thousand feet, where the stronger winds will disperse them. Markee, ff. Tr. 6883, at 2. The computer model run for Limerick by the Applicant is consistent with this expert view. It indicates that the Limerick plumes will always reach a height of at least 1,000 feet above ground before leveling off, if they have not dissipated before reaching that altitude. Smith and Seymour, ff. Tr. 6234, at 7-8. See also our Finding A-14.

5. Aircraft Carburetor Icing

A-24. AWPP's assertion that the Limerick cooling tower plumes will lead to increased aircraft carburetor icing ignores the fact that the conditions causing carburetor ice formation are well understood and that steps have been taken to assure that it does not present a significant problem to pilots who are reasonably attentive. Smith and Seymour, ff. Tr. 6234, at 8; Geier, ff. Tr. 6883, at 2-4; Krug, ff. Tr. 6883, at 2-3. Carburetor icing occurs as follows: The vaporization of fuel, combined with the rapid expansion of air as it passes through the carburetor intake valve, causes that mixture to cool; the water vapor content of the intake air may then condense, and if the temperature in the carburetor reaches 32° F. or below, the moisture can be deposited in the fuel intake system as frost or ice which may reduce or block the passage of the fuel/air mixture to the engine and cause engine failure. Due to the venturi effect of a partially closed throttle valve, carburetor ice is more likely to form when the throttle is not fully open. The temperature of air passing downstream of the throttle valve may drop as much as 60° F. Smith and Seymour, ff. Tr. 6234, at 8; Geier, ff. Tr. 6883, at 2.

A-25. On very dry days and when the temperature is well below freezing, the moisture content of the air is not sufficient to cause carburetor icing. But if the temperature is between 20° F. and 90° F., and moderate humidity or visible moisture is present, there is a potential for carburetor ice to form. Smith and Seymour, ff. Tr. 6234 at 8-9; Tr. 6517-18 (Seymour).

a. Time for Formation

A-26. Experiments have been conducted on the ground using an automobile engine and an airplane carburetor to accumulate the greatest amount of carburetor ice in the least amount of time so as to establish the power losses associated with timed exposure to optimum icing conditions. Such studies are done in a laboratory because it is difficult to find optimum conditions for carburetor ice accumulation occurring naturally. Tr. 6507-08 (Seymour).

A-27. At such conditions (68° F. and 100% humidity), the study found it would take eight minutes of flying time for enough carburetor ice to accumulate to cause a 25 rpm reduction in engine speed. This result assumes that the proper preventive and remedial measure of using the carburetor heat control, discussed below, is not taken. Such a drop is not even significant enough to probably be noticed by the pilot. Smith and Seymour, ff. Tr. 6234, at 9; Tr. 6374-77, 6527-28 (Seymour). The FAA witness appearing on behalf of the Staff stated in his direct written testimony that although carburetor ice can form instantaneously under the proper conditions, it does not accumulate at such a rate that the pilot who pays attention to the signs cannot prevent engine stoppage due to blocking by ice of the carburetor throttle. Geier, ff. Tr. 6883, at 2.

A-28. On its face, the FAA witness' prepared testimony is not inconsistent with the Applicant's testimony based on the icing test studies. Instantaneous ice formation is not an accumulation of carburetor ice which would create a flying hazard. That this is what the FAA witness meant was clarified at the hearing. He and the other Staff pilot witness did not wish to testify to a particular time frame such as five, eight or ten minutes, due to variation in aircraft and conditions. Tr. 7002-03 (Krug, Geier). However, he explained he agreed with and had no evidence to believe that the conclusion of the study relied on by the Applicant was wrong -- i.e., that it would take some time (eight minutes according to the study) of flying through adverse conditions without carburetor heat to accumulate enough carburetor ice to present a significant hazard to an aircraft. Tr. 7001-03 (Geier).

A-29. Based on the above, even if an airplane would fly in the plume within a quarter mile of the tower, it would pass through that area in a matter of seconds -- much too soon for hazardous carburetor ice to accumulate. The use of the quarter mile distance as the maximum area of potential adverse effect was conservatively based on the premise that differential conditions between the plume and ambient air conditions of not more than one degree centigrade or a half a gram of water vapor per kilogram of air would not have an effect on carburetor icing. Tr. 6249 (Smith). As discussed above (Finding A-16), the conditions beyond the quarter mile distance would not exceed that. Actually, the one quarter mile distance proposition is conservative, because a differential between the plume and ambient air conditions of two or three degrees centigrade and ten or twenty percent humidity would not significantly affect aircraft carburetor icing. Tr. 6267 (Smith).

A-30. Moreover, even if we believed, contrary to the evidence, that the cooling tower plumes could cause carburetor icing for distances beyond one quarter mile from the tower, and that pilots would not apply carburetor heat to prevent or remedy icing, there is another factor which demonstrates that the contention has no merit. The record fully supports, and we agree with, Applicant's proposed findings (45-47), showing that it would be highly unlikely -- indeed a nearly impossible, purposeful maneuver -- for a pilot to keep a small general aviation airplane of concern in this contention within even the largest cooling tower plumes for their full extent long enough for enough carburetor ice to form to present a hazard to the airplane. See e.g., Smith and Seymour, ff. Tr. 6234, at 7-11.

b. Prevention and Elimination of Carburetor Icing

A-31. It is not necessary to make further findings in order to decide that the contention lacks merit. However, we do so to show that the conservative assumption used to this point that the pilot would not prevent or, if encountered, remedy carburetor icing, is unrealistic.

A-32. All airplanes with carburetors are required to have carburetor heat systems to prevent and eliminate icing. Geier, ff. Tr. 6883, at 3. All parties agree that aircraft manufactured since World War II have such systems, and therefore 99% of the airplanes flown in the Limerick area are so equipped. Tr. 6651 (Seymour); Tr. 6834 (Romano).

A-33. AWPP agrees that if carburetor heat is used, ice will not form. Tr. 6852 (Romano). Unless the ice were allowed to accumulate over a long enough time, during which the pilot would have to ignore seriously degrading engine performance, by design of the airplane carburetor ice can be removed in seconds by the use of carburetor heat. Tr. 6364-67, 6376-78, 6383-84, 6668-71 (Seymour); Tr. 7004-05 (Geier). Carburetor ice would not cause instantaneous engine failure without significant noticeable symptoms alerting the pilot to the problem. Tr. 6376-81, 6628-29 (Seymour). A trained pilot would not be likely to confuse the indications of other engine problems with the indications of the accumulation of carburetor ice. Geier, ff. Tr. 6883, at 4-5.

A-34. Beyond the fact that a pilot should be able to remedy a carburetor ice problem after detection, there are proper flight procedures for different maneuvers to prevent a carburetor ice problem. These procedures would prevent problems in the local Limerick area even though there are airplanes taking off and landing at local airports near Limerick. 2/

A-35. Carburetor heat is not used in normal flight as it reduces the output of the engine, but pilots are trained to apply carburetor heat at the first indication of an icing problem. Smith and Seymour, ff. Tr. 6234, at 12. Also, carburetor heat is not normally used during takeoff because full power is desired and the potential for carburetor ice is less when the throttle is fully open. Tr. 6673-75 (Seymour); Tr. 7042 (Krug). However, before taking off a pilot should test his carburetor heat control. This will assure that it is working. It will also indicate whether any ice is present based on the reaction of the engine to the application of the heat. If symptoms of ice occur during that preflight check, then the carburetor heat should be reapplied just

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2/ Based on our findings on plume behavior, local airport traffic will not be affected by the plumes which, if they do not dissipate first, will rise to over a thousand feet above the ground. The typical airport traffic altitude is 800 feet for light aircraft and 1000 feet for heavy aircraft. Tr. 6688-89 (Seymour). The pattern altitude at the closest airport, Pottstown - Limerick, is 889 feet above the ground (1200 msl), well below the lowest heights at which plumes will level off. Tr. 7101-02 (Geier).

before take-off to assure the carburetor is clear at that time. Smith and Seymour, ff. Tr. 6234, at 12; Tr. 6673-74 (Seymour).

A-36. In making an approach for landing an aircraft which has a carburetor, the pilot normally applies carburetor heat on the downwind leg even if there is no indication of carburetor ice. An increase in engine rpm after the carburetor heat is applied is an indication that carburetor ice was present and that the heat has eliminated it. Such an increase is an indication that the pilot should continue to use the carburetor heat. "As required" in a flight manual instruction regarding the use of carburetor heat means that normal procedure is to leave the carburetor heat on throughout the approach. Tr. 6890, 7007-08 (Geier).

A-37. In the case of a "go-around," a situation in which a pilot must reapproach the runway after beginning his pre-landing descent, carburetor heat would have been applied during the pre-landing descent. Once a pilot realized that a go-around had become necessary, carburetor heat would be eliminated and full power applied, thus ameliorating any icing potential. Carburetor heat would again be applied upon reentering the landing approach. Tr. 6676 (Seymour); Tr. 6835-36 (Romano); Tr. 6890 (Geier).

A-38. It is not our conclusion that aircraft cannot be placed in hazardous circumstances, perhaps even to the point of a tragic accident, by carburetor icing. But it is our finding that this would occur only due to pilot failure to use well established procedures and available equipment. The procedures are well established and the carburetor heat systems are required precisely because aircraft carburetor icing is a well recognized potential hazard.

A-39. More to the point, any variation between the cooling tower plumes and the ambient air is insignificant when compared to the much larger normal temperature and moisture variations over relatively small changes in location that pilots face in routine flights through ambient air. Indeed, changes in altitude of a few hundred feet may result in differences of five to ten degrees Fahrenheit and fifty to sixty percent in humidity. Tr. 6997-98 (Krug); Tr. 6356 (Smith); Tr. 6367 (Seymour); Tr. 6644-47 (Smith, Seymour).

A-40. Based on all of the above, we find that AWPP Contention V-4 lacks merit.

B. FOE Contentions V-3a and V-3b: Natural Gas and Petroleum Pipeline Accidents

1. Background.

B-1. On September 19, 1981, Mr. Robert L. Anthony filed a petition to intervene on behalf of himself and Friends of the Earth in the Delaware Valley (FOE), including some 13 proposed contentions. In its Memorandum and Order of October 14, 1981, this Board scheduled a special prehearing conference for approximately the first week in January 1982 to consider, *inter alia*, the contentions, the objections to the contentions, and the responses by petitioners to the objections -- from all participants in the proceeding at that time. We also required that all contentions be refiled, since coordination among petitioners had not taken place and some of the preliminary contentions were poorly organized, redundant and unclear.

B-2. On November 24, 1981, in a Supplemental Petition of Coordinated Intervenors, FOE, among eleven other petitioners, filed seven proposed contentions, which superseded those filed previously. FOE/Mr. Anthony was found to have standing to intervene in this proceeding. The Board denied six of FOE's seven contentions in its Special Prehearing Conference Order (SPCO) of June 1 1982. 15 NRC 1423 (1982). Our ruling on one of FOE's contentions (VIII-11, having to do with emergency planning) was deferred until after the Limerick emergency plans became available. While we denied FOE's Contention V-3, related to the danger of fire and explosions in connection with gas and oil pipelines and industry near the plant, we allowed FOE 30 days to file contentions which would allege specific deficiencies which FOE believed existed in the FSAR analysis of these matters. Id. at 1513-14. FOE responded to our SPCO on July 7, 1982, listing ten contentions that it characterized as severe deficiencies in Section 2.2 of the FSAR. Generally, these related to explosions, fires and missiles arising from pipeline and industrial activities.

B-3. In our Order (Concerning Proposed FOE Contentions on Hazards from Industrial Activities) of November 22, 1982, we denied all but two of the newly proposed contentions, i.e., Contentions No. 3 and 5. To focus these contentions on the areas of concern, the Board rewrote and renumbered them, as follows:

> V-3a. In developing its analysis of the worst case rupture of the ARCO pipeline, the Applicant provided no basis for excluding consideration of siphoning. Thus, the consequences from the worst case pipeline accident are understated.
>
> V-3b. In discussing deflagration of gas and petroleum due to pipeline rupture, no specific consideration has been given to the effect of radiant heat upon the diesel generators and associated diesel fuel storage facilities.

B-4. We note that with respect to Contention V-3a, consequences from the worst case pipeline accident were understood to encompass missiles of pipe fragment or rock damaging plant facilities as well as damage from overpressure. With respect to Contention V-3b we note that concerns about the impact of a pipeline fire on the diesel generators and the diesel fuel storage facilities were not discussed explicitly in the FSAR. [3/] Although not explicitly part of FOE's contentions as admitted, the Board found that consideration of the detonation of natural gas from the Columbia Gas pipelines, which all parties had addressed in their prefiled testimony, should properly be considered for completeness, given the issues in controversy before us. "Memorandum and Order Ruling on Motions to Strike Testimony." (Unpublished) (December 1, 1983).

B-5. As a preliminary matter, we note that the proposed testimony of Mr. Anthony on Contentions V-3a and 3b was not accepted, because he does not possess the expertise necessary to testify as an expert witness. We did allow the testimony of Mr. Bevier Hasbrouck, on the basis that he was marginally qualified as a physicist to discuss pipeline explosions, even though he had no direct experience in this area. Evidentiary hearings on these matters were held on December 12-16, 1983; January 9-10, 23-25, March 8-9, 20-23, 1984.

[3/] FOE/Anthony filed a response to and a motion to reconsider our November 22, 1982 order regarding FOE contentions on December 19, 1982. Upon reconsideration, we denied the motion on March 10, 1983.

B-6. The Board wished to ascertain from the Applicant and the Staff at the outset whether they depended, for any part of their cases on these contentions, on the probability of a breach in the pipelines occurring, as opposed to the nature of such a breach and its potential consequences. Both Applicant and Staff conceded that a pipe break could occur. Tr. 5076 (Wetterhahn), Tr. 5076-77 (Vogler). Consequently, we do not consider the probabilities of rupture of either the ARCO or the Columbia pipelines. We do consider the consequences of worst case accidents potentially resulting from the rupture of these pipelines in the vicinity of the Limerick Nuclear Generating Station. To do this we determine, in turn, the nature of the materials transported in the pipelines, how much of these materials could react to produce heat and blast overpressures and the ability of safety related structures, systems and components to withstand such impacts, including interactions from the non-safety related structures, systems and components that could be damaged from the results of potential heat or blast impacts.

2. Summary.

B-7. In consideration of FOE's Contentions V-3a and V-3b, the Board has carefully evaluated the potential effects on the Limerick Station of postulated ruptures of the ARCO and Columbia pipelines. We have not considered what might have been argued as to the low probability of such ruptures. We have considered what we believe to be very conservative postulates of accident scenarios that would lead to radiant heat and overpressure impacts on the Station. Such conservatisms include the distribution of material released from the pipelines, the meteorological conditions prevailing at the time of rupture, the transportation and dispersion of flammable mixtures toward the Station and the assumption that such unconfined mixtures could be detonated. Even assuming burning or detonation of such mixtures, conservative calculations of the radiant heat loads and overpressures on the safety-related structures at Limerick, and the effects of failure of nonsafety-related structures on the safety-related structures, demonstrate the adequacy of these structures to withstand the effects of postulated ruptures of the ARCO and Columbia pipelines. Accordingly, we find FOE's Contentions V-3a and V-3b to have no merit.

B-8. We find the Applicant's and Staff's witnesses to be qualified and competent in their respective disciplines and their testimony to be credible and persuasive. On the other hand, we find the qualifications of FOE's sole witness to be limited, in education, training or experience applicable to the issues raised in these contentions. Based on limited qualifications, and the content of his testimony, we assign no weight to his testimony.

3. The ARCO Pipeline.

a. Description of Pipeline.

B-9. The ARCO Pipe Line Company operates and maintains a pipeline that traverses Chester and Montgomery Counties in Pennsylvania. This is known as the 8" Northeast Boot (Pa.) to Fullerton (Pa.) Pipeline. It consists of an 8" diameter, 0.250" wall thickness X 42 grade steel pipe coated with a coal tar enamel and additionally protected against corrosion by an impressed electrical current cathodic protection system. Christman, ff. Tr. 5093, at 1-3. The pipeline has a capacity of 31,700 barrels per day [4/] and operates at a maximum pumping pressure of 1,100 pounds per square inch gauge (psig). Normal operating pressures for gasoline are 850 to 875 psig and for diesel and furnace oil, 950 to 1,000 psig. The pipeline was buried at least three feet below grade at the time it was constructed in 1955. Christman, ff. Tr. 5093, at 3.

b. Contents of Pipeline.

B-10. The pipeline carries automobile gasoline, kerosene, diesel oil and home heating oil. ARCO Pipe Line Company has stipulated in an

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4/ One barrel of petroleum products is equivalent to 42 gallons. Thus, 31,700 barrels per day is equivalent to 55,475 gallons per hour (gph).

amendment to its right-of-way agreement with PECo that it will not carry propane through the line. The pipeline has never carried butane or liquefied natural gas (LNG) and could not carry either product without physical modification of the pipeline. Tr. 5109 (Christman). Although the pipeline could carry aviation fuel, which is simply a higher octane gasoline than used for automobiles, the line has never been used for this purpose, to the knowledge of Mr. Christman, who is the Montello District Manager for ARCO for approximately 1,000 miles of pipeline in Pennsylvania and New York, including the 8" Northeast Boot to Fullerton Pipeline. The present tariffs on file with the Pennsylvania Public Utilities Commission (PUC) cover transportation of the following: gasoline, kerosene, jet engine fuel, tractor fuel, diesel fuel, and light and medium fuel oil. Christman, ff. Tr. 5093, at 1, 4. Kerosene and jet engine fuel would be less volatile than automobile gasoline. Tr. 5231 (Christman). Automobile gasoline was considered in the Applicant's analysis because it is the most volatile substance carried and has the highest energy content. Aviation gasoline has a lower volatility and lower heat content than automobile gasoline. Walsh, ff. Tr. 5411, at 4. No new product has been added since 1978. Tr. 5122 (Christman). If propane were added to the tariff, it would certainly be known by Mr. Christman and others well in advance. Tr. 5122 (Christman). See also Agreement attached to the Testimony of Vincent Boyer, ff. Tr. 5412.

c. Location of Pipeline.

B-11. The Northeast Boot to Fullerton line is 48.87 miles long. Christman, ff. Tr. 5093, at 3. Within a radius of five miles of the Limerick site the pipeline runs generally in a south to north direction. FSAR Fig. 2.2-1. See also Fig. 1, taken from the SER (Staff Ex. 6) and reproduced at the end of this section of the decision solely to provide a general depiction of the orientation of the ARCO and Columbia Gas pipelines. Its location in the vicinity of the site is depicted in Applicant's Ex. 18, a site plan drawn with a scale of one inch equal to 200 feet. This plan includes two-foot topographical contour lines. It shows the pipeline proceeding northward from the easternmost corner of the Limerick Information Center parking lot approximately 400 feet, then slightly west of north for approximately 850 feet, then north for approximately 500 feet, and then east of north for approximately 1,200 feet. Almost directly east of the valve and meter house (located between the two cooling towers), the pipeline crosses Possum Hollow Run. Approximately 550 feet south of this crossing, the surface elevation reaches the nearest high point in this direction of approximately 244 feet m.s.l. Approximately 1,300 feet to the east of north of this crossing, the surface elevation reaches the nearest high point in this direction of approximately 272 feet m.s.l. PECo's witness Payne identified these high points as being approximately 270 feet elevation, approximately 1,400 feet north and approximately 245 feet elevation, approximately 600 feet south of the Possum Hollow Run crossing. Tr.

5378-79 (Payne). The elevation of Possum Hollow Run at the point of the pipeline crossing is approximately 168 feet m.s.l. The nearest approach of the pipeline to the Unit 2 reactor building is approximately 1603 feet. The Unit 2 Diesel Generator Building is 1665 feet away. Payne, ff. Tr. 5357, at 5. It should be noted, however, that the location of the pipeline itself, or the location of breaks in the pipeline, are not necessarily considered to be the actual locations of the fires or explosions that are postulated for the purposes of this decision. These latter locations are determined from the postulated break locations and other factors, such as topography, wind direction and speed, as discussed below.

B-12. FOE contended that the Applicant did not know where the ARCO pipeline was located (in the vicinity of the Limerick site) and that the Applicant could be wrong by 50 to 100 feet. Tr. 5135-36 (Anthony). Witness Payne testified that using a more refined technique than photogrammetry, PECo knew the location of the pipeline within less than one foot over 90 percent of its length and within a foot or two over the remaining 10 percent. Tr. 5380-81 (Payne). The more refined technique is described in detail at Payne, ff. Tr. 5357, at 3-4. From its recent investigation, the Applicant determined that the location of the pipeline as indicated in FSAR Figure 2.2-4 deviates slightly from its true location. At its maximum deviation, it is actually 50 feet farther from the Station facilities than shown in the FSAR figure at the point where the pipeline exits from the northern boundary of the Station property. Payne, ff. Tr. 5357, at 10.

B-13. Staff witness Ferrell testified that he checked this location of the ARCO pipeline in three ways, (a) by use of a high altitude (24,000 feet) infrared photograph of the Limerick site (Attachment 1 to the prefiled testimony of Ferrell et al. See Tr. 6133-35.), (b) a high altitude (12,000 feet) black and white photograph of the Limerick site (Attachment 2 to the same prefiled testimony) (c) and by flying over the site at low elevations. Ferrell et al., ff. Tr. 6136, at 4, 5. He concluded that the ARCO pipeline is accurately indicated on Figure 2.7 of the SER. This Figure appears to be a reduced replica of Applicant's Ex. 18.

B-14. FOE failed to controvert the evidence of the Applicant and Staff concerning the location of the ARCO pipeline. The Board finds that the location of the ARCO pipeline is accurately indicated on Applicant's Ex. 18.

B-15. In any event, the exact location of the pipeline is important only for the purpose of determining the location of potential flammable mixtures of gasoline and air that could result from a pipe break. Measuring distances to within 1/16 inch on Applicant's Ex. 18 permits distances to be determined within approximately ten feet, which, as will become evident in our discussion of consequences, is clearly more than accurate enough for the analysis required for reaching our conclusions with respect to this contention. We rely, however, on the Applicant's survey, as presented in Mr. Payne's testimony. Payne, ff. Tr. 5357, at 3-5.

d. Nature of the Release.

B-16. A number of "scenarios" were postulated for the release and distribution of gasoline from the ARCO pipeline, its evaporation and formation of an explosive volume within the atmosphere, its burning or detonation and the resulting heat and overpressure impacts on the Limerick structures. Initially, Applicant assumed a break to take place where the pipeline crosses Possum Hollow Run at a time when automobile gasoline was being transported. Gasoline was postulated because it is the most volatile substance transported by the pipeline and has the highest energy content. Because the pipeline is monitored by pressure sensors to detect sudden rises or decreases in pressure that would automatically shut off the pumps, Applicant assumed that the total amount of gasoline released would be limited to that contained in the pipe between the high points on either side of the break. This was calculated to be 4,962 gallons. Walsh, ff. Tr. 5411, Attachment 1, at 1-2. By assuming the break at the low point -- Possum Hollow Run -- the maximum amount of gasoline would be released. In the case of a small leak, Applicant testified that it would be detected by the operators in a relatively short time by inventory procedures and the pipeline would be shut down. Walsh, ff. Tr. 5411, at 3-4. Applicant also initially omitted consideration of any siphoning effects that could increase the amount of gasoline escaping, because to achieve such siphoning, an additional opening to the atmosphere would have to occur at a location beyond an adjacent high point. Id. at 5-6. Intervenor challenged the lack of consideration of siphoning in its Contention V-3a. While the Board finds that siphoning could not be conclusively excluded, based on the record before us, we need not try to speculate on the additional amount of gasoline discharged from the break caused by siphoning which might result from an additional opening in the pipe at some other undefined location. Rather, the Board notes that the record also does not support the reliability of automatic or manual shutdown of the pumps in the event of a leak from or break of the pipe. Thus, as a worst case, we consider the case where the pumps operate continuously after the break.

e. Formation of a Flammable Mixture.

B-17. The "source term" for the quantity of gasoline that could lead to an explosive mixture with air, is not the total amount that escapes the pipe, but instead the surface area of the gasoline as it spreads over the terrain after leaving the pipe. The surface area is the important consideration because it controls the rate at which the gasoline evaporates and permits the vapor and air to form an explosive mixture. Walsh, ff. Tr. 5411, at 6. We proceed to consider the surface area that might be covered with gasoline as a result of a pipe break not only at the low point where the pipeline crosses Possum Hollow Run, but at other locations as well. Breaks at locations other than the low point could produce a larger surface area of gasoline for evaporation.

B-18. Considering the topography traversed by the ARCO pipeline (see App. Ex. 18), it is clear that given a break in the pipeline at any point between the high points on either side of Possum Hollow Run, the escaping gasoline will flow downhill under the force of gravity toward Possum Hollow Run and thence downstream in Possum Hollow Run (generally to the southwest) to the Schuylkill River. Given a break in the pipeline on the other side of either high point (away from Possum Hollow Run), the escaping gasoline would flow downhill under the force of gravity in a direction generally away from the plant structures, to less proximate drainage systems, and therefore cause lesser effects. Walsh, ff. Tr. 5411, at 4. Thus, the worst case, and therefore the bounding case, that we need only to consider is a break between the high points on either side of Possum Hollow Run.

B-19. The size of a pipe break can, of course, range from a complete double-ended guillotine failure to a small crack. For the complete break, gasoline would be released from the upstream section of the pipe no faster than the quantity pumped per unit time. For the downstream section of the pipe, only that gasoline in the pipe which could flow out of that section under gravity and/or siphoning could escape. Flow under these conditions would be characterized as a gushing as opposed to a spray. For smaller cracks, gasoline would be sprayed at a rate depending on the crack size and existing pressure within the pipe. It is known from experience that under conditions similar to a break in the ARCO pipeline, the sprayed material from a crack can cover a significant area, certainly as much as the order of 9,000 square feet. Staff Ex. 9, NTSB-PAR-76-8, Fig. 3. 5/ Assuming such a continuous discharge to be spraying an area on the east bank of Possum Hollow Run and just below the southern high point of the pipeline, the gasoline would then flow downhill to Possum Hollow Run, covering additional terrain. Assuming the area sprayed to be roughly circular, its diameter would be approximately 130 feet. Thus the width of the swath covered by the downward flowing gasoline would be approximately 130 feet. From the site plan (App. Ex. 18) the distance from the postulated break to Possum Hollow Run is approximately 500 feet. The total area on the east bank covered with gasoline would be not more than 500 x 130 = 65,000 square feet. In fact, the area would be much less, since the gasoline would flow in rivulets rather than uniformly covering the entire area. Tr. 5723 (Walsh).

5/ From the figure the maximum distance gasoline was sprayed from the SOCAL 8" pipeline was approximately 130 feet. The area sprayed approximates one sixth of a circle with a radius of 130 feet. Thus, the area sprayed was approximately $\pi(130)^2/6$ = 9,000 square feet.

B-20. In its initial analysis the Applicant assumed that the quantity of gasoline (4,962 gallons) it assumed to be discharged from the break located at Possum Hollow Run was confined to the creek bed between the location of the break and the first downstream bridge in a pool 610 meters long by one meter wide by three centimeters deep. Walsh, ff. Tr. 5411, at 5. No credit was taken for outflow to the Schuylkill River or for absorption of gasoline into the soil. This 610 square meter pool corresponds to 6,566 square feet. The Staff, in its Supplemental Testimony, postulated the area of the spill from the hillside break as the sum of the area of the spill pathway on the hillside (3 m x 158 m) and the area of the pool 610 m long, but 3 m wide, i.e., 474 m^2 + 1830 m^2 = 2300 m^2, or 24,800 square feet. Ferrell et al., ff. Tr. 7136, at 2. Due to the width of Possum Hollow Run, the Staff considers the assumption of a 3 meter width water surface of the pool to be conservative by a factor of two. Tr. 7157 (Ferrell).

B-21. Applicant assumed the evaporation rate of gasoline to be one centimeter per hour, with all the butane being evaporated in the first hour at a uniform rate. From this, Mr. Walsh calculated that 1,922 gallons of gasoline evaporated in the first hour. Then, using the explosive limits for gasoline vapor, of 1.3 to 6.0% by volume, he calculated that if layering and gradual upward expansion of the vapors in the valley are assumed, (0.06-0.013 = 0.047) x 1922 = 90.3 gallons of gasoline would be within explosive limits. For gasoline at 5.75 lb/gal this corresponds to 519 pounds, which would be equivalent to 5,252 pounds of TNT equivalent, if all were detonated. Walsh, ff. Tr. 5411, Attachment 1, at 1-3. The Staff, using a conservative calculational technique to estimate the gasoline evaporation rate, and conservative atmospheric temperature and stability assumptions, derived the amount of gasoline vapor assumed to be in the valley to be 773 pounds (approximately 134 gallons). The Staff then, very conservatively, assumed all of this vapor to be in the flammable range and thus equivalent to 1,856 pounds of TNT if detonated. Ferrell et al., ff. Tr. 7136, at 5. Applicant initially used a conversion factor for TNT equivalent that was four times too great.

f. Overpressure Calculations.

B-22. The actual volume of explosive vapor would be distributed over a length of some 600 meters along Possum Hollow Run. Both Applicant and Staff, however, assumed a point source for the blast. Such an assumption is clearly conservative, perhaps by a factor as much as 10. Ferrell et al., ff. Tr. 7236, at 5-6; Tr. 7158-59, 7263 (Ferrell); Tr. 6187 (Campe); Tr. 7165 (Markee); Tr. 5602 (Walsh). The Staff assumed the location of the point source to be 960 feet due east of the Unit 2 reactor building, whereas the Applicant assumed both 800 feet (where the slope of the valley toward the reactor building is most gradual) and at 550 feet (in the direction of the closest approach of Possum Hollow Run to the Station). Both Applicant and Staff took no credit for shielding effects of the topography on the calculated overpressure resulting at the reactor building from the assumed detonation of all of the explosive mixture. The Applicant's results were 1.9 psi at 800 feet and 3.0 psi at 550 feet (using the incorrect, overly conservative conversion factor for TNT equivalence). Walsh, ff. Tr. 5411, at 7-8; Tr. 5575-78, 5583-88 (Walsh). The Staff calculated a peak reflected blast overpressure, from a detonation 960 feet due east, on the Unit 2 containment building of 1.1 psi for an assumed wind speed of 1 m/sec and 1.2 psi for 2 m/sec. Ferrell et al., ff. Tr. 7136, at 6. For a wind speed of one m/sec. and 550 feet the Staff calculated 2.1 psi. Tr. 7344 (Campe).

B-23. With respect to the postulated break in the ARCO pipeline, Mr. Hasbrouck's scenario included the following: 42,000 gallons of gasoline sprayed over 10,000 m^2 (approximately 108,000 $ft.^2$), for which he had no scientific basis, Tr. 5995, 6004, 6100-01, 6115 (Hasbrouck), resulting in 10,500 gallons of gasoline in an explosive mixture. This compares with Applicant's result of 90 gallons and the Staff's conservative estimate of approximately 135 gallons. The sprayed patch of brush and trees on the side of the hill supposedly would generate dense vapor which then slides down the hill. This movement supposedly sucks in fresh air which causes added evaporation. Thus the vapor density supposedly powers a convection current down through the patch. With an unlucky selection of slope, breeze, etc., this convection current consists of an explosive mixture, i.e., any value between 1.3 percent and 6 percent by volume. Hasbrouck 1, ff. Tr. 5750, at 2-3.

B-24. Other FOE postulates, i.e., two simultaneous explosions, transport of a flammable mixture to the Schuylkill River and upstream along the railroad track and suction by the cooling towers of an explosive mixture out of Possum Hollow towards the plant, were similarly unsupported. Tr. 5257-58 (Ferrell, Markee); Hasbrouck 2, ff. Tr. 5750, at 3; Tr. 7352-53 (Hasbrouck); Tr. 7353, 7488-89 (Markee).

B-25. The Board assigns no credence to the FOE postulates and resulting calculations of overpressure on the Limerick structures resulting from a breach of the ARCO pipeline. Rather, the Board finds that the peak positive reflected pressure of 2.1 psi calculated by the Staff is conservative.

4. The Columbia Gas Pipelines.

a. Description of the Pipelines.

B-26. Columbia Gas Transmission Corp. operates two pipelines that transport only natural gas (methane). These pipelines share a common right of way and run parallel to each other 20 to 30 feet apart, generally southwest to northeast through Montgomery County, Pennsylvania (See Fig. 1 at the end of this section). Pipeline No. 1278 is 14 inches in diameter. It was constructed in 1949 and operates at a normal pumping pressure of 750 psig and a maximum pumping pressure of 938 psig. Pipeline No. 10110 is 20 inches in diameter. It was built in 1965 and operates at a normal pumping pressure of 1,100 psig and a maximum pumping pressure of 1,200 psig. Each pipeline was constructed of steel commensurate in thickness and grade with its maximum operating pressure and, when constructed, was buried a minimum of three feet below grade. Both pipelines are protected against corrosion by an impressed current cathodic protection system which prevents rusting in the same manner as a battery cathode is protected. Brown, ff. Tr. 5261, at 3-4.

B-27. The nearest compressor stations (i.e., pumping stations) to the Limerick Station are the upstream Eagle Compressor Station, located 9.7 miles south of the point where the pipelines cross the Schuylkill River (6,000 feet southeast from the Limerick Station structures) and the downstream Easton Compressor Station located 44.4 miles north of this point. The valves in the pipelines closest to the Limerick Station are at the Schuylkill River and four miles north of the river for line 1278 and 4.3 miles north of the river for line 10110. Id. at 6. These are manual valves. Tr. 5330-31 (Brown).

B-28. Suction and discharge pressures are monitored at both the Eagle and Easton Stations and by the gas control center at Bethel Park, Pennsylvania. High pressures (938 psi on line 1278 and 1,200 psi on line 10110) are designed to cause automatic shutdown of compressors. Tr. 5322 (Brown). Low pressures (425 psi on line 1278 and 770 psi on line 10110) trigger alarms at the control centers and at the Eagle and Easton Stations. Tr. 5321 (Brown). If a low pressure alarm occurred, the compressor units would be shut down manually and no additional gas would be introduced into the lines. Tr. 5288 (Brown). Under worse conditions, where a line break or large leak occurs in the middle of the night and crews must be called out, it was estimated that valves could be closed and the flow of gas stopped within approximately two hours. Brown, ff. Tr. 5261, at 6. Neither line 1278 or line 10110 has experienced any leak or rupture in the history of their operation. Id. at 6. Breaks in other natural gas lines of similar design, structure and usage have occurred. In 1960 a 30-inch pipeline operating at 936 psig suffered a linear fracture of approximately 625 feet. A fire occurred at the moment of rupture, burning trees and landscape 400 to 500 feet on either side of the line, but no damage occurred beyond 500 feet. In 1982, a 10 inch pipeline operating at about 980 psi completely severed, resulting in an instantaneous fire which burned trees and the landscape 250 to 300 feet on either side. Brown, ff. Tr. 5261, at 6.

b. Contents of Pipelines.

B-29. The Columbia Gas pipelines transport only methane in the gaseous state. There are no plans to transport either propane or butane and the existing compressors would have to be replaced before these materials, in either gaseous or liquid form could be transported in any event. Tr. 5318, 5325-27, 5341, 5349-50 (Brown). Further, approval by the Federal Energy (Regulatory) Commission would be required to transport anything other than natural gas. Tr. 5349 (Brown).

c. Location of the Pipelines.

B-30. The Columbia Gas pipelines cross the Schuylkill River at a point approximately 6,000 feet from the Limerick Station structures and proceed approximately in a straight line somewhat north of northeast for more than 2 1/2 miles. Staff Ex. 6, (SER) Fig. 2.6. The actual location, at their closest approach to the Limerick site, is depicted in Applicant's Ex. 18 from which it can be determined that the closest approach is at least 3,400 feet. Applicant verified that the closest approach is approximately 3,500 feet. Payne, ff. Tr. 5357, at 7-10. His attempt to determine the possible error in the location of the pipelines from comparison of a U.S. Geological Survey map and photogrammetric interpretation of pipeline traces and Columbia Gas Transmission Company plans indicated possible mean errors ranging from 15 to 51 feet. Payne, ff. Tr. 5357, at 8, 9. Intervenor FOE/Anthony indicated that he had a lot of confidence in Applicant's site plan and that even if the location of the pipelines were off by 100 feet, he didn't think that would be a controlling factor. Tr. 5361 (Anthony). We agree.

d. Nature of the Release.

B-31. Disregarding the reality or probability of a break in the larger (20-inch) pipeline, for purposes of analysis a double ended rupture was assumed by the Applicant to occur at the closest approach of the pipeline to each of the safety-related structures of the Limerick plant. Boyer et al., ff. Tr. 8213, at 6, 7. For such a break it would be possible for the entire contents of the pipeline between the Eagle compressor station and the Easton compressor station to be released. Since the gas is immediately dispersed in the atmosphere by its own momentum, by diffusion and by wind, the nature of the cloud formed that is potentially explosive depends upon the rate at which the gas is released, not upon the total quantity released during an incident. Thus, it is irrelevant whether or not the compressor stations are shut down after the breaks. The rate of release of gas from a break depends upon the size of the opening in the pipe and the sonic velocity of the released gas. Walsh, ff. Tr. 5411, at 11.

e. Formation of Flammable Mixture.

B-32. When the gas is first released from the pipe, the concentration of methane in air is too rich to be flammable or explosive. As the gas disperses into a cloud, the concentration decreases to the upper limit of flammability and continuing dispersal reduces the concentration below the lower limit of flammability. The flammable limits of natural gas are between 6 and 14 percent by volume in air. Walsh, ff. Tr. 5411, at 12. This dispersion is a continuous process, so that for a constant rate of release of gas, a constant stability condition and constant temperature of the ambient atmosphere and a constant wind speed, a fixed region in space will result within which the methane-air mixture will be within flammable limits. The dimensions of this region define the amount of methane that could burn or explode.

B-33. To calculate conservatively the potential blast and heat effects on the Limerick structures, the Applicant made a number of conservative assumptions. First, the maximum openings in the two ends of the ruptured pipe were assumed to be the full cross-sectional area of the pipe. Second, both pipe ends were assumed to be forced into a vertical orientation. Any other configuration would result in additional turbulence and consequent increased dispersion, causing the point at which the methane-air mixture decreased below the flammable limit to be further from the Limerick plant. Walsh, ff. Tr. 5411, at 11; Tr. 5424 (Walsh). Third, Applicant conservatively assumed an atmospheric stability of Pasquill "F", an inversion condition. Atmospheric conditions actually are more conducive to dispersion 95% of the time. Fourth, Applicant assumed a one meter per second wind, moving the gas cloud directly toward the Limerick Station, during Pasquill "F" conditions, a situation that occurs only 0.004% of the time. Walsh, ff. Tr. 5411 at 10, 11; Tr. 5432-35, 5458, 5470 (Walsh). If the wind were blowing in any other direction, the effects of a potential detonation on the Limerick facility would be less, since the location of the detonation would be further from the Station. Similarly, if the wind speed were higher, greater dilution of the methane-air mixture would occur and the region of flammability would be further from the Station. Walsh, ff. Tr. 5411, at 12. Fifth, Applicant assumed the escaping gas first rose above the ground level from momentum velocity to an elevation of approximately 500 feet, before traveling toward the plant. Tr. 5421 (Walsh). This assumption results in the maximum concentration of the methane-air mixture to occur as far downwind as possible. If the mixture traveled at ground level there would be more mixing with air which also would cause the region of flammability to be further from the plant. Walsh, ff. Tr. 5411, at 12; Tr. 5463-65 (Walsh).

B-34. The Applicant calculated the concentration of natural gas in the atmosphere both downwind, crosswind and vertically as a function of distance at 100 meter intervals downwind from the source of natural gas, under the assumed conservative conditions. From the results of these calculations, Applicant calculated the volume of the region in which the methane-air mixture would be within explosive limits to be 3.74×10^5 m^3. 6/

6/ Volume of ellipsoid = V = 4 x abc/3, where a, b, c are the lengths of the semi axes. A = 840/2 = 429 m, b = 50/2 = 25 m and c = 25/2 = 12.5 m, for the ellipsoid whose surface corresponds to the points where the concentration of methane is at 4.31×10^7 micrograms/m^3, the lower explosive limit. A = 480/2 = 240 m, b = 35/2 = 17.5 m, c = 20/2 = 10 m, for the ellipsoid whose surface corresponds to the points where the concentration of methane is at 1.01×10^8 micrograms/m^3, the upper explosive limit. Walsh, ff. Tr. 5411, Attachment 3, at 3-5.

f. Overpressure Calculation.

B-35. Assuming the average concentration of the gas within the upper and lower explosive limits to be (14% + 6%)/2 = 10%, the volume of natural gas contained within the volume of detonable mixture is 0.10 x $3.74 \times 10^5 = 3.74 \times 10^4$ m^3. Also, assuming the density of methane to be 0.0448 lb/ft^3 at 0^oC, this volume is equivalent to 5.92×10^4 pounds of natural gas at explosive mixture concentration, or 347 tons of TNT equivalent. Walsh, ff. Tr. 5411, Attachment 3, at 3-5. Since the density of methane decreases with increasing temperature, the assumption of 0^oC is conservative most of the time and would not affect the result significantly if the temperature were below 0^oC.

B-36. Using Staff Ex. 7 (NRC Regulatory Guide 1.91) and assuming that the explosion centroid is located at an elevation 500 feet above ground and approximately 700 meters downwind (toward the Limerick Station structures, which would be approximately 1,200 feet from the Unit 2 containment building), triggered by some undefined high energy ignition source, the calculated peak positive normal reflected pressure was determined to be 10 psi at the nearest safety related structure, i.e., the Unit 2 reactor building. Walsh, ff. Tr. 5411, at 5. Additional conservatisms (see B-33, above) in this analysis include:

a. break at exactly the nearest point of approach to the Limerick Station.

b. vertical rise of the gas column to 500 feet above plant grade (where the momentum energy decays), without dilution. Tr. 5428 (Walsh).

c. natural gas clouds seldom, if ever, detonate in an unconfined space.

d. it is difficult to hypothesize an ignition source to trigger a detonation in an elevated cloud.

B-37. FOE postulated a number of conditions which it alleged would cause a flammable mixture to be transported to the vicinity of the Station, i.e., Possum Hollow. These included the assumption of a negatively buoyant (i.e., much colder than ambient) cloud being transported to reach the closest location to the Station. 7/ FOE performed no calculations and did not provide any credible technical basis to support this postulation. Tr. 5990-94, 6085-86 (Hasbrouck). In fact, practical experience in purposely blowing down a natural gas pipeline indicates a reduction in temperature of the gas of seven degrees Fahrenheit per 100 psi reduction in pressure, but the gas does not stay cold because of immediate mixing with the air around it. Tr. 5298, 5346, 5353-54 (Brown); Tr. 5430 (Walsh).

7/ At $0^{o}C$ the density of air is 0.081 lb/ft^3; the density of methane is 0.045 lb/ft^3. Walsh, ff. Tr. 5411, Attachment 3, at 1.

B-38. Consideration also was given by the Applicant to simultaneous rupture of both Columbia Gas pipelines, notwithstanding the lack of basis for such a postulated event. Enhancement of the effects resulting from the simultaneous rupture of the 14" line and of the 20" line would be minimal because of several factors. The difference in diameters and the difference in operating pressures would cause the two plumes to enter the atmosphere at different elevations, causing the zones of flammability to occur at different distances from the Station. Thus, for simultaneous detonations or simultaneous rupture, the overpressure effects would arrive at the Station at different times and therefore not be directly additive. Merging of the two plumes, which could only take place under much less favorable meteorological conditions, would result in the flammable mixture being located closer to the point of release, reducing any overpressure effect. Tr. 5604-04, 5727-28 (Walsh).

B-39. With respect to the Columbia pipelines, Mr. Hasbrouck assumed 350 tons of TNT equivalent at a distance of 800 feet. Hasbrouck 1, ff. Tr. 5750, at 4. Applicant calculated 347 tons of TNT equivalent using a TNT equivalence factor of 10, which is four times too great according to Regulatory Guide 1.91, Rev. 1 (Staff Ex. 7). Ferrell, ff. Tr. 9401, at 5; Tr. 7467 (Campe); Tr. 9170 (Ferrell). Staff used a TNT equivalence factor of 2.4 to obtain 71 tons and used the Applicant's calculated horizontal distance to the cloud centroid of 1200 feet. Ferrell, ff. Tr. 9041, at 6-9; Tr. 9138, 9147 (Ferrell). Mr. Hasbrouck chose 800 feet, by assuming the methane gas would not rise above ground until after reaching Possum Hollow Run and then rising before detonation. Hasbrouck 1, ff. Tr. 5750, at 3-4. In fact, he believed it was possible for a flammable mixture to be caused by a break in the pipeline where it crosses Possum Hollow Run and to travel 5,500 feet and remain in a concentration that would be flammable. He did not have a technical basis for this (scenario) and characterized it as half-baked. Tr. 6008-09 (Hasbrouck). The Board gives no weight to this testimony and finds the testimony of the Applicant and Staff to be credible and uncontroverted with respect to the overpressure and radiant heat load impacts of potential ruptures of the ARCO and Columbia pipelines on the Limerick Station.

B-40. For further explication of the Applicant and Staff results of overpressure calculations, we provide, as Figs. 2, 3 and 4, tabular summaries of overpressure calculations. Boyer et al., ff. Tr. 8213, Tables I and II and Staff Ex. 23. Using the correct value for TNT equivalence, the maximum overpressure calculated by the Applicant was 8.3 psi from an air burst on the reactor building and diesel generator building exterior walls (Fig. 3). The comparable calculations by the Staff resulted in overpressures of 7.4 psi on the diesel generator building Unit 2 exterior wall and 7.3 psi on the reactor building Unit 2 exterior wall (Fig. 4). Figure 2 values were calculated using the conservative (by a factor of four) value for TNT equivalence.

5. <u>Radiant Heat Load Calculations</u>.

a. <u>ARCO Gasoline Pipeline</u>.

B-41. Both the Applicant and the Staff calculated the radiant heat load on the Limerick Station safety related structures resulting from burning gasoline released from the ARCO pipeline. The Applicant's calculation assumed that the total amount of gasoline contained in the pipeline between high points adjacent to the break (4962 gallons) burned in 15 minutes. The 15-minute period was conservatively used to maximize the heat generation rate. Walsh, ff. Tr. 5411, at 8. Based on 20,000 Btu/lb of gasoline, this would amount to 5.71×10^8 Btu released in 15 minutes or at a rate of 2.28×10^9 Btu/hr. Id., Attachment 2, at 5-6. The radiant heat may be calculated using the formula, Id. at 5,

$D = (FQ/(4\ K))^{\frac{1}{2}}$, where

D = distance in feet from flame midpoint to receptor

F = fraction of heat radiated

Q = heat release in Btu/hr

K = heat radiated in Btu/ft^2 hr,

$D^2 = FQ/12.57\ K$

$K = FQ/12.57\ D^2$

For $F = 0.30$ (based on Butane values)

D = 800 feet, the distance to Possum Hollow Run in the direction in which the valley wall is least steep on the Station side, to minimize the effects of shielding by the valley wall.

$K = 0.30 \times 2.28 \times 10^9/12.57 \times 6.4 \times 10^5$

$= 85$ Btu/ft² hr. This is equivalent to approximately 270 watts/m².

B-42. Applicant also calculated the radiant heat load on the Unit 2 reactor building arbitrarily assuming 21,000 gallons of gasoline burned in 15 minutes, a scenario it does not believe to be credible, to demonstrate the effects of four times as much gasoline burned as in its original calculations. Using the same method and 800 foot distance, the result was 350 Btu/ft² hr. Walsh, ff. Tr. 5411, at 9. This would be approximately 1100 watts/m².

B-43. The Staff's calculation proceeded differently. It believes that ignition of a gasoline vapor cloud would cause burning in less than one minute, or would flash back to the point of issuance of gasoline from the pipe rupture. This was considered reasonable, since the liquid gasoline on the hillside and along the creek would be rapidly consumed. Ferrell et al., 7136, at 12. It believes the potential thermal effects of such burning would be insignificant because of the distance from the Unit 2 reactor building and because of the expected short duration of the fire. To estimate the radiant heat from a sustained fire of the gasoline issuing from the rupture, it assumed a 100 foot diameter vertical column of burning gases located at the pipe break, i.e., at the nearest approach of the pipeline to the Unit 2 reactor building, a distance of 1625 feet. The result was 265 watts/m². Ferrell et al., ff. Tr. 7136, at 12-13; Tr. 7431 (Ferrell).

B-44. The Staff noted that the average solar flux in Washington, D.C. is 170 watts/m² and the peak solar flux in Albuquerque, N.M. is in the range of 1000 to 1250 watts/m². Id.

B-45. The Board finds, based on the uncontroverted testimony of the Applicant and Staff, that the radiant heat load on the safety related structures of Limerick Station resulting from burning gasoline released from a rupture of the ARCO pipeline will not pose an undue hazard to the Station.

b. Columbia Gas Pipelines.

B-46. With respect to a rupture of the Columbia 20" gas pipeline, the Applicant calculated the radiant heat load on the safety related structures of the Limerick Station using the same formula, as above.

B-47. Applicant assumed the heat release to be the volume of gas burned per second times the heat content released per unit volume, i.e., 4800 ft³/sec x 1050 Btu/ft³ = 5.04×10^6 Btu/sec or 1.814×10^{10} Btu/hr. Walsh, ff. Tr. 5411, Attachment 2, at 1. The record does not show the basis for the 4800 ft^3/sec number, but the heat release clearly is conservative, since the Applicant assumed extended burning of the vapor cloud at its closest approach to the Station. Assuming that the cloud burns at 1200 feet from the station

$$K = 0.25 \times 1.814 \times 10^{10}/12.57 \times (1200)^2$$

$$= 250 \text{ Btu/ft}^2\text{-hr}$$

B-48. The Staff also calculated the consequences of burning of natural gas released from the 20" Columbia pipeline. It considered a double ended rupture occurring at the closest approach (3500 feet) of the pipeline to the Station, resulting in a natural gas fireball of 300 foot diameter and infinite height. The 300 foot diameter is believed by the Staff to be characteristic of previous experience. Even if the initial diameter were larger, it would diminish in seconds and the Staff analysis assumed sustained burning over a long period of time. The infinite height was assumed for calculational simplicity. Tr. 7436-37 (Campe). The Staff concluded that the potential heat flux from a burning natural gas cloud would be insignificant with respect to the plant structures. Campe, ff. Tr. 6131 at 3. This conclusion is corroborated by reference to Staff Ex. 14, NUREG/CR-1748, which estimates the thermal radiation (mean emissive power) from a turbulent methane flame to be 100 kw/m^2. Using the formula, Id. at F-2,

$\bar{F} \doteq F(D/r)^2$, where

$\bar{F}$ = radiant heat at the receptor

F = radiant heat at the flame edge

D = diameter of flame

r = distance from flame to receptor

τ = transmissivity of the atmosphere

And using a conservative value of τ as 0.66, Id. at F-3, a diameter of 300 feet and a distance of 3350 feet,

$$\overline{F} = 100(300/3350)^2 \times 0.66$$

$$= 0.802 \times 0.66 = .53 \text{ kw/m}^2$$

$$= 530 \text{ w/m}^2$$

B-49. This is the result reported in the SER, Staff Ex. 6, p. 2-13. While comparable to solar heat radiation radiation, the effect on Station structures would indeed be insignificant.

6. Effects of Postulated Detonation on Safety-Related Structures.

B-50. In response to a request by the Board, the Applicant and Staff analyzed the ability of safety-related structures at the Limerick Generating Station to withstand the effects of postulated detonations resulting from the assumed rupture of the ARCO and Columbia Gas transmission pipelines. The Board expressed an interest in both the ability of the structures to withstand such postulated detonations and the margins of structural safety above the calculated blast overpressures inherent in the design of the structures. Tr. 5934-35. Evidentiary hearings on the ability of the structures to withstand the postulated explosions and the margins of structural safety took place on March 8, 9, and 20-23, 1984.

B-51. In assessing the ability of a structure to resist the effects of explosions, the effect to be considered is the resulting pressure on the structure. This pressure (or overpressure) is in the form of a shock-wave which expands through the air radially from the center of the explosion and diminishes with distance. As the shock wave impinges on the structure, the structure will experience a structural loading. The magnitude of the loading is measured in units of pressure -- commonly pounds per square inch (psi). Given the size of the explosion in TNT equivalence and the distance to a given structure, the overpressure on the structure in psi can be calculated. The structure can then be assessed as to its ability to withstand the applied overpressure loading. Both Applicant and Staff, using conservative explosion scenarios, assessed the ability of the safety-related structures at the Limerick Station to withstand the postulated explosions. Boyer et al., ff. Tr. 8213; Ferrell, ff. Tr. 9041; Kuo and Romney, ff. Tr. 9043.

B-52. Applicant calculated the highest overpressures that would result from the worst-case ARCO or Columbia Gas pipeline explosion on the roof and exterior walls of each safety-related structure. Boyer et al., ff. Tr. 8213 at 6-13. See Fig. 2 at the end of this section.

B-53. The pressures resulting from the postulated rupture and detonation of gasoline from the ARCO pipeline were always significantly less than that resulting from an assumed detonation of the vapor from the Columbia Gas transmission line rupture. The maximum peak positive reflected pressure from an ARCO pipeline explosion calculated by the Applicant (Walsh) was found to be 1.9 psi. Id. at 7.

B-54. For the postulated Columbia Gas pipeline rupture, both Staff and Applicant utilized the methodology set forth in Reg. Guide 1.91 (Rev. 1), for determining TNT equivalency to hydrocarbons and graphs provided in the Army Technical Manual TM 5-1300 "Structures to Resist the Effects of Accidental Explosions." Id. at 6-11; Ferrell, ff. Tr. 9041, at 2. Staff Ex. 7 and 20. The peak pressures shown as design/assessment values for the Columbia pipeline explosion in Applicant's Table I (see Fig. 2 at the end of this section), represent the maximum pressures that would be developed assuming a surface burst and a detonable mixture approximately four times that suggested by Reg. Guide 1.91 (Rev. 1). Applicant recalculated the blast overpressures in accordance with the guidance of Reg. Guide 1.91 (Rev. 1). The recalculated values are shown in Columns 1 and 2 of Applicant's Table II (see Fig. 3, attached), and are lower than the values in Table I. The pressures used in Applicant's structural margin assessments were taken from Table I and represent an additional conservatism. The highest overpressure for a Columbia gas explosion shown in Table I is 10 psi while the highest value shown in Columns 1 or 2 of Table II is 8.3 psi. Boyer et al, ff. Tr. 8213, at 7, Table I and II.

B-55. Neither Staff nor Applicant agreed that the detonation of unconfined or open-air natural gas cloud is a credible event. Ferrell, ff. Tr. 9041, at 2 and Tr. 9066; Boyer et al., ff. Tr. 8213, at 5. Uncontroverted evidence established that unconfined natural gas can only be detonated with high energy sources such as TNT and even then with difficulty. No such sources of energy are known to be available at the Limerick site. Tr. 6157-58, 7423, 7450-52 (Campe).

B-56. Regardless of the evidence presented as to the improbability of an open-air gas detonation, as a conservatism, both Applicant and Staff assumed a gas explosion at a horizontal distance of 1200 feet from the structure and at 500 feet elevation, the maximum height to which the natural gas could rise as a result of momentum from the postulated pipeline breach. The Board notes that no sources of ignition exist at 500 feet, let alone a source of sufficient energy to cause a detonation. Boyer et al., ff. Tr. 8213, at 6, 8; Ferrell, ff. Tr. 9041, at 2.

B-57. Applicant also calculated overpressures assuming an air burst and a surface burst. From these calculations, Applicant determined that estimated overpressure produced from the postulated TNT-loaded railroad boxcar explosion used in the design basis and elevated natural gas

(500-foot elevation) explosions were greater than those of all other postulated pipeline scenarios. Boyer et al., ff. Tr. 8213, at 11.

B-58. Staff and Applicant calculations for the 500-foot elevation gas explosion and employing the guidance used in Reg. Guide 1.91 (Rev. 1) are in close agreement. Tr. 8815 (Walsh); Tr. 9067-8 (Ferrell). Any differences in the numbers are attributed to the analyst's accuracy in picking the numbers off the table in Army Technical Manual TM 5-1300. Tr. 8815 (Vollmer). The comparable values are contained in Column 2 of Applicant's Table II and Column 1 of Staff's Table 1 (Boyer et al., ff. Tr. 8213 and Staff Ex. 23, ff. Tr. 9055 resp.). The largest difference between comparable Applicant and Staff Columbia blast overpressure calculations was 1.0 psi (for the reactor building wall). This is larger than might be expected to result from inaccuracy in reading values from a graph. The difference might be explained by the Staff's use of 1300 feet as the distance from the structure. Ferrell, ff. Tr. 9041 at 7. It appears that Applicant used a horizontal distance of 1200 feet in its calculations, not the slant distance of 1300 feet. Boyer et al., ff. Tr. 8213 at 6.

B-59. Staff calculations indicated that the railroad boxcar explosion generated greater overpressures than any postulated explosions of either the ARCO or Columbia Pipeline materials. Ferrell, ff. Tr. 9041, at 10 and Table 1 (Staff Ex. 23), ff. Tr. 9055. (Figure 4 of this Decision.)

7. Margin Analysis of Margins of Structural Integrity to Postulated Overpressures.

B-60. After determining the critical overpressure for each safety-related structure (Reactor Buildings and Diesel Generator Buildings for Units 1 and 2, the Control Building and the Spray Pond Pumphouse), Applicant identified the critical wall of each structure and the critical element of that wall for detailed analysis. The critical element selected was a one-foot wide beam element with fixed ends. This is a conservative selection of the critical element because if the wall slab had been evaluated as a whole rather than as a beam section, considerable additional support would have been provided by the adjacent walls. Tr. 8417, 8479-81, 9018 (Vollmer); Kuo and Romney, ff. Tr. 9043, at 4.

B-61. Applicant then isolated the one-foot wide wall strip and applied the highest determined overpressure as a uniform load on the length of the strip. The criterion used for structural adequacy was the ductility ratio of the element. Tr. 8822-23 (Wong).

B-62. The response of a structure or structural member to load is deformation. Loading up to a certain level results in elastic deformation. For any loading imposed up to the elastic limit, the structure will return to its original shape when the load is removed. Any loading greater than the elastic limit puts the material into the plastic range and results in permanent deformation. Materials or structural elements that have deformed into the plastic range will not return to their original shape. Ductility is the ability of a structure or structural member to deform beyond its elastic limit without rupturing. The "Ductility Ratio" is the ratio of the total deformation (elastic plus plastic) to the deformation that would occur at the limit of the elastic range. Kuo and Romney, ff. Tr. 9043, at 5.

B-63. Applicant calculated the ductility ratios for the loaded critical sections and compared the calculated values against the maximum code allowable, which is forth set in Reg. Guide 1.142 as a mid-span ductility ratio of 3.0 and an end-point ductility ratio of 10. Tr. 8948 (Palaniswamy).

B-64. After applying the maximum blast overpressures to the structures and calculating the ductility ratios, the ratios were compared with the code-allowable value of 3.0 for mid-span and 10.0 for the end-point ratio. In all cases the determined ductility ratios were within the limits established by the code. The highest mid-span ratio calculated was 2.2 and the worst case end-point ratio was 2.9. Tr. 8947-48 (Palaniswamy); Tr. 9069 (Kuo).

B-65. The Applicant then determined the blast overpressure that would cause deformation up to a ductility ratio of 3.0 at mid-span and compared that value with the calculated blast overpressure. The result was expressed as a percent of margin. Boyer et al., ff. Tr. 8213, at 13-15; Tr. 8822-24 (Wong).

B-66. Staff did not make independent calculations of ductility ratios, margins, or shear and moment calculations of the safety-related structures. They did, however, make a detailed review of the assumptions, models, techniques and methodologies employed by Applicant and found them to be appropriate and conservative. Kuo and Romney, ff. Tr. 9043, at 3-4; Tr.. 9069-70, 9221 (Romney); Tr. 9206-08, 9221-23 (Kuo).

B-67. Regarding the conservatism of the bounding ductility ratio of 3.0 for mid-span deformation, tests have indicated that beam elements such as the wall panel strips used in the structural analysis here, do not actually fail until they reach ductility ratios of 20 and beyond. Tr. 9019-20 (Palaniswamy). The one-way slab analysis, used by Applicant in its assessment, rather than a two-way analysis, is conservative in that no credit is taken for support from adjacent walls. If a two-way analysis were to be used, the structural safety margins would be larger. Tr. 9206-07 (Kuo); Tr. 8417, 9018 (Vollmer). The calculated safety margins are not predicated on the ultimate failure threshold of the structure. They are based on code values acceptable for structures of the type considered here. Accordingly, some additional unquantified safety margin above the calculated margins exist for these structures. In Applicant's Table II (ff. Tr. 8213) (Fig. 3, attached), a comparison of Columns 3 and 4, respectively, which are the pressures calculated using the conservative TNT equivalent (by a factor of four), with the pressures used in structural assessment (Column 5), margin is shown to be available in both the reactor building and the diesel generator building. For the control structure and the spray pond pumphouse the values of four times the Reg. Guide values exceed the structural assessment values. For those cases, using the proper TNT conversion factor, margins do exist, as is apparent from the values listed in column 2 of Figure 3. Applicant's demonstration of a structural safety margin for the reactor and diesel generator buildings even when using four times the TNT - equivalent explosion suggested by Reg. Guide 1.91 (Rev. 1) is a significant additional conservatism in assessing the adequacy of the Limerick structures to resist the effects of blast overpressures. Boyer et al., ff. Tr. 8213, at 12, 13; Tables I and II, ff. Tr. 8213.

B-68. Applicant also conducted an evaluation of the global response margins inherent in the design of the safety related structures at Limerick. This evaluation consisted principally of a determination of the overturning moment and story shear on entire structures as a result of the postulated explosions and a comparison with the moments and shears resulting from the design basis safe shutdown earthquake (SSE). In each case, the overturning moment and the story shear associated with the SSE were found to be larger than that associated with the postulated explosions. Since the plant has been designed to withstand the safe shutdown earthquake loading values, there is more than adequate structural capacity to resist the forces associated with the postulated explosions. Global response safety margins were calculated by dividing the SSE loading values by the loading values calculated as a result of the explosions. Kuo and Romney, ff. Tr. 9043, at 8 and 9; Tr. 9361-62 (Kuo); Vollmer et al., ff. Tr. 8213, at 11; Tr. 8824-26 (Wong); Tr. 8826-27 (Vollmer).

8. Factors Allegedly Not Considered in Margin Analysis.

a. General.

B-69. FOE alleged that the Applicant's margin analysis did not consider the effec f deadload, vibratory loads, inside/outside pressure and temperature differentials, hydrostatic pressure and differential settlement on the safety-related structures at the Limerick generating station. Testimony indicated that each of these factors was adequately considered. Tr. 8368-83, 8442-54, 8463-73 (Wong, Boyer, Vollmer, Palaniswamy, Walsh, Benkert); 9181-9247 (Romney, Kuo).

B-70. Regarding the consideration of gravity and deadload, uncontroverted evidence established that the deadload consisting of the weight of the walls and equipment attached th.reto is transmitted to the ground as a vertical compressive load. Si.ce the forces associated with the postulated explosions would act horizontally and thus perpendicular to the walls, the effect of the deadload and the blast overpressure would not be directly additive. Tr. 8442-45 (Vollmer, Palaniswamy); Tr. 9201 (Romney). Structural members are designed for combination of deadload, liveload, earthquake and tornado loads. Forces resulting from the appropriate load or loads are combined with the blast overpressure and were considered in the margin calculations. Tr. 9236-37 (Kuo), Tr. 9202-03 and 9245 (Romney). Applicant's witnesses further testified that the compression resulting from deadload is actually beneficial in terms of the ability of a structural wall to withstand bending since it acts as a pre-stress. Tr. 8445 (Palaniswamy). The roof slab deadload acts in the same direction as a downward acting blast pressure and was therefore considered additive as appropriate. Tr. 8372 (Vollmer), Tr. 8442-43 (Palaniswamy), Tr. 8442-45 (Vollmer).

B-71. FOE's allegation that vibratory load from equipment operating within the reactor building was not considered in the structural analysis was likewise unsupported by the evidence. Tr. 8372-73 (Vollmer, Palaniswamy). Evidence indicated that vibratory loads were considered and found to be negligible. Tr. 8374, 8378-79 (Palaniswamy). Applicant's witnesses further testified that any portion of the vibratory load not eliminated by the damping effect of the 1½- to 2-foot thick floors would primarily be transferred from the floor slab to the supporting beams and columns, thus leaving the wall slabs largely unaffected. Tr. 8375 (Boyer); Tr. 8377 (Wong). The roof slabs would not experience vibratory loading since there is no moving equipment on them. Tr. 8378 (Wong); Tr. 8378-79 (Palaniswamy).

B-72. FOE's claim that Applicant's margin analysis did not examine pressure or temperature differentials between the interior and exterior of the reactor building was also found to be without merit. The evidence indicated that the reactor building is operated under a negative pressure of about 0.01 psi to prevent releases from escaping the building. Such a small pressure difference would have no effect on the results of a detonation or on the margin analysis. Tr. 8446 (Vollmer). As regards temperature differences, the evidence indicates that temperature loading is considered in the design of safety related structures as required by Regulatory Guide 1.142, but is not required to be considered in the analysis of blast overpressures. Tr. 9181-83 (Romney). Further, any difference between the inside and outside temperatures would have a negligible effect on the margin analysis since the containment wall is over thirty inches thick and is well insulated from temperature changes. Tr. 8447-50 (Vollmer).

B-73. Hydrostatic forces were considered in the design of below grade walls of the safety related structures at Limerick. Tr. 8463-64 (Vollmer); Tr. 9189-92 (Romney). Both Applicant and Staff testified that hydrostatic pressure exerts force only on the portions of the wall that are below grade level. Walls above grade level are not affected by hydrostatic pressure. In evaluating the effects of an explosion on a building structure only the walls above grade need be considered. Tr. 8464, 9191-96, (Kuo, Romney); Tr. 8468-69 (Vollmer).

B-74. FOE's allegation that differential settlement was not considered is without merit. Stresses that would be caused by differential settlement were considered in the design of the structure. The Limerick structures, however, are located on a competent rock foundation and on foundations of this type there is no differential settlement. Tr. 8469 (Vollmer); Tr. 9215-17 (Romney).

b. Reactor Building Openings.

B-75. FOE postulated that the blast wave would enter the reactor building through a nine-foot high by a forty-foot wide louver in the south wall and/or a two-foot by two-foot roof opening of the reactor building and damage the safety-related equipment and systems inside. Both Applicant and Staff testified that the louver in the south wall is not safety-related and opens into a compartment which houses non-safety related HVAC equipment. Its failure would in no way affect the integrity of the reactor building or the ability to safely shutdown the facility. Tr. 9110-13 (Kuo, Romney, Lefave); Tr. 9132-33 (Kuo, Romney); Tr. 8956-57 (Wong). Additionally, the walls surrounding the compartment housing the HVAC equipment are one-foot thick and would resist any residual overpressure that is not absorbed by the louver. Tr. 9114 (Kuo); Tr. 8955-58, 8965 (Wong). Applicant's calculations indicate that even if the pressure from an explosion were not absorbed in any way, by the louver, inter-compartment walls or plenum, the average pressure inside the reactor building would increase by no more than 0.016 psi and would have a negligible effect on the building and any equipment contained therein. Tr. 8965-66 (Walsh). By comparison it takes 0.1 psi to break a normal house window. Tr. 8958 (Ashley).

B-76. The two-foot square roof opening in the reactor building which is covered by a sheet metal blowout panel designed to relieve pressure inside the building and does not serve any structural purpose. Tr. 8959-60 (Wong). Even if the sheet metal blowout panel were displaced, the resulting pressure differential would be insufficient to dislodge any pipes that might be nearby and the pressure wave would quickly be reduced to ambient as it expanded inside the large volume of the reactor building. The increase in pressure within the building's interior would be less than 0.01 psi. Tr. 8960-61 (Ashley); Tr. 8960-63 (Wong, Ashley).

B-77. The sheet metal buildings on the north and south sides of the reactor building roof could conceivably be damaged by a postulated natural gas explosion. These buildings, however, are not required for the safe shutdown of the station and even if destroyed, would not provide an opening into the reactor building since the conduits passing between these buildings and the reactor building are sealed and would not be affected by an explosion. Tr. 8969-70 (Wong).

c. Effect of Detonation on Underground Structures.

B-78. Applicant and Staff also determined that the blast pressure or deflagration would have no effect on underground related structures or equipment since buried safety-related pipes and ducts must have a minimum cover of four feet of soil or the equivalent in concrete or other material. Kuo, Romney, ff. Tr. 9043, at 11; Tr. 8864-65 (Boyer). Four feet of soil or equivalent cover can withstand a minimum of 3,000 to 4,000 lbs. per sq. foot, which is an order of magnitude greater than the load that would result in any of the postulated explosions. Similarly, the manhole and duct-to-bank covers are at least that strong since they are designed for high impact loads such as would result from a tornado missile. Tr. 8805-06 (Wong); Tr. 8806 (Vollmer).

9. The Effects of a Postulated Cooling Tower Collapse.

B-79. FOE speculated that the cooling towers would rotate about their base and overturn from explosive forces, thereby causing potential damage up to a radius of greater than the 550 feet height of the towers. Both Staff and Applicant testified that this event is highly unlikely because the relatively thin shelled cooling tower structure is not likely to maintain its rigidity as it collapses. Kuo and Romney, ff. Tr. 9043, at 11; Tr. 9278, 9284-5 (Romney); Boyer *et al.*, ff. Tr. 8213, at 15, 16.

B-80. Applicant postulated a concrete missile 5'x5'x1' resulting from the failure of a cooling tower falling directly onto buried safety-related piping. Using conservative assumptions (200 feet per second velocity as compared to a free fall velocity of 188 feet per second from the top of the 550-foot tower and orientation such that the corner strikes the ground first), Applicant calculated that the concrete section would only penetrate 2.8 feet into the soil and would not affect the safety-related facilities buried below. The analysis further showed that the impact would not overstress the buried pipes or concrete duct banks due to compression. The analysis included the duct bank manholes which would be adequately protected by their steel and concrete covers. Boyer et al. ff. Tr. 8213, at 16-17. Staff agreed with Applicant's analysis stating also that it is conservative in that the cooling tower collapse would likely produce much smaller pieces of debris than assumed by Applicant. Kuo and Romney, ff. Tr. 9043, at 11-12.

B-81. FOE then postulated several scenarios involving pieces of cooling tower debris. One such scenario involved steel reinforcing rod by itself or extending from a dislodged concrete section penetrating greater than the 2.8 feet calculated by Applicant and causing damage to buried structures. Unrebutted evidence established that individual steel rods will not fall separately or protrude in any significant length from broken pieces of concrete. Tr. 8876 (Vollmer), Tr. 8877-77 (Buchert).

B-82. FOE also speculated that the 70-foot tall column supporting the cooling tower and the 500 kv transmission towers would also fail and penetrate nearby buried safety-related structures. Evidence established that the 70-foot cooling tower support columns would pivot on their bases and fall, penetrating about one foot into the ground. Since the nearest buried safety-related structures are one hundred feet away and buried at a minimum of 4 feet or equivalent, they would not be affected. Tr. 8913-14 (Vollmer); Tr. 8914 (Boyer); Applicant's witnesses testified that even if the transmission towers failed, they would buckle and fold over. The effect of their impact on falling would be less than the missiles for which the buried safety-related ducts (e.g. power lines, to spray pond) are designed to resist. Tr. 8923-24 (Vollmer); Tr. 9260 (Romney).

B-83. FOE postulated failure of the walls of the cooling tower basin and subsequent flooding of the turbine building and allowing water to enter the reactor building and control building, preventing a safe shutdown of the plant. FOE, in the alternative, postulated that even if the walls of the cooling tower basin were to remain relatively intact, cooling tower debris falling into the basin would result in increased flooding. Both Staff and Applicant addressed the possible consequences of water loss from the cooling tower basins. Each agreed that the worst case scenario for a basin related flooding accident was a breach in the south wall of the basin. Wescott, ff. Tr. 9045, at 2, 3; Boyer et al., ff. Tr. 8213, at 18. A complete breach of the basin wall or a break in other than the south wall would send most of the flood water away from the power block complex and towards the Schuylkill River or Possum Hollow Run. Id. Even in the event of a failure of the south wall of either basin, the circulating water pumphouse, which is between the cooling towers and the power block complex, would tend to divert water to the east or west and away from the turbine building. Wescott, ff. Tr. 9045, at 2.

B-84. Both Applicant and Staff assumed a 50-foot breach in the basin wall and in order to maximize the amount of flooding in the turbine building, each also assumed that all of the turbine building main doors on the north side were open. Even with the north wall turbine building doors open, Applicant calculated a water height rise of about 4 feet. Because the walls of the reactor building and central building are water or steam tight to above that level, there would be no entrance for water into the category 1 structure and no adverse impact on the ability to safely shut down the reactor. Tr. 9028 (Buchert).

B-85. Staff and Applicant also evaluated the possible effects of erosion by escaping water on buried safety-related structures. Each concluded that no adverse effects would occur. Wescott, ff. Tr. 9045, at 4; Tr. 9324-25, 9335-36 (Wescott); Boyer et al., ff. Tr. 8213, at 19-20; Lefave, ff. Tr. 9047, at 2-3.

10. Integrity of the Spray Pond.

B-86. FOE raised questions concerning the integrity of the spray pond -- which is the ultimate heat sink for the Limerick decay heat removal from the reactor cores -- with respect to missiles that could be generated as a result of blast pressure from an explosion resulting from a pipeline break. The Applicant testified that missiles generated by destruction of the cooling towers could not reach the spray pond. Tr. 8900 (Vollmer). Mr. Vollmer was not aware of any other missiles from an explosion that could reach the spray pond. Id. Missiles from an explosion would not be similar to missiles from a tornado. Id. Because the design explosion is an air blast, at an elevation of 500 feet above ground, there is going to be a force radiated downward which would not have a tendency to lift missiles up, as in a tornado which rotates them and lifts them. Id. at 8900-01 (Vollmer). Various structures that appear in an aerial photograph around the towers would not be exploded by an explosive force from a gas pipeline explosion and carried in the direction of the spray pond. Id. at 8901. The photograph showed some temporary structures, including a concrete batch plant that will be removed as well as some old structures that were used for the fabrication of the reactor vessel. (Tr. 8901 (Boyer). There is one permanent one-story Butler-type building located somewhere exceeding 800 feet from the spray pond pump house building. Since the spray pond pump house was designed against tornado missiles failure of the Butler building would have zero impact on the spray pond building. Id. The

Applicant estimated that whatever missiles were generated -- side panels, disks or whatever -- might be moved 50 feet, but not to exceed 100 to 200 feet away from the building. Id. at 8908. Mr. Boyer did not think that sheet metal would have any effect on the spray pond fixtures or the pipes leading to the fixtures. Id. at 8908-09. We agree.

B-87. The spray nozzles and the piping within the spray pond are safety-related. Tr. 9368 (Lefave). The Applicant is doing a probabilistic risk assessment of the tornado event to determine the probability of how many nozzles and trains in the piping can be affected by tornado missiles. Id. Presumably, the results will be evaluated against the required function ability for this system. The Staff considers this to be an open item in its review of externally-generated missiles. SER Section 3.5.2. It was not conceivable to the Staff, however, that the postulated pipeline accidents could generate missiles which could impact the spray nozzles. This conclusion was based on the belief that the blast wave travels so fast that it would be unable to pick up anything and carry it. Tr. 9368 (Romney). For a detonation of 56 tons of TNT the positive phase pulse time of the blast wave at 1200 feet would be approximately 170 milliseconds. Staff Ex. 21.

B-88. The Staff had not, and did not know whether the Applicant had, conducted an analysis of what potential effects a blast wave would have on the spray pond nozzles. Tr. 9369 (Romney). The Staff did think they are strong enough to take the blast pressure, since they and related piping are designed to withstand the safe shutdown earthquake and because the pressure the blast wave would exert on the piping is not going to be a pressure large enough to affect the structural integrity of the piping system. Any effect would be rather small. Tr. 9371 (Kuo). The calculated pipeline accident blast pressure on the surface of the spray pond water is approximately 1.9 psi. Tr. 9373 (Ferrell).

B-89. The Applicant also testified that if a cooling tower were to fail from a blast from the southwest direction, it would collapse within its own perimeter and would not reach the spray pond pump house. Tr. 9284, 9364 (Romney). A cooling tower has never failed as a rigid body. Tr. 9341-42 (Romney).

B-90. We find that all of FOE's allegations and speculations of sequences of events omitted from the Applicant's and Staff's analyses to be without merit. Applicant has demonstrated reasonable assurance that the safety-related structures at Limerick will withstand the postulated pipeline accidents. Accordingly, FOE's contentions V-3a and 3b are without merit.

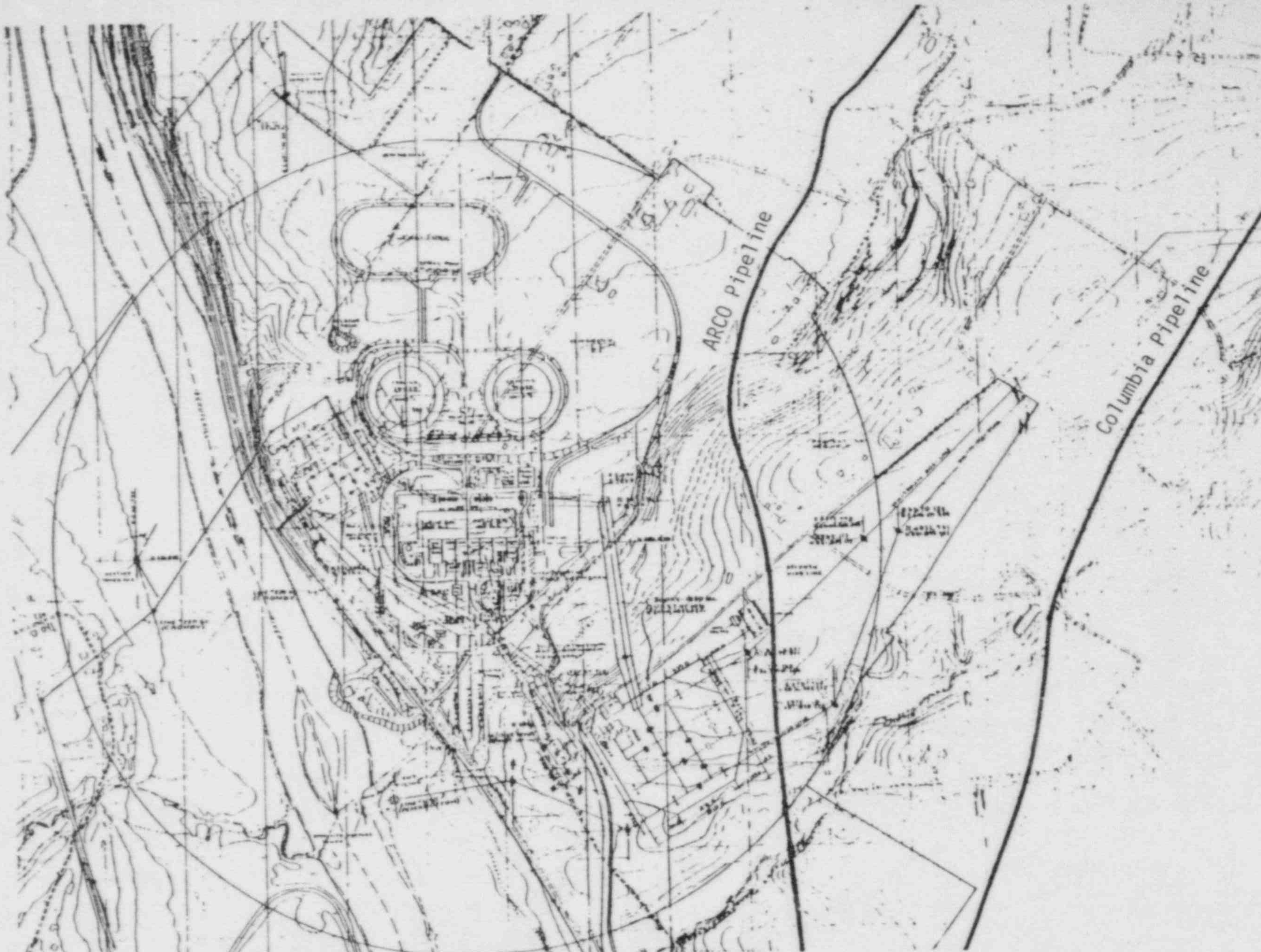

Figure 1. ARCO and Columbia gas pipelines

Source: Limerick SER (p. 2-12), Staff Ex. 6

LIMERIC PROJECT
JOB 8031

TABLE I

SUMMARY OF ACCIDENTAL EXPLOSION PRESSURES

LOADING ON STRUCTURE / BUILDING FACILITIES	DESIGN/ASSESSMENT VALUES: POSITIVE PEAK REFLECTED PRESSURE-PSIG — COLUMBIA PIPELINE NATURAL GAS EXPLOSION		ARCO PIPELINE GASOLINE EXPLOSION		READING RAILROAD BOX/TANK CAR EXPLOSION		MARGINS (%) OVER DESIGN/ASSESSMENT PRESSURE FOR EXPLOSION				N-S DIRECTION COMPARISON OF GLOBAL BLDG. RESPONSE — EXPLOSION PRESSURES		SAFE SHUTDOWN EARTHQUAKE		REMARKS
	ROOF	EXT. WALL	ROOF	EXT. WALL	ROOF	EXT. WALL	ROOF BENDING	ROOF SHEAR	EXT. WALL BENDING	EXT. WALL SHEAR	OVER-TURNING MOMENT (FT-K)	STORY SHEAR (K)	OVER-TURNING MOMENT (FT-K)	STORY SHEAR (K)	
REACTOR BLDG. UNIT 1	NC (1)	NC	NC	NC	5.3	16.1	NC		19	15	1.37×10^7	88,630	1.51×10^7	120,440	
REACTOR BLDG. UNIT 2	5.4	10.0	1.9	1.9	NC	NC	35	3.3	NC						
DIESEL GEN. BLDG. UNIT 1	NC	NC	NC	NC	5.7	16.4	NC		14	28	1.55×10^5	8390	4.65×10^5	9,060	
DIESEL GEN. BLDG. UNIT 2	6.7	10.0	1.9	1.9	NC	NC	84	20	NC		1.55×10^5	8390	4.65×10^5	9,060	
CONTROL BLDG.	4.9	10.0	<1.9	<1.9	3.3	10.0	83	14	15	20	NA	NA	NA	NA	
SPRAY POND PUMPHOUSE	3.0	5.0	<1.0	<1.0	2.1	4.7	143	9	900	101.	1.92×10^4	2,025	14.8×10^4	4,242	

Figure 2.

Source: Boyer et al., Attachment

NOTES:

1. NC MEANS NOT COMPUTED. ELEMENT IS LESS CRITICAL THAN IN CORRESPONDING STRUCTURAL UNIT.
2. NA MEANS NOT APPLICABLE. THE ELEMENT OR LOADING CASE DOES NOT EXIST OR APPLY TO THE STRUCTURE UNDER CONSIDERATION.

TABLE II
SUMMARY OF PRESSURES RESULTING FROM
A NATURAL GAS PIPELINE DETONATION

Pressure (PSI) / BLDG.	COLUMN 1 REG. GUIDE 1.91 REV. 1 SURFACE BURST		COLUMN 2 REG. GUIDE 1.91 REV. 1 AIR BURST		COLUMN 3 4 x REG. GUIDE SURFACE BURST		COLUMN 4 4 x REG. GUIDE AIR BURST		COLUMN 5 PRESSURES USED IN STRUCTURAL ASSESSMENT	
	ROOF	EXT. WALL	ROOF	EXT. WALL	ROOF	EXT. WALL	ROOF	EXT. WALL	ROOF	EXT. WALL
DIESEL GEN.	1.9	5.8	3.5	8.3	4.0	13.0	2.5	16.0	6.7	16.4
REACTOR BLDG.	1.2	5.8	2.8	8.3	2.6	13.0	5.2	16.0	5.4	16.1
CONTROL STRUCTURE	1.6	5.0	2.8	6.9	3.3	11.0	4.7	14.0	4.9	10.0
SPRAY POND PUMP HOUSE	0.8	2.5	1.2	3.3	1.8	5.0	1.4	6.0	3.0	5.0

Figure 3.

Source: Boyer et al., ff. Tr. 8213, Attachment

IN FORMAT OF APPLICANT'S TABLE I

[illegible]ERIC PROJECT
JOB 8031

TABLE I

SUMMARY OF ACCIDENTAL EXPLOSION PRESSURES

LOADING ON STRUCTURE / BUILDING FACILITIES	DESIGN/ASSESSMENT VALUES — POSITIVE PEAK REFLECTED PRESSURE-PSIG					
	COLUMBIA PIPELINE NATURAL GAS EXPLOSION		ARCO PIPELINE GASOLINE EXPLOSION		READING RAILROAD BOX/TANKCAR EXPLOSION	
	ROOF	EXT. WALL	ROOF	EXT. WALL	ROOF	EXT. WALL
REACTOR BLDG. UNIT 1	NC[1]	NC	NC	NC	5	12.2
REACTOR BLDG. UNIT 2	3.2	7.3	<1	1	NC	NC
DIESEL GEN. BLDG. UNIT 1	NC	NC	NC	NC	5.2	12.5
DIESEL GEN. BLDG. UNIT 2	3.6	7.4	<1	<1	NC	NC
CONTROL BLDG.	3.6	7.2	<1	<1	3.6	7.2
SPRAY POND PUMPHOUSE	1.9	3.7	<1	<1	2	4.5

NOTES:

1. NC MEANS NOT COMPUTED. ELEMENT IS LESS CRITICAL THAN IN CORRESPONDING STRUCTURAL UNIT.
2. NA MEANS NOT APPLICABLE. THE ELEMENT OR LOADING CASE DOES NOT EXIST OR APPLY TO THE STRUCTURE UNDER CONSIDERATION.

Figure 4.

Source: ff. Tr. 9055, Staff Ex. 23

NRC CALCULATIONS

C. LEA I-42: Environmental Qualification of Electric Equipment

C-1. LEA Contention I-42, admitted as respecified, states:

> The Applicant has not shown compliance with the Commission's rule, Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants, Jan. 21, 1983, 48 FR 2729, 10 C.F.R. § 50.49. Particularly, it has neither established a program for qualifying all of the electrical equipment covered by § 50.49, nor performed an analysis to ensure that the plant can be safely operated pending completion of equipment qualification, as required by § 50.49(i). Failure to comply will threaten the health and safety of the public.

1. Summary.

C-2. Testimony by the Applicant and the Staff supports the conclusion that the Applicant has an acceptable program, although not completely implemented, for qualification of electric equipment important to safety at Limerick, which is in compliance with 10 C.F.R. § 50.49, as adopted in January 1983. This testimony described how items to be qualified were identified and how the program was developed and implemented. Proper identification was assured by an independent verification program conducted by a qualified contractor. The Staff's review, while also not complete, verified the adequacy of the program.

C-3. Based on qualification efforts so far, it is not anticipated that completion of the program would identify any components not properly qualified. Should this occur, however, the Applicant would then have to perform and have approved by the Staff an analysis, as required by Section 50.49(i) to ensure that the plant can be safely operated pending completion of equipment qualification. Such an analysis is called a Justification for Interim Operation (JIO) by the Staff. Subject to that possibility, we find that the Applicant has met its burden of proof on this contention by demonstrating, (1) that it has a proper program in place for qualifying all of the electrical equipment covered by Section 50.49; and (2) that those particular components of concern to LEA, as set forth in the bases for the contention, have been properly considered by the Applicant.

C-4. The Applicant and the Staff provided expert witnesses and testimony; LEA and the City of Philadelphia cross-examined these witnesses, but did not provide their own witnesses. Evidentiary hearings were held on April 9 and 10, 1984, in Philadelphia, Pennsylvania.

2. Compliance with the January 1983 Environmental Qualification Rule.

C-5. As a framework for discussing the merits of this contention, we begin by considering the state of compliance of the Applicant with the subsections of 10 C.F.R. § 50.49, adopted in January 1983, as applicable to the contention.

C-6. Section 50.49(a) states each applicant for a license to operate a nuclear power plant shall establish a program for qualifying the electric equipment defined in paragraph (b) of this section. Section 50.49(b) states that electric equipment important to safety covered by this section is:

(1) Safety-related electric equipment[3/]: This equipment is that relied upon to remain functional during and following design basis events to ensure

(i) the integrity of the reactor coolant pressure boundary,

(ii) the capability to shut the reactor down and maintain it in a safe shutdown condition, and

(iii) the capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposures comparable to the 10 C.F.R. Part 100 guidelines. Design basis events are defined as conditions of normal operation, including anticipated operational occurrences, design basis accidents, external events, and natural phenomena for which the plant must be designed to ensure functions (i) through (iii) of this paragraph.

(2) Nonsafety-related electric equipment whose failure could prevent satisfactory accomplishment of safety functions specified in subparagraphs (i) through (iii) of paragraph (b)(1) of this section by the safety-related equipment.

(3) Certain post-accident monitoring equipment. (Footnote omitted)

3/ Safety-related electric equipment is referred to as "Class IE" equipment in IEEE (standard) 323-1974.

C-7. LEA asserts, in part a) of its Basis for the contention, that Applicant's environmental qualification (EQ) program, designed prior to issuance of the new rule, was designed to qualify safety-related equipment only (and therefore does not include nonsafety-related equipment whose failure under postulated environmental conditions could mislead the operator or otherwise prevent satisfactory accomplishment of specified safety functions, and certain post-accident monitoring equipment). Applicant argues that even though its program for EQ was designed before the promulgation of the new rule, because of its anticipation of the new requirements and because of its conservative equipment classification practice, its program does comply with the new rule. Boyer et al., ff. Tr. 9529, at 1-2. Further, Applicant avers that all Limerick equipment within the scope of 10 C.F.R. 50.49 will be qualified by the fuel load date. Id. at 4.

C-8. LEA, also in part a) of its Basis, asserts that the Applicant should promptly develop a list of the equipment at Limerick, subject to Section 50.49(b)(2), that is "important to safety" (and not just safety-related) and that will be tested in its EQ program as required by Section 50.49(d). Examples given by LEA of systems or equipment that should be reviewed for inclusion in the Applicant's EQ program were the feedwater control, emergency lighting and communications systems, the plant process computer system, and computer software.

C-9. The Limerick Project "Q-List" was developed and established as the controlling document identifying the safety-related structures, systems and components [including electric equipment] to meet the requirements of Section 50.49(b)(1). Id. at 4-5.

C-10. The Applicant testified that there is no equipment at Limerick in the subset Section 50.49(b)(2). Id. at 3, 7. The interfaces between safety-related electrical components are evaluated as part of the plant design process. Whenever cases are identified in which failure of nonsafety-related components could prevent attainment of the safety function objectives, they are eliminated by implementing design modifications or by adding (such components) to the Project Q-List and qualifying them as necessary. The Electrical Equipment Separation Program is an example of such an interface evaluation. Id. at 7. All electrical equipment on the Q-List is reviewed to determine its environmental qualification requirements. If the electrical equipment is determined to be located in a harsh environment, the appropriate environmental qualification parameters for the component are identified. Id. at 8.

C-11. "Certain post-accident monitoring equipment" is defined by the footnote to Section 50.49(b)(3), which references Regulatory Guide 1.97, "Instrumentation for Light-Water Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident." This Guide defines three categories of design and qualification criteria. Category 1 criteria are similar to the criteria applicable to safety-related systems. Category 2 criteria include selected criteria normally associated with safety-related systems, but the same environmental requirements as Category 1. Category 3 criteria specify only a high quality commercial-grade installation, for which there are no environmental qualification requirements. Id. at 5-6.

a. Independent Component Classification Program.

C-12. To assure the identification, in the Limerick Environmental Qualification Program, of all electrical equipment required to perform a safety function, the Applicant contracted with Quadrex Corporation to perform an independent verification, the Component Classification Program. Boyer et al., ff. Tr. 9526, at 9. Quadrex had conducted five identical independent review analyses of the overall environmental qualification programs at other nuclear power plants prior to the Limerick program. Tr. 9551 (Stanley). The extensive effort at Limerick showed that of the approximately 30,000 components considered, of which approximately 1600 were different (i.e., non-identical) electrical items, 16 differences in electrical equipment classification from the original Applicant architect-engineer classifications were identified. Nine of the 16 components were found to be located in a mild environment. Four of the 16 were to be reclassified as not requiring environmental qualification. The remaining three are included in the EQ Program. Boyer et al., ff. Tr. 9526, at 22-23; Tr. 9622-23 (Boyer).

C-13. A comparison of the Component Classification Program (CCP) rules against Section 50.49 was performed and it was determined that the classification rules fully complied with the requirements of Section

50.49, even though they were prepared and implemented prior to publication of the new rule. This determination was also based on a comparison of the CCP rules with draft Regulatory Guide 1.89, Rev. 1, Qualification of Class 1E Equipment for Nuclear Power Plants. Boyer et al., ff. Tr. 9526, at 23.

3. Systems Excluded from the EQ Program.

C-14. As a part of the basis for its Contention I-42, LEA asserted that the emergency lighting system, inplant communications system, plant process computer system and computer software were examples of systems that were improperly excluded from PECo's qualification program. The evidence indicated that the exclusions were proper in that the systems cited by LEA are not important to safety as the term is used in 10 C.F.R. § 50.49; that is, they are not relied on during a design basis accident in areas subject to a potentially harsh environment and their failure would not prevent achievement of safety function objectives. Boyer et al., ff. Tr. 9529, at 11-15; Masciantonio, ff. Tr. 9640, at 7-8.

a. Emergency Lighting System.

C-15. The Applicant testified that this system was not included in the CCP because it is not safety-related as defined by Section 50.49, it is not relied upon to provide lighting during a design basis accident in areas which could produce a harsh environment, and its failure could not prevent achievement of the safety function objectives defined in subparagraphs (i) through (iii) of Section 50.49(b)(1). Boyer et al., ff. Tr. 9526, at 12. The Staff concurs. Masciantonio, ff. Tr. 9640, at 7.

b. In-plant Communications Systems.

C-16. The Applicant testified that these systems were not included in the CCP because they are not safety-related, they are not relied upon during a design basis accident in areas that could produce a harsh environment, and their failure could not prevent the achievement of the safety function objectives defined in subparagraphs (i) through (iii) of Section 50.49(b)(1). Boyer et al., ff. Tr. 9526, at 13. The Staff concurs. Masciantonio, ff. Tr. 9640, at 7.

c. The Plant Process Computer System.

C-17. The Applicant testified that this system and the computer software were not reviewed because the computer is not safety-related; it is not relied upon to provide information during a design basis accident in areas that could produce a harsh environment, and its failure could not prevent achievement of the objectives defined in subparagraphs (i) through (iii) of Section 50.49(b)(1). The computer software has not been reviewed because it is outside the scope of Section 50.49. Information obtained via the plant process computer is not required during or following these accidents. The computer system interfaces with other systems that are safety-related, but these electrical interfaces are designed in compliance with Regulatory Guide 1.75, "Physical Independence of Electric Systems." Boyer et al., ff. Tr. 9526, at 14. The Staff concurs. Masciantonio, ff. Tr. 9640, at 7.

d. Feedwater Control System.

C-18. The Applicant testified that this system was included in the CCP. The review showed, however, that it contains no equipment having a safety function as defined by Section 50.49. Boyer et al., ff. Tr. 9526, at 14-15. The Staff concurs. Masciantonio, ff. Tr. 9640, at 7.

e. Standby Liquid Control System.

C-19. The Applicant testified that the squib values, in this system, have been added to the EQ List of Equipment Important to Safety. Boyer et al., ff. Tr. 9526, at 3. The Staff concurs. Masciantonio, ff. Tr. 9640, at 10.

C-20. The keylock switch is located in the control room which is maintained by a safety-related ventilation system and therefore is not subject to harsh environments. Boyer et al., ff. Tr. 9526, at 21. The Staff concurs. Masciantonio, ff. Tr. 9640, at 10.

f. Human Interaction Problems.

C-21. In part b) of its Basis for its contention, LEA contends that failure of nonsafety-related valves, but which are important to safety, could mislead an operator into miscategorization of an accident for emergency planning purposes. Since there is no electrical equipment in the class defined by Section 50.49(b)(2), this could not happen for such equipment. With respect to the post accident monitoring equipment defined by Section 50.49(b)(3), the operators will be directed by written procedures to rely only on the equipment that is qualified in accordance with Regulatory Guide 1.97, Rev. 2, if the equipment is subjected to a harsh environment, and thus will not be misled by unqualified equipment. Boyer et al., ff. Tr. 9526, at 3, 25-32.

C-22. The Limerick-specific Transient Response Implementation Plan (TRIP) procedures are initiated and keyed to entry condition symptoms to treat these symptoms and are specific to Limerick. The procedures are organized in such a manner as to control those plant parameters important for protecting the plant safety barriers against the release of radioactive material to the environment. Whenever a symptom develops, the operator immediately enters the applicable procedure and takes the corrective action directed by the procedures, until its exit conditions are satisfied. If the particular transient continues to degrade, the operator enters contingency procedures to handle the more degraded conditions until he can return to the main procedures. Boyer et al., ff. Tr. 9529, at 25-27.

C-23. Review of the listing of Reg. Guide 1.97 instrumentation reveals that all entries into the TRIP procedures are monitored by environmentally qualified instrumentation. The impact on execution of TRIP procedures is minimal since the qualified instrumentation that must be used is either the instrumentation which the operator would normally choose to use under those conditions or the only qualified instrumentation available to monitor the parameter. The operator is specifically instructed in the TRIP procedures to utilize only certain instrumentation in the event of an indication of adverse environmental conditions. In accordance with the requirements of Reg. Guide 1.97, the applicable instrumentation will be highlighted by special markings on the control panel to aid in its identification and assure that only such instruments will be used under the circumstance of adverse environmental conditions. Boyer et al., ff. Tr. 9529, at 28-30; see Tr. 9601-10 (Doering).

C-24. Many TRIP procedures use only environmentally qualified instrumentation. However, that instrumentation may cover a broader range than non-qualified equipment and may, therefore, be less precise. The instrumentation an operator normally relies on is generally restricted to a narrow band around the operating range and is, therefore, more exact. Absent an indication of actual adverse environmental conditions in the reactor building, the operator is not restricted to the use of environmentally qualified instrumentation. Tr. 9607-09 (Doering); Masciantonio, ff. Tr. 9640, at 8.

C-25. A "human interaction review," per se, is not a requirement of Section 50.49. Id. at 8.

4. Aging of Equipment.

C-26. In part c) of its Basis, LEA contends that where the qualified life of a piece of equipment does not equal the 40 year plant life, no action is identified to correct the deficiency. The environmental qualification of electrical (and other) equipment is contingent upon replacing such equipment at the end of its designated life and upon performing required maintenance during its designated life. The Limerick Plant Staff Maintenance Group has a systematic program to determine required replacement intervals for the equipment whose designated life is less than 40 years and to define the maintenance and frequency thereof for equipment whose environmental qualification is required to be sustained. Boyer et al., ff. Tr. 9526, at 32-35; Masciantonio, ff. Tr. 9640, at 9.

5. Completeness of EQ Program.

C-27. At the time of hearing the Applicant's EQ Program was 95 percent complete. Final completion was anticipated to occur in June 1984. For the remaining five percent, the work on the qualification packages was sufficiently along the way that an informed judgment was that there would be no unqualified equipment for which a Justification for Interim Operation would be requested. Tr. 9617 (Boyer).

6. Staff Review of the Limerick EQ Program.

C-28. The Limerick EQ program is reviewed by the Staff for completeness, accuracy and conformance -- to determine proper definition of the scope of the program, proper definition of postulated environments, and demonstration of qualification in accordance with NRC rules and regulations, which include 10 C.F.R. § 50.49, Regulatory Guide 1.89 (Qualification of Class 1E Equipment for Nuclear Power Plants), NUREG-0588 (Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment) and Institute of Electrical and Electronics Engineers (IEEE) standards. Masciantonio, ff. Tr. 9640, at 4. In addition, the Staff reviewed the total number of components and equipment types in the Limerick EQ program as compared to other plants of similar design to assure consistency, and reviewed the process used for selecting components, as described in the EQ report. Id. at 6. Conformance to Section 50.49(b)(2) concerning nonsafety-related equipment whose failure under postulated accident conditions could prevent the satisfactory accomplishment of safety functions is determined by the Staff's review of Limerick with respect to the issues in IE Information Notice 79-22 (Qualification of Control Systems) and conformance with Regulatory Guide 1.75 (Physical Independence of Electric Systems). Id. at 6. Tr. 9665-66, 9678-79 (Masciantonio). See also Tr. 9683-88 (LaGrange). The Staff review of conformance of Limerick to Regulatory Guide 1.75 is complete and Limerick has been found acceptable. Id. at 7. Tr. 9709 (LaGrange, Masciantonio). Review of the Applicant's response to Information Notice 79-22 (Qualification of Control Systems) was not yet complete. Id. at 7. The Staff testified that similar reviews, which analyze the effects of high energy line breaks on the interactions between nonsafety-related and safety-related components, had been completed for several plants and it had no reason to believe it would be a special problem for Limerick. Tr. 9710 (LaGrange). In addition, the Staff had not completed its review of the pressure-temperature profile following a loss of coolant accident submitted by the Applicant. This "profile" is substantially lower than for typical boiling water reactors that have been reviewed and therefore needs special Staff review. Tr. 9711-12 (Masciantonio). The equipment has been environmentally qualified against the Applicant's proposed profile. Tr. 9712 (LaGrange).

C-29. An audit of the Applicant's Equipment Qualification files, including a plant walkdown, was conducted by the Staff, primarily to verify the bases of the information submitted. Twelve EQ files, representing approximately 10 percent of the equipment items in the EQ program, were selected for detailed review. In all cases it was determined that adequate proof of qualification was provided to establish qualification as claimed. Masciantonio, ff. Tr. 9640, at 11.

C-30. The Staff has determined that the Applicant has established a program for qualifying electric equipment important to safety within the scope of Section 50.49, but its review is not complete and no approval of the program has been issued. Its review was expected to be complete within a few months (from April 1984). Id. at 11. Should there be any unqualified equipment, Applicant will be required, according to Section 50.49(i), to perform an analysis to ensure that the plant can be safely operated pending completion of environmental qualification. This analysis (Justification for Interim Operation) must be submitted and approved by the Staff before the Staff would support issuance of a license. Id. at 12.

7. Discussion.

C-31. LEA would have the Board find in its favor that there is no basis in the present record for a finding that Limerick is in compliance with 10 C.F.R. § 50.49. Further, it would have us retain jurisdiction until several actions by the Applicant and Staff are taken as preconditions for a finding of such compliance. LEA's proposed findings (June 21, 1984), at 13. Applicant and Staff would have us find, on the basis of the present record, that the Applicant has fully complied with the requirements of Section 50.49. App. PF (June 8, 1984), at 26; Staff PF (July 2, 1984), at 19.

C-32. All parties agree that Applicant's EQ program has not been completely implemented and Staff's review is not complete. Prior to the time of hearing Staff had received a report from the Applicant indicating that approximately 80 percent of the equipment items as being qualified. (As noted in finding C-27 above, at hearing the Applicant stated that its program was 95 percent complete, although all of this had not been officially reported to the Staff.) The Staff Safety Evaluation Report (SER) will not be closed out until full compliance with Section 50.49 has been demonstrated. Tr. 9698 (Masciantonio). The Staff must conclude that compliance with the requirements of Section 50.49 has been demonstrated before an operating license is issued. Masciantonio, ff. Tr. 9640, at 14.

C-33. When governing statutes or regulations require a licensing board to make particular findings before granting an applicant's requests, a board may not delegate its obligations to the Staff. The responsibilities of the boards are independent of those of the Staff under the Commission's system, and the boards' duties cannot be fulfilled by the Staff, however conscientious its work may be. 8/

C-34. Applicant argues that the prerequisite to the issuance of a decision in a case such as this where the Staff's review is not yet complete, is a basis in the present record on which to reach an informed conclusion, citing Cincinnati Gas and Electric Company (Wm. H. Zimmer Nuclear Power Station, Unit 1), LBP-82-68, 16 NRC 741, 748 (1982). In that case, however, the Board found that "[w]e have no basis in the present record on which to reach an informed conclusion with regard to the FEMA (emergency planning) review. Consequently, we require that the results of the FEMA review be served on the Board and parties ...". The Applicant also claims there is specific precedent for the action it seeks -- post-hearing resolution of this matter by the Staff -- in the Shoreham proceeding. In that proceeding, the Atomic Safety and Licensing Board (two of whose members also serve on the instant board) found that in the area of environmental qualification the deficiencies were minor and would be resolved by the Staff subsequent to the Board's order, but prior to issuance of a license. Long Island Lighting Company (Shoreham Nuclear Power Station, Unit 1), LBP-83-57, 18 NRC 445, 544

8/ Cleveland Electric Illuminating Company (Perry Nuclear Power Plant, Units 1 and 2), ALAB-298, 2 NRC 730, 737 (1975). See Vermont Yankee Nuclear Power Corp. (Vermont Yankee Station), ALAB-124, 6 AEC 358, 360, 361-62, n. 4 (1973).

(1983). Consequently, the Board concluded that the environmental qualification program and the intended further revisions to implement Section 50.49(b)(2) were acceptable.

C-35. On the basis of the evidence before us we can and do conclude that the Applicant has established, in the words of the contention, an acceptable program for qualifying all of the electrical equipment covered by Section 50.49. Classification of components by the Applicant, verified by an independent contractor and audited by the Staff, with no evidence of any component currently improperly qualified, gives us a basis to reach an informed conclusion with respect to the adequacy of the program for compliance with Section 50.49.

C-36. Implementation of the EQ program admittedly is incomplete. It is a close question, in our view, whether we can conclude, based on the present record, that the remainder of the implementation, including Staff review, constitute minor procedural difficulties (see Consolidated Edison Co. of New York) (Indian Point Station, Unit No. 2), CLI-74-23, 7 AEC 947, 951 (1974), or minor documentation deficiencies (see Shoreham, supra).

C-37. The Appeal Board, relatively recently, had occasion to deal specifically with the question of reliance on predictive findings and post-hearing verification, albeit in the context of contentions with respect to emergency planning. Louisiana Power and Light Company

(Waterford Steam Electric Station, Unit 3), 17 NRC 1076, 1103 (1983).

First, the Board said:

> We are in agreement with the basic principles upon which Joint Intervenors rely. The Commission, in fact, has long held that, "[a]s a general proposition, issues should be dealt with in the hearings and not left over for later (and possibly more informal) resolution." Consolidated Edison Co. of New York (Indian Point Station, Unit No. 2), CLI-74-23, 7 AEC 947, 951 (1974). "[T]he 'post-hearing' approach should be employed sparingly and only in clear cases" - for example, where "minor procedural deficiencies" are involved. Id. at 952, 951, n.8. Accord, Marble Hill, supra, 7 NRC at 318; Cleveland Electric Illuminating Co. (Perry Nuclear Power Plant, Units 1 and 2), ALAB-298, 2 NRC 730, 736-37 (1975); Washington Public Power Supply System (Hanford No. 2 Nuclear Power Plant), ALAB-113, 6 AEC 251, 252 (1973).

C-38. Second, the Board noted that the Commission takes a slightly different course with respect to emergency planning:

> At one time, the Commission's regulations required a finding that "the state of onsite and offsite emergency preparedness provides reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency." 10 C.F.R. § 50.47(a)(1)(1982) (emphasis added). In July 1982, the Commission amended this provision by clarifying that "the findings on emergency planning required prior to license issuance are predictive in nature" and by eliminating the reference to the "state" of emergency preparedness.

C-39. In the Waterford case the Appeal Board did allow predictive findings in five areas of emergency planning, but made no such concession on other issues.

C-40. The record may be summarized as follows. The evidence shows that the Applicant has established a program for qualifyin, all of the electrical equipment covered by Section 50.49. No equipment specified by LEA in the bases for its contention has been shown to be misqualified. The program has been audited by the Staff and found acceptable. With respect to the five percent of the EQ program yet to be completed, there is reasonable assurance that it will be completed in compliance with Section 50.49, based on the adequacy of the program itself and the Staff commitment to conclude its review of the entire program prior to issuance of a license. Further, the work on the remaining five percent was sufficiently far along that an informed judgment by the Applicant was that there would be no unqualified equipment for which a Justification for Interim Operation would be requested (thus obviating the need for any analysis required by Section 50.49(i)).

C-41. With respect to completion of the Staff review of the Applicant's response to questions related to IE Information Notice 79-22, there is reasonable assurance that this will be completed to the Staff's satisfaction. Similarly, there is reasonable assurance that the Staff review of the temperature and pressure behavior following a loss of coolant accident will be completed to the Staff's satisfaction. LEA raised no particular concern with either of these Staff reviews, other than the general complaint of incompleteness. If the results of the Staff review of Applicant's response to IE Information Notice 79-22 show a high energy line break interaction which was not designed for, then additional components may have to be included in the environmental qualification program (in the absence of design changes to correct any such interaction). This still does not detract from our finding that the allegation in the contention, of the lack of a proper environmental qualification program, is without merit. Similarly, if the results of the Staff review of the temperature and pressure profile following an accident show that those parameters would be higher than assumed for the EQ program, then the environmental qualification of the affected components will have to be reanalyzed by the Applicant, following the same approved program, but against different postulated temperature and pressure conditions.

C-42. We find that we cannot strictly characterize the incomplete aspects of the Applicant's implementation of its EQ program and the Staff's review thereof as minor procedural or documentational deficiencies. Within the scope of the contention as worded, however, we can and do find that this is a clear case where reasonable assurance exists that the Applicant will comply with Section 50.49 before any license will be issued. In other words, no specific complaint of LEA (including particular components alleged by LEA to be improperly qualified) remains to be explored in the Staff's overall review of electric equipment qualification at Limerick, which review is broader than the litigated issues. This situation could change only if, contrary to the record before us, the Applicant decides to seek a

Justification for Interim Operation under Section 50.49(i). In such an eventuality, the parties obviously are obligated to bring such change in the record promptly to the attention of the parties and any adjudicatory body with jurisdiction. Subject to this possibility, we find this contention without merit and do not retain jurisdiction.

D. Confirmation of Findings of Fact Made on the Record that AWPP Contention VI-1 (QA/QC of Welding) Lacks Merit

1. The Contention Lacks Merit as Previously Determined in the Bench Decision

D-1. AWPP Contention VI-1, as admitted by the Board, states:

> Applicant has failed to control performance of welding and inspection thereof in accordance with quality control and quality assurance procedures and requirements, and has failed to take proper and effective corrective and preventive actions when improper welding has been discovered.

D-2. This contention was admitted as an issue in controversy on reconsideration by the Board (after earlier conditional admission and then rejection given the issue specified by AWPP). The reconsidered admission was subject to the important requirement that, after discovery, AWPP specify in advance of the hearing the particular instances of alleged improper actions of Applicant with regard to quality control and quality assurance of welding at Limerick, which AWPP would rely upon to litigate its contention. 9/ This particularization

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9/ See "First Special Prehearing Conference Order," LBP-82-43A, 15 NRC 1423, 1517-18 (1982); "Memorandum and Order (Concerning Objections to June 1, 1982 Special Prehearing Conference Order" (unpublished), slip op. at 6 (July 14, 1982); "Second Special Prehearing Conference Order," LBP-83-39, 18 NRC 67, 88-91 (1983); "Memorandum and Order Confirming Rulings Made at Prehearing Conference," (unpublished), slip op. at 5-7 (October 28, 1983).

of the contention was accomplished in the course of prehearing filings by the parties and rulings by the Board. 10/

D-3. This contention was litigated on May 7-10, 1984. Expert and factual testimony was presented by separate witness panels for the Applicant and NRC Staff. The proposed direct testimony offered by AWPP's representative, Mr. Frank R. Romano, was not admitted into evidence for the reasons set forth in the Board's May 2, 1984 "Memorandum and Order on Pretrial Motions Regarding Testimony on Contention VI-1" (unpublished), which granted the motions by the Applicant and Staff to strike Mr. Romano's testimony. In addition, at the hearing the Board rejected the late-filed testimony of Professor Iversen proffered by AWPP (AWPP Ex. 3 for Id.), because it was inexcusably late (it had been filed at the hearing), did not relate to any of AWPP's specified instances, and in any event was not sufficiently probative towards any matter relating to quality assurance of welding to be admitted as late testimony. Tr. 10,428-435, 11,931 (Brenner, J.)

10/ AWPP filed its list of specified allegations of improper welding and related quality assurance actions on March 6, 1984. Thereafter, the Board ruled on the Applicant's and Staff's objections to some of the alleged instances as being beyond the scope of welding related matters. "Memorandum and Order Ruling on Applicant's Motion to Strike Specific Instances Advanced by AWPP in Support of Contention VI-1," (unpublished) (April 2, 1984).

D-4. The evidentiary hearing on this contention involved extensive written testimony by the Applicant which detailed the facts involved in each instance relied on by AWPP for its allegation of improper welding and quality assurance thereof. Boyer et al., ff. Tr. 10,321. The NRC Staff's testimony fully supported the Applicant's. Durr and Reynolds, ff. Tr. 10,977. The extensive oral testimony, including cross-examination by AWPP and Board questions, also fully supported and confirmed the accuracy and completeness of the written direct testimony.

D-5. Accordingly, at the conclusion of the hearing on the contention, the Board announced that at that time it was its provisional judgment that, based on the entire record, there are no facts upon which it could be concluded that the Applicant had not overwhelmingly met its burden of proof on the contention. We noted our view that the facts were straightforward, fully stated in the Applicant's direct testimony and not contradicted in any way under cross-examination or Board questions. Tr. 11,047 (Brenner, J.). See also Tr. 11,050-054 (Brenner, J.). We also noted our provisional view that the witnesses were straightforward, truthful and candid and that they had fully disclosed the bases for the facts and conclusions in their written testimony. Tr. 11,048 (Brenner, J.)

D-6. Given our provisional view, we held it was unnecessary for the Applicant to follow the normal course and file its proposed findings of fact first. It was not necessary to have all the facts and conclusions in the record regurgitated in lengthy findings, which the Applicant, as the party with the burden of proof, would have had to file if the Board had not revealed and announced its provisional decision on the merits. Tr. 11,048-49 (Brenner, J.) However, the Board refrained from making final its provisional ruling -- that the conclusions in the testimony of the Applicant and Staff were correct and fully supported and that therefore the contention lacked merit -- in order to give AWPP the opportunity to file proposed findings of fact and conclusions of law. The Board informed AWPP that it should point out in its proposed findings evidence in the record which it believed showed that there was merit in any of its instances alleged in support of its contention. The Applicant and Staff would then have an opportunity to file reply findings discussing the matters covered in AWPP's proposed findings. Tr. 11, 049-050 (Brenner, J.) See also Tr. 11,052, 11,055-58 (Brenner, J.).

D-7. As scheduled, AWPP filed its proposed findings on May 22, 1984, and the Applicant and Staff filed their separate replies on May 29. On the record of May 31, 1984, the Board heard oral argument and set forth its reasons as to why none of the matters raised in AWPP's proposed findings raised any item which contradicted the Applicant's and Staff's evidence as had been previously ruled upon by us. See Tr. 11,915-94. We found the reply findings of the Applicant and Staff to accurately and fully reflect the record. We found that AWPP's proposed findings were inaccurate on several points. Tr. 11,935-36

(Brenner, J.). Therefore, there was no item meriting further deliberation by the Board and we entered our ruling that AWPP's contention lacked merit. As we stated we would, that bench ruling hereby is confirmed and becomes the partial initial decision that AWPP Contention VI-1 lacks merit. Tr. 11,964, 11,993-94 (Brenner, J.).

D-8. Before setting forth the Board's conclusions, which are based on those of the Applicant's and Staff's testimony which we find to be correct, we summarize the points raised in AWPP's proposed findings with which the Board disagreed for the reasons stated in our May 31 bench ruling: AWPP continuously ignored the testimony showing there is reasonable assurance that 100% of all safety-related welds were inspected. The sampling procedures, which we also find to be acceptable, were for audits of the inspection program. See Tr. 11,923-935, 11,945, 11,984-85. AWPP was totally incorrect in its belief that Applicant's witnesses did not fully answer its questions. We find the witnesses to be qualified, truthful and accurate and worthy of belief. See Tr. 11,940-46, 11,953-58. We also set forth why an instance in a Staff inspection report regarding the apparent lack of certified qualification for a receipt of materials inspector could not be related to any alleged welding problems. Tr. 11,946-48. We also set forth why an old matter involving the calibration of weld oven thermometers, raised for the first time in AWPP's findings, was beyond the scope of the contention because it could have been, but was not set forth as one of AWPP's specified instances in support of the contention. See Tr. 11,948-51.

D-9. The Board, on its own, also noted the potential concern it had harbored before the evidentiary hearing regarding the Applicant's remedial actions on the scope of its search of all types of QA records, given the fact that its initial search of QA weld records had been incomplete. Indeed, it was this incomplete search by Applicant, which incompleteness was discovered and corrected by Applicant because of this proceeding and the pending AWPP contention, which led the Board to admit AWPP's welding contention after reconsideration. See Tr. 10,708-10 (Boyer). We were satisfied that the scope of Applicant's remedial and preventive actions were appropriate. See Tr. 11,958-62, 11,989-91. We also stated why the facts on welds of hangers, and the deficiencies found, did not undercut the conclusion that the contention lacked merit. Tr. 11,985-88.

D-10. The Board finds, as applied to the instances of improper welding activities advanced by AWPP to form the scope of its contention, as follows:

D-11. The Limerick Quality Assurance (QA) program meets the requirements of 10 C.F.R. Part 50, Appendix B and is effective in assuring that the welding meets the quality requirements and satisfies the design criteria required for the safe operation of the plant.

Throughout the course of construction of Limerick, the Applicant has monitored, through audits, all welding-related activities. These audits have confirmed that the QA program has been properly and effectively implemented. Boyer et al., ff. Tr. 10,321, at 3 and 89-90. See also Durr and Reynolds, ff. Tr. 10,977, at 23.

D-12. Since there are in excess of two million safety-related welds at Limerick, there is the potential for occasional welding deficiencies as have occurred at Limerick. Most of these have been discovered and corrected as the result of the effective implementation of Applicant's QA program. Although the NRC Staff has also identified a few such welding deficiencies, the deficiencies have not formed any pattern of repeated similar instances. Boyer et al., ff. Tr. 10,321, passim and particularly at 89. Durr and Reynolds, ff. Tr. 10,977, passim and particularly at 11, 13, 15, 17, 18 and 23.

D-13. The circumstances relating to two structural weld deficiencies, emphasized by AWPP, which were not discovered by the Applicant's Quality Control inspector, as well as all the other instances cited by AWPP, and the Applicant's evaluations and corrective and remedial actions as audited by the NRC Staff, have been fully and truthfully described in the Applicant's and Staff's testimony. The testimony clearly establishes that AWPP's instances, all of which were taken from NRC Staff inspection reports and/or Applicant's own audit reports and responses to the NRC Staff, are isolated, nonprogrammatic, and, particularly given their source, in general, indicative of the effectiveness of the Limerick QA program. There has been no "breakdown" of the Limerick QA program for welding. Boyer et al., ff. Tr. 10,321, passim and particularly at 4. Durr and Reynolds, ff. Tr. 10,977, passim and particularly at 11, 13, 15, 17, 18 and 23.

D-14. Additional expert views finding that the Applicant's welding quality assurance program was effective were provided by the NRC Staff's 1983 programmatic evaluation (1983 "SALP Report"). It states:

> Observations by the Resident Inspector and Construction Inspection Team indicated that a strong construction QC program was in place. In addition to the E-C's well staffed and trained QC organization, the Licensee's QA organization also is staffed by well trained and knowledgeable QA engineers. The Resident Inspectors have noticed that the Licensee's QA engineers have performed more than the required inspections and surveillances in this area.

App. Ex. 52, at 12-13; Boyer et al., ff. Tr. 10,321, at 90.

2. AWPP's Post-Hearing Motions

D-15. Subsequent to the close of the record (as well as after the filing of its proposed findings and our May 31, 1984 bench decision on the merits), AWPP filed a motion to reopen the record on this contention (June 8, 1984), followed by its "Motion to Withhold Final Decision Re AWPP Contention VI-1" (June 11, 1984). We agree with the answers of the

Applicant and Staff that there is no basis in support of these motions and accordingly deny them.

D-16. The subject of AWPP's motion to reopen is a finding in an NRC Staff inspection report regarding deficiencies in the placement of pipe support hangers resulting from interferences with other structures. Although AWPP cites a May 21, 1984 letter to the Applicant from the NRC Staff, this letter is simply a follow-up acknowledging Applicant's responses to the underlying Staff inspection report findings and notice of violation issued on January 10, 1984. This is an old matter, arising from combined NRC Staff IE Report 50-352/83-19 & 50-353/83-07, which AWPP previously had included in its list of instances specified in support of this contention. designated by AWPP as the second of its two items "AWPP 260A." In our unpublished "Memorandum and Order Ruling on Applicant's Motion to Strike Specific Instances Advanced by AWPP in Support of Contention VI-1" (April 2, 1984), slip op. at 4-5, we ruled that the hanger interferences violation was not related to welding quality or welding-related quality assurance and that therefore this alleged instance would be stricken as being irrelevant to the contention. AWPP now simply again brings this instance to our attention, and mentions test welding in the same pleading. No reason to reconsider our prior ruling is shown or apparent, even if we consider AWPP's very untimely attempt to seek, in effect, reconsideration after the close of the record. We adhere to the previous determination in our April 2 order.

D-17. AWPP's June 11 "Motion to Withhold Final Decision" cites the fact that the NRC Staff informed the Applicant in a June 4, 1984 letter that it would be conducting routine verifications, by nondestructive examinations, of construction activities and materials. AWPP asserts, without basis and inconsistently with the routine nature of this facet of the NRC Staff's ongoing inspection program, that the plans for this inspection confirms that there is a basis to doubt the previous inspections of welds. Given the actual routine nature of the situation, there is no reason to defer this decision to await and consider on this record the results of the Staff's inspection. This is reason enough to deny the motion. In any event, even if the inspections were related to the contention, AWPP's motion does not address, let alone satisfy, the standards for reopening the record to admit a late-filed contention, and is denied for this reason as well.

E. Onsite Emergency Planning

1. Summary

E-1. In this section of the decision we rule on seventeen contentions or parts of contentions which Limerick Ecology Action (LEA) puts forward on the Applicant's emergency plan, generally called the onsite plan. 11/ Issues involving the Commonwealth's and local governments' offsite plans are still pending for litigation and will be considered in a later partial initial decision. The hearings were held April 23-25, 1984 in Philadelphia. The Commonwealth took part in them under the provisions in 10 C.F.R. § 2.715(c) for the participation of interested governments. In accord with its rights under Section 2.715(c), the Commonwealth also filed proposed findings, which we have considered in coming to our decisions.

E-2. LEA's contentions allege shortcomings or insufficient development in many areas of the Applicant's onsite planning: the spectrum of accidents covered by the Plan; the operation centers for emergency response; the length of time which might pass before offsite authorities were notified of an emergency; the Applicant's capabilities

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11/ The pertinent parts of the Plan are in the record as Applicant's Exhibit 32. However, for the sake of brevity, our citations to the Plan will be of the form, "Plan, § 6.1.1."

for predicting and assessing the radiological consequences of an accident; its capabilities for determining the location of all onsite personnel at the start of an emergency, and for monitoring them for radiation and decontaminating them if necessary; hospital care for onsite personnel who are both injured and contaminated; and the agreements with offsite organizations which would provide onsite support, the training of their personnel, and the backups for these organizations. The number and range of the contentions which were dealt with in the hearings were even greater than the number and range of the seventeen we rule on here, for LEA withdrew some contentions and parts of others between the hearings and the filing of its Proposed Findings. The course of the litigation also brought about enough changes in the contentions which remain to cause their texts as admitted to no longer adequately reflect them. Thus, in our rulings below, we paraphrase the contentions when setting out what they now allege. Their full texts may be found in a November 14, 1983 compilation by LEA.

E-3. At the hearings, the Applicant presented a panel of witnesses which included some of the Applicant's senior management officials, the Applicant's Director of Emergency Preparedness, and the Senior Health Physicist at Limerick. The Staff's one overall general witness was a Senior Reactor Safety Engineer in the Emergency Preparedness Branch, Division of Emergency Preparedness and Engineering Response, Office of Inspection and Enforcement. Both LEA and the Commonwealth took part in cross-examination of these witnesses but presented none themselves.

E-4. As set forth in our findings of fact on each contention detailed below, we rule in favor of the Applicant on all seventeen contentions. Except on Contention VII'-12(a), hospital arrangements for contaminated injured, our rulings are unanimous.

E-5. With a number of contentions we have found it necessary to go to the Plan's implementing procedures to decide a controversy. We are aware that by going to the procedures we may appear to have run counter to the ruling in Louisiana Power and Light Co. (Waterford Steam Electric Station, Unit 3), ALAB-732, 17 NRC 1076 (1983), which may appear to say that no implementing procedure is to be subject to scrutiny in a licensing hearing. Id. at 1107. However, we read Waterford less broadly. It does say that the whole body of implementing procedures need not be ready in time for challenge in a hearing, and the case wisely counsels against getting bogged down in the detail of the procedures. Id. We give similar counsel below in our discussion of Contention VIII-6(c), and we believe we have avoided getting bogged down in detail. However, we do not construe Waterford to rule that we cannot examine implementing procedures which are -- as were the ones we consider below -- already available and arguably necessary to determine whether certain plan provisions meet NRC planning standards and guidelines. Examining such procedures has the adequacy of the plans foremost in mind, and thus is in keeping with Waterford's reminder that the proper object of litigation is the adequacy of the plan. See also our Special Prehearing Conference Order, LBP-84-18, 19 NRC ___, slip op. at 29 (April 20, 1984).

E-6. As the reader may note, almost none of our citations to implementing procedures are to the record. This is because only early revisions of the pertinent implementing procedures appear in the record, in App. Ex. 33, and yet we early on discovered that the latest revisions of these procedures, filed by the Applicant after the completion of the hearing on this subject, made moot some of the controversies in this proceeding. Thus, we acquired the habit of referring to the latest revisions, even on matters which have remained unchanged from revision to revision. The parties were given an opportunity to set forth, in writing, any specific objections or other points they wished to make regarding these revisions.

2. LEA Contention VIII-1: Spectrum of Accidents Envisioned in Plans.

E-7. Contention VIII-1 as admitted and Contention VIII-1 as argued in LEA's Proposed Findings are not the same. As admitted, this contention had alleged the onsite plan did "not encompass the spectrum of credible accidents for which emergency planning is required." The narrow factual basis of the contention was that although Section 4.2 of the Plan said that the adequacy of the Plan could be demonstrated by, among other things, noting that the provisions of the Plan encompassed the radiological consequences of the "postulated accidents," Table 4-1 showed that the only accidents postulated were design basis accidents.

E-8. In reply, the Applicant argued that Table 4-2 of the Plan, which sets out responses to a variety of events, in fact included some accidents which were beyond design basis. Boyer _et al_., ff. Tr. 9972 at 1-2. Both the Applicant and the Staff argued that the provisions of the Plan encompassed the accident-initiating conditions listed in NUREG-0654, Rev. 1, in Appendix 1. _Id_. at 2; Sears, ff. Tr. 9776, at 5.

E-9. On Contention VIII-1 as admitted, we find for the Applicant. LEA neither proffered witnesses on the issues raised by the contention nor cross-examined the witnesses of the other parties. Thus, all the evidence in the record points to the conclusion that the Plan does indeed encompass accidents beyond design basis.

E-10. As argued in LEA's Proposed Findings (PF), this contention is much broader than it was as admitted. It alleges that, whether or not the Plan recognizes initiating conditions which could lead to a severe core melt accident, the Plan does not _adequately_ encompass "severe core melt accidents which are likely to result in doses exceeding the PAGs [Protective Action Guides] and to require protective actions, including evacuation of the plume exposure pathway emergency planning zone." LEA Proposed Findings at 2 (footnote omitted) and 3 n.1. The issue now is not the narrow one of whether the Plan in fact covers accidents beyond design basis, but the broader one of whether it does so adequately. 12/

E-11. The bases of this new version of Contention VIII-1 are likewise broader. As bases, the Proposed Findings on Contention VIII-1 proffer not merely a table, as Contention VIII-1 in its admitted form did, but rather "the entire record . . . established on all other contentions," and all the findings LEA proposes we make on all the other contentions. Id. at PF 1-2, 5. Thus, LEA argues, the Applicant cannot carry its burden of proof by merely citing a table of initiating conditions. "The Plan in its entirety must be examined to determine whether the Plan's operation in fact will encompass the sequence of events which would occur in a severe accident." Id. at PF 7 (footnote omitted).

E-12. It is difficult to view this new version of Contention VIII-1 as more than a kind of summary of LEA's other onsite planning contentions. It cites them as bases and proposes no remedy of its own.

12/ The Board notes that the NRC does not intend that emergency plans must aim at the impossible in an emergency, namely the prevention of any dose which exceeds the relevant PAG, or on the other hand, that PAGs are acceptable dose levels in situations other than emergencies. See NUREG-0396/EPA 520/1-78-016, at 4 (December 1978). Rather, PAGs are intended by the NRC to be simply levels of radiation dose which when predicted or exceeded trigger protective actions designed to minimize the impacts of the actual or threatened doses.

It is arguable that given its newness and redundancy we are not obliged to rule on it at all.

E-13. However, treating the VIII-1 of the Proposed Findings as both admitted and distinguishable from a mere summary of the other onsite contentions, we nonetheless again find fc the Applicant. The Findings of LEA we accept on the other contentions are far too few to support so broad a claim as that the onsite plan taken as a whole does not adequately encompass the spectrum of credible accidents, both design basis and beyond.

3. LEA Contention VIII-3: Onsite Monitoring Systems.

E-14. As admitted, this Contention was quite broad, alleging that the onsite plan did not identify and establish the onsite monitoring systems called for by Evaluation Criterion H.5 in NUREG-0654, Chap. II. These systems cover a variety of phenomena, among them wind speed and direction, reactor coolant levels, radioactivity, and fire. The data from these monitoring systems would be used to initiate emergency action levels. In its written testimony, the Applicant listed the sections of the Final Safety Analysis Report (FSAR) in which the monitoring systems called for by Criterion H.5 are discussed. Boyer et al., ff. Tr. 9772, at 2-5. The contention now concentrates on the adequacy of three of these systems. We find that the first of them is adequate, and that, in the circumstances, the Staff should make the final evaluation of the other two.

E-15. The first of the three systems monitors for certain toxic chemicals which could incapacitate control room operators. Criterion H.5 does not explicitly call for a chemical release monitoring system, but the Applicant has installed one nonetheless, and its inclusion seems necessary given the goals of the Criterion. Thus there can arise an issue over its adequacy. LEA claims that the system does not cover all the chemicals which might present a hazard to control room operators. For the reasons given below, the claim is true, but not significant.

E-16. The Applicant's determination of which chemicals present a hazard to control room operators is set out in § 2.2.3.1.3 of the FSAR. The determination rests on this definition: "A chemical is considered a potential hazard if it is stored or transported nearby in such quantities that its concentration at the control room air intake following a spill could exceed the toxic incapacitation level." FSAR at p. 2.2-7. After consultation with Conrail, surveys of nearby manufacturers and users of toxic chemicals, and a modeling of toxic plume transport, the Applicant determined that six of 154 chemicals evaluated fit the definition just quoted. All six are covered by the Applicant's chemical release monitoring system. See FSAR § 2.2.3.1.3. Thus, in testimony LEA does not mention, one of the Applicant's witnesses could say, "we are monitoring for all the chemicals which have the capability of resulting in concentrations in the control room which would incapacitate the operators." Tr. 10,207 (Boyer).

E-17. Of course, it is possible, but extremely improbable, that one of the chemicals not covered by the monitoring system would be released, say by a train derailment, in such a way as to threaten the control room. However, the Applicant has already exceeded the standards of Criterion H.5 in this regard, and LEA has raised no question about the adequacy of the consultation, surveys, and modeling which the Applicant used to determine which chemicals the monitoring system would cover. Much of the analysis which led to the determination followed NRC guidelines in various documents. See FSAR § 2.2.3.1.3. We see no legal or practical point in requiring that the Applicant's monitoring system cover more chemicals than the six it now covers.

E-18. The second of the monitoring systems LEA is concerned about is the meteorological system. Data from two meteorological towers, called Met-Towers 1 and 2, are direct inputs in a system the Applicant would use to predict cumulative population dose. Tr. 10,187-88 (Murphy). The dose prediction would be used in determining what emergency measures to initiate. LEA notes that the Staff has said that Met-Tower 1 is close enough to the cooling towers for there to be distortion of Met-Tower 1's readings of wind speed and direction. See NUREG-0991, Safety Evaluation Report related to the operation of Limerick Generating Station, Units 1 and 2 (SER), August 1983. at p.

2-19. The Staff has said that it will include this subject in its review of emergency preparedness. Id. LEA proposes that we "require, as part of any order, a Staff report on the evaluation and resolution of these concerns prior to any fuel loading or testing." LEA PF 18.

E-19. We find that any such requirement is unnecessary. First, in the course of its review of emergency preparedness, the Staff will be preparing a report which will include evaluation of the impact on emergency planning of the possible distortions in the data from Met-Tower 1. SER at p. 2-19, p. 13-17. LEA has offered no evidence that that report will be inadequate. We see no gain to safety from simply including that report in one of our orders.

E-20. Perhaps more important, a glance at the SER passage on Met-Tower 1 reveals that the Staff's concern about its location is minimal. There the Staff says that meteorological measurements at Met-Tower 1 "will probably be affected by the cooling towers less than 10% of the time," and probably not at all in a slow wind. Id. at p. 2-19. Also, the Staff says that the potential for significant distortions of Met-Tower 1's measurements of wind speed and direction is "small." Id. Indeed, the Staff concludes that the location of Met-Tower 1 is "satisfactory." Id. LEA does not dispute any of these statements.

E-21. The last of the three systems or pieces of equipment LEA is concerned about under Contention VIII-3 is the wide-range water level transmitter used to monitor the level of the coolant in the reactor. As is the case with the other systems and equipment considered in this contention, data from the wide-range water level transmitter would be used in an emergency to help determine the appropriate level of emergency response. Regulatory Guide 1.97 calls for the reference leg of the transmitter to be located at the required tap at centerline of the main steam lines, but the Applicant, excepting to this guidance, has put the reference leg five feet below the location the Regulatory Guide prefers. See the FSAR at p. 7.5-27, in App. Ex. 38. Moreover, the Staff is in the midst of reviewing the whole of Applicant's treatment of Regulatory Guide 1.97. See the SER § 7.5.2.3, and SER, Supp. 1 at p. 1-2. LEA would have us therefore conclude that the water level monitoring system is not yet "established" and so does not conform to Criterion H.3, the legal basis for all parts of Contention VIII-3.

E-22. We do not so conclude. First, it must be remembered that Regulatory Guide 1.97 is guidance, not regulation. Therefore, an Applicant need not conform to some particular guideline in the Guide if it has good reason not to. The Applicant has chosen to place the reference leg of the wide-range water level transmitter below where Regulatory Guide 1.97 would have it placed in order to "eliminate long runs of exposed sensing line tubing that contribute to erratic indication." FSAR at p. 7.5-27, in App. Ex. 38. LEA doesn't even mention this reason, let alone criticize it. Nor is there in the record any indication that the Staff will find the reason inadequate in the course of its review of the Applicant's treatment of Regulatory Guide 1.97.

E-23. Thus, we have ruled against LEA on all three parts of Contention VIII-3. In relation to the second and third parts, our rulings have been the result largely of LEA's nearly identical approaches to the issues of the locations of Met-Tower 1 and the wide-range water level transmitter: In both cases LEA has chosen to second a concern the Staff has raised in the SER, but LEA has added nothing to the record on either issue, either by testimony or cross-examination. The result is that LEA has in effect asked us to be not adjudicators of conflicting claims each backed by a part of the record, but solely reviewers of Staff work. It is not our function to review Staff work except in the context of adjudication proper. Therefore, we leave to the Staff the final determination of the adequacy of the locations of Met-Tower 1 and the wide-range water level transmitter.

4. LEA Contention VIII-6(a): Mutually Agreeable Bases for Notification of Organizations with Responsibility for Onsite Augmentation.

E-24. Evaluation Criterion E.1 of NUREG-0654, Chap. II, says that "Each organization shall establish procedures which describe mutually agreeable bases for notification of response organizations . . . ." LEA contends that the onsite plan does not demonstrate that mutually agreeable bases exist for notification of organizations with responsibility for onsite augmentation. Arguing more specifically, LEA says that each of the three organizations it regards as having responsibilities for onsite augmentation -- Linfield and Limerick Fire Companies, and Goodwill Ambulance Corps [13/] (LEA PF 27) -- has offsite responsibilities which can conflict with its responsibilities onsite, and that for there to be the mutually agreeable bases called for in Criterion E.1, there should be something in either the Plan or the letters of agreement with these organizations which "provides a resolution . . . of conflicting claims upon these very limited resources," or which "describes how these resources already committed offsite would be notified and required to leave offsite duties to travel to the site." LEA PF 31.

13/ The Applicant argues that Goodwill cannot be construed to have any responsibilities for onsite augmentation. Applicant's Reply Findings at (Footnote Continued)

E-25. For the reasons set out below, we find that the letters of agreement between the Applicant and the three organizations LEA names in this contention conform to Evaluation Criterion E.1 of NUREG-0654, Chap. II, and that the real issue which LEA raises in this contention -- the adequacy of the resources of these three organizations -- is litigated in other contentions.

E-26. LEA is confusing two possible agreements, one on the allocation of allegedly scarce resources, and the other, more properly the subject of the cited criterion E.1, on the means of notification of the need for the resources. The contention alleges nothing about how the three organizations in question are to be notified of the need for their resources, only that the Applicant and the three organizations have not agreed on whether and when onsite needs should take priority over offsite. Thus, the issue the contention raises is whether the resources of these organizations are adequate where conflicting needs for these resources might arise. This issue is the principal one in Contentions VIII-11 and VIII-12(b), and thus is redundant here.

E-27. Evaluation Criterion E.1 seeks not adequacy of numbers but rather agreement which is likely to preclude confusion during an

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(Footnote Continued)
5. Given the grounds of our decision on this contention, we need not determine whether Goodwill's responsibilities include augmentation of onsite functions.

emergency about what constitutes official notification. During an emergency, a response organization should not have to wonder whether a call for its resources was made by a responsible party. The agreements with each of three organizations LEA names in this contention appear to preclude such confusion. Each of the two fire company letters says that the fire company which is the subject of the letter will receive notification from the "Montgomery County Division of Public Safety, Office of Communications." App. Exs. 44 and 45. According to unchallenged testimony of one of the Applicant's witnesses, the Office of Communications is aware of these agreements. Tr. 10,007-08 (Kankus). The letter of agreement between Goodwill Ambulance Corps and the Applicant says that Goodwill and the Applicant's Medical Director have "reviewed arrangements for the Goodwill ambulance Unit to respond to a call for assistance" to the Limerick plant. Plan, Appendix A, Item 10.

5. LEA Contention VIII-6(c): Notification to Offsite Authorities.

E-28. As did other onsite emergency planning contentions, VIII-6(c) changed in the course of being litigated. The contention in its admitted form is now only a secondary part of the contention in its litigated form. As admitted, VIII-6(c) is aimed only at one provision of the onsite plan. Section 6.1.1 provides that notification to governmental authorities of an emergency event "shall be within about fifteen minutes after classifying the event." LEA alleges that this provision does not conform to the guidance in NUREG-0654, Appendix 1, at

p. 1-3, which LEA interprets as saying that notification should take place within fifteen minutes "not from classification, but from the time that operators recognize that an emergency event has occurred." LEA PF 37 (footnote omitted).

E-29. However, during litigation VIII-6(c) expanded and became aimed not only at the Plan but also at some of the implementing procedures under it. LEA claims that given the provisions of certain implementing procedures, the time between classification of the emergency event and notification of offsite authorities -- let alone the time between recognition that the event has occurred and notification -- may "easily" be longer than fifteen minutes. LEA PF 48.

E-30. Thus Contention VIII-6(c) now has two parts; they can be summarized thus: First, the plan measures the fifteen minutes to notification from too late a moment, and second, even if it should be measured from the later moment, notification may well be delayed beyond fifteen minutes. Each of the two parts of the Contention is a fall-back position for the other, but the second part has been foremost in the litigation of VIII-6(c). Below, we consider the second part first. Happily, the issue it raises has become largely moot because of revisions of the implementing procedures, revisions LEA and, surprisingly, the Applicant did not inform the Board of. We end our discussion of VIII-6(c) with an examination of the NUREG-0654 guidance on which LEA relies in claiming that the Plan measures the fifteen minutes from too late an event. For a number of reasons we conclude that NUREG-0654 intends that the fifteen minutes be measured from classification of the emergency event. Thus, the Plan conforms to the guidance.

E-31. To support its claim that notification could easily be delayed beyond fifteen minutes after classification, LEA examined in some detail EP-103, the implementing procedure which provides guidelines for the site response to the Alert level of emergency action. EP-103 lists several tasks to be performed by the Emergency Director, or the Interim Emergency Director if the Emergency Director is not available. The task of filling out the Alert Notification Message to be sent to offsite authorities is the seventh item in the list, after such apparently time-consuming tasks as directing evacuation of the site. Citing testimony by one of the Applicant's witnesses, LEA claims that just the first listed task alone, verification of the emergency classification, could well take anywhere from ten minutes to an hour. LEA PF 46. LEA could have made similar arguments about what, at the time of the hearing on this contention, were the current texts of EP-102, EP-104, and EP-105, the other three documents which provide guidelines on site response at one of the four levels of emergency action the NRC has established. See NUREG-0654, Appendix 1.

E-32. However, in the latest revisions of EP-102 (Unusual Event), EP-103 (Alert), and EP-104 (Site Emergency) -- Revision 3 of each -- the notification tasks are listed immediately after verification of the emergency classification, which is still listed first in each of the three documents. No Revision 3 has been issued yet for EP-105 (General Emergency), the last of the four implementing procedure documents on site response at the four emergency action levels, but, given the latest revisions of the first three documents, there is no reason to think that there will not be a revision of EP-105 which will list notification tasks right after verification. 14/

E-33. With these latest changes in implementing procedures, the claim in Contention VIII-6(c) that notification might well come more than fifteen minutes after classification of an emergency event depends wholly on whether verification of the classification could take more than fifteen minutes, for verification is now the only step between classification and notification. As we've said, LEA claims that verification could take up to an hour. LEA PF 46.

14/ Even though the Applicant sent these latest revisions to the Board and the other parties on June 11, ten days before LEA filed its Proposed Findings and nearly a month before either the Applicant or the Staff filed theirs, it appears that no party knew of the changes we have just described. We might have expected LEA and, in particular, the Applicant to have noted changes in documents which figured so prominently in their Proposed Findings. On the other hand, there is illustrated here one of the difficulties which inheres in trying to cope with implementing procedures in litigation, rather than focussing on the plans, as case law would generally have us do. See Louisiana Power & Light Co. (Waterford Steam Electric Station, Unit 3), ALAB-732, 17 NRC 1076, 1107 (1983). Taken altogether, the implementing procedures are a maze of

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E-34. The claim is misleading. It is stated generically, without mention of the single example on which it rests, and rests not at all firmly. The example is a wreck onsite of a train carrying toxic chemicals. It could take up to an hour to obtain a report from Conrail on the contents of damaged cars. Tr. 10,101 (Boyer). However, if the chemicals were identified by labels on the cars which carried them, as they usually are, it would take only ten to fifteen minutes for someone sent from the Limerick plant to the site of the wreck to learn what the chemicals were. Id. at 10,100 (Boyer). Moreover, under EP-101, Rev. 1, and EP-102, Rev. 3, the mere fact of a train derailment within the site boundary is enough to trigger notification of offsite authorities. Therefore, there is no evidence in the record that verification of a classification could delay notification.

E-35. Thus, as the relevant implementing procedures now stand, there is reasonable assurance that notification of offsite authorities will occur within fifteen minutes of the classification of an emergency event. 15/ All that remains of Contention VIII-b(c) therefore is the

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(Footnote Continued)
details undergoing more or less constant revision in a process which sometimes can be beyond the reach of even the Applicant's counsel, as apparently it was here.

15/ Even if the latest revisions of the implementing procedures had not made largely moot the issue of the length of time between classification and notification, we might well have found for the Applicant on this issue, principally because it would appear that, with the exception of
(Footnote Continued)

original part of it, the claim that the onsite plan should measure the

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site evacuation, none of the Emergency Director's tasks which in the earlier texts of the procedures came before notification would consume more time than a quick telephone call would; and even "directing" site evacuation requires the Director to perform what is arguably only a short series of simple acts. See EP-305, Rev. 1, § 9.1.

The Applicant makes two other arguments about the earlier versions of the procedures, but neither is persuasive. The first is that site evacuation, which in the earlier versions preceded notification, would be initiated and "directed" by the Emergency Director but that classification of an event and notification of offsite authorities would be performed by the Shift Superintendent. Thus, the Applicant argues, site evacuation would not have to precede notification: The different personnel assigned these tasks could perform them simultaneously. Tr. 10,121-22, 10,124-25 (Ullrich). However, this argument is difficult to square with the texts of the implementing procedures. EP-103, Rev. 3, is typical. It assigns all three tasks -- classification, direction of site evacuation, and notification -- to what it calls the "(Interim) Emergency Director." The Interim Emergency Director is the Shift Superintendent (Plan § 5.2.1.1); he is to serve until the Emergency Director, who is the Station Superintendent (id. § 5.2.1.2), takes over (id. § 5.2.1.1). Thus, although the Applicant's witness says that EP-103 assigns the Shift Superintendent and the Emergency Director to different tasks, it appears that EP-103 actually assigns them at most to different times, and therefore that if the Shift Superintendent were to stay long enough, or the Emergency Director to come early enough, under EP-103, Rev. 1, either officer could well have to perform all three tasks.

The Applicant's other unpersuasive argument is that notification and site evacuation could be simultaneous because "[t]here is no evidence in the record that the effectiveness of Applicant's implementing procedures . . . is dependent upon the execution of steps within a procedure in any particular order." Applicant's Reply Findings at 7. Such a claim is implausible a priori, but it is also difficult to square with certain particulars in the procedures. For instance, even a witness for the Applicant testified that in EP-305, Rev. 1, which governs site evacuation, the Emergency Director would have to perform § 9.1.1.3, notification of Security, before § 9.1.1.7, activation of the alarm, so that Security would have time to prepare for evacuation. Tr. 10,102-04 (Ullrich). Indeed, the very revisions which have placed notification just after verification would indicate that the order in which the tasks
(Footnote Continued)

fifteen minutes not from classification, but from the time onsite personnel recognize that an emergency event has occurred. LEA rests its claim on the following sentence from NUREG-0654: "The [fifteen minutes] is measured from the time at which operators recognize that events have occurred which make declaration of an emergency class appropriate." Id., Appendix 1 at p. 1-3. The meaning of this sentence is not crystal clear. LEA's reading of it is certainly plausible, but three arguments point to a conclusion that the sentence means that the Applicant should be able to notify offsite authorities within fifteen minutes of classification of an emergency event.

E-36. The first two arguments are textual. First, immediately before the sentence we just quoted from NUREG-0654 comes this one: "Prompt notification of offsite authorities is intended to indicate within fifteen minutes for the unusual event class and sooner (consistent with the need for other emergency actions) for other classes." Id. Here the time to notification is a function of the emergency class and therefore must be measured from classification.

E-37. Second, the fifteen minute requirement is stated less ambiguously in Appendix E of 10 C.F.R. Part 50: "A licensee shall have

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(Footnote Continued)
are listed is intended to be the order in which they are to be performed.

the capability to notify responsible agencies within fifteen minutes after declaring an emergency." Id. at § IV.D.3. LEA acknowledges that this regulation measures the fifteen minutes from classification, but apparently, LEA also wants to treat the regulation in Part 50 and the guidance in NUREG-0654 as different requirements, as if the Applicant had to be capable of notification within fifteen minutes of two quite different moments. LEA PF at 14 n.1. We do not see how this makes sense.

E-38. The third and last argument is practical: Recognition of an emergency event and classification of it for the purposes of site response are, in relation to notification, barely separable; thus measuring the fifteen minutes from classification could not cause significant delay. Apparently, LEA imagines that plant personnel will first recognize that something has gone wrong and then may have to spend some time determining how serious it is before they put it in an emergency level classification: LEA claims that classification may be delayed "for as long as twenty minutes beyond event recognition under some circumstances, e.g., a transient plus failure of the core shutdown system, in which the symptoms of the event will be the initiation of the liquid control system, but the failure of the core to become subcritical [sic]." LEA PF 38, citing Tr. 10,085-86 (Boyer).

E-39. While one witness of the Applicant did say that it could take "twenty minutes say" after the initiation of the liquid control system to determine whether the reactor was becoming subcritical (id.), another witness of the Applicant pointed out that under EP-101, Rev. 1, at 15, even while the operator was initiating the liquid control system an Alert level of emergency response would probably be declared because of the failure to automatically scram, combined with a failure of a scram to bring the reactor subcritical. Tr. 10,087-88 (Kankus). Notification of offsite authorities would follow declaration of the Alert level, not the determination of whether the liquid control system had brought the reactor subcritical. Tr. 10,088 (Kankus); see also EP-101, Rev. 3. Similarly, as we've noted before, in the case of a train derailment onsite, notification of offsite authorities would follow recognition of the derailment, not determination of whether toxic chemicals were released in the accident.

E-40. Thus, no period of uncertainty about how threatening an initial event was would delay notification, for while reclassification might come more than fifteen minutes after an initial event, notification would not, since even the initial event would fall within a classification which required notification to offsite authorities. We note also that as the implementing procedures now stand, reclassification would bring about renotification well within fifteen minutes.

E-41. In conclusion, we find that NRC regulations and guidance require that notification of offsite authorities follow within fifteen minutes of classification of an emergency event, and that as the implementing procedures now stand, there is reasonable assurance that this time constraint would be met in an emergency.

6. LEA Contention VIII-8(b): Adequacy of Emergency Facilities, Equipment, and Supplies.

E-42. In this contention, as in VIII-3, LEA focuses on areas still under review by the NRC Staff. Here, unlike in VIII-3, the Staff has not identified a possible shortcoming in the Applicant's work, but at the time of the hearing on onsite planning, the Staff's review was still far from complete.

E-43. At the time of the hearing, in April 1984, the Applicant was still in the process of establishing three emergency facilities called for by NRC guidelines in various documents: the Emergency Operations Facility (EOF), the Technical Support Center (TSC), and the Operations Support Center (OSC). The Staff's witness estimated that the three facilities were about 75 percent complete (Tr. 10,062 (Sears)), and that the Staff's review of the facilities would not be available for about another three months (Tr. 10,273 (Sears)).

E-44. In view of the importance of these three facilities, and the work which at the time of the hearing remained to be done on them, LEA asks that before we make findings on the three facilities, the Staff make its review of them available to the Board and the parties and the parties be given opportunity after the review becomes available to propose additional findings on the adequacy of the facilities. LEA PF 54.

E-45. Having balanced certain considerations, we have decided to close the record on these facilities now. On the one hand, it is crucial that these facilities be adequate to the uses which would be made of them in an emergency. Moreover, determining their adequacy would appear to require some judgment, considerably more than determining the adequacy of, say, the location of Met-Tower 1 or a wide-range water level transmitter. See our discussion of Contention VIII-3. Thus an outside observer such as an intervenor could be both interested in the outcome of the Staff's review and in a position to reasonably and fruitfully disagree with the Staff's review.

E-46. On the other hand, the review work which the Staff had yet to do at the time of the hearing was hardly novel, nor have such facilities been the objects of great controversy in proceedings on other plants. Limerick is not the first plant to use the instrumentation and equipment which will be in the three facilities. Tr. 10,065 (Sears). Moreover, the criteria for judging the facilities -- NUREGs 0696 and 0818 -- are well-known and not particularly controversial -- and not at all controversial in this proceeding.

E-47. But last and perhaps decisive, litigation on emergency planning is first and foremost concerned with the plans; yet, even though a certain amount of information about these three facilities is available in §§ 7.1.2., 7.1.3, and 7.1.4 of the onsite Plan, LEA has raised no issue based on any of this information. Even now, LEA raises no specific concern that any of these facilities will not meet a particular requirement.

E-48. On balance, we find that LEA has not shown any justification for keeping the record open.

7. LEA Contention VIII-10(a): Delineation of Authority in Certain Letters of Agreement.

E-49. LEA contends here that the Applicant's agreements with local agencies do not conform to Evaluation Criterion B.9 of NUREG-0654, Chap. II, because they do not delineate the authorities, responsibilities, and limits on the actions of the agencies, but merely briefly describe the general nature of the service to be provided. Though stated quite broadly, the contention deals only with the Applicant's agreements with the Linfield and Limerick fire companies and the Goodwill Ambulance Unit.

E-50. The issue LEA raises about the agreements with the fire companies is that although the letters do say that the fire companies will be "under the direction and control of Philadelphia Electric Co." (App. Exs. 44 and 45), the letters do not reflect, but should, what LEA thinks is the more complicated division of authority which the Applicant actually has in mind: The fire companies would not have authority to decide how to fight an onsite fire, but would to decide what equipment to bring, though not to decide where to place it; they would also have authority to decide which of their personnel to bring, but not to decide how long they would fight a given fire. LEA PF 58 (citing Tr. 9968-69 (Kankus)). LEA claims that unless such divisions of authority are delineated in the agreements, there is likely to be conflict and confusion when the Applicant's fire-fighting personnel, who have had only a two-day course in fire-fighting, try to assert authority over experienced municipal fire fighters. LEA PF 59.

E-51. We find that the agreements are adequate as they stand. All the divisions of authority which LEA elicited in cross-examination from one of the Applicant's witnesses, and which LEA apparently thinks are too confusingly arranged to be left out of the agreements, follow directly from the single principle laid down by the same witness: "Again, before they [the fire companies] come to the site, they have -- the decision is theirs to determine what they will bring. Once they're on the site they're under the direction of our fire-fighting personnel." Tr. 9969 (Kankus). And this principle is only a paraphrase of the one already stated in the letters of agreement, that while on the site the fire companies will be under the direction and control of Philadelphia

Electric. There is no need for the letters to spell out the direct consequences of so simple a principle.

E-52. There is no reason either to think that the fire companies will resist the application of the principle. They have, after all, agreed to it, and it makes good sense, for, of all the fire-fighting personnel, only the Applicant's will be well-informed about the layout of the plant, the location of electrical equipment that may be feeding the fire, ventilation systems, and the like. Tr. 10,012-13 (Ullrich). Moreover, personnel named by the fire companies will be trained by the Applicant (App. Exs. 44 and 45) and so will be accustomed to the division of responsibility the principle entails.

E-53. Last, we note that the Applicant's fire-fighting personnel have something more than just a superficial two days of training in fire-fighting. Unrefuted testimony has it that the two days will be "intensive." Tr. 9970 (Kankus). The course is well-established, being given by the Applicant's fire school, which has been in service for a number of years. Id.; Tr. 9971 (Reid, Boyer). Finally, there will be annual retraining. Tr. 10,008-09 (Ullrich).

E-54. There is even less reason to make a finding that the Applicant's agreement with Goodwill Ambulance is inadequate. One of the Applicant's witnesses testified that the only authority the Applicant would exercise over Goodwill's personnel would be that exercised by an escort who would keep them away from areas where they were not needed and would lead them to where they were needed. Tr. 9967-68 (Kankus). Such "authority" is more aptly called "help," and is so self-evidently what Goodwill personnel would need in an environment with which they were not familiar that it need not be spelled out.

8. LEA Contention VIII-11: Offsite Augmentation of Onsite Fire-Fighting Capabilities.

E-55. LEA once again contends that the agreements between the Applicant and Linfield and Limerick Fire Companies for augmentation of the Applicant's own fire-fighting capabilities are not adequate. See also our discussions of LEA Contentions VIII-6(a) and VIII-10(a). Here the difficulty LEA sees is that there is a chance that the two fire companies would have offsite duties that would keep them from performing their onsite duties. Under the offsite emergency plan for the Limerick plant, both fire companies are assigned to do route-alerting if notification to the public should be required while the siren system is inoperable. Tr. 9982 (Kankus). LEA admits that the probability of there being both a general emergency and a failure of the siren system "may be relatively low." LEA PF 63. Nonetheless, asserting the principle that the adequacy of emergency plans is to be measured "in light of the circumstances of accidents which may require evacuation of the plume exposure EPZ" (LEA PF, at 27 n.1), LEA claims that the

Applicant should make some further arrangements, ones which will secure offsite augmentation even when route-alerting is necessary.

E-56. The Applicant and the Staff emphasize that the plant is "basically self-sufficient in fire-fighting capabilities." See App. PF 40-41, and Staff PF 24. The Applicant goes so far as to claim that its fire detection and suppression capabilities, together with the configuration and safety systems of the plant, are enough to suppress any credible fire at the plant, or to assure that if the fire could not be suppressed the damage would be limited enough to permit the plant to be safely shut down. Boyer et al., ff. Tr. 9772, at 12. Both the Applicant and the Staff also claim that in the 86 times the Linfield fire company was called out last year, it was unavailable only once. Id. at 13; Staff PF 24.

E-57. These arguments are not very persuasive. The Applicant is not so self-sufficient in fire fighting that there has not been the need to arrive at an agreement with a second fire company. Moreover, it may be that the Linfield company was unavailable only once in 86 times to fight an offsite fire, but that is not quite relevant, for the question here is not how often a fire company might be called on to fight two offsite fires at once, but whether it might be called on to fight an onsite fire and do route-alerting at the same time.

E-58. Nonetheless, we find that it is unnecessary for the Applicant to make further arrangements for augmentation of its firefighting capabilities. The principle that emergency plans must be judged with evacuation in mind is a good one. But probabilities must be kept in mind. It is prudent to assume, given the emergency planning regulations, that offsite evacuation could be required while there is a fire at the Limerick site. However, the further possibility that the fire companies could be called on to fight a fire at the plant and do route-alerting at the same time is just too remote. Not only is it improbable, as LEA admits, that the siren system would fail in a general emergency, it is also improbable that during the same emergency there would be a fire which exceeded the Applicant's considerable fire-fighting capabilities, the "basic self-sufficiency" of which LEA chooses not to question. The Applicant's planning for augmentation of its fire-fighting capabilities already goes beyond what prudence would suggest as a minimum. We will not require that it go still further.

9. LEA Contention VIII-12(a): Emergency Hospital Care for the Contaminated Injured.

a. Unanimous Board Findings

E-59. LEA here contends that there is not yet reasonable assurance that adequate measures would be taken in a radiological emergency to care for onsite personnel who suffer both traumatic injury and contamination. Such persons are called "contaminated injured." Southern California Edison Co. (San Onofre Nuclear Generating Station, Units 2 and 3), CLI-83-10, 17 NRC 528, 535 (1983).

E-60. Planning Standard (b)(12) in 10 C.F.R. § 50.47 requires that "arrangements are made for medical services for contaminated injured individuals." The first Evaluation Criterion under this Standard, Criterion L.1 of NUREG-0654, Chap. II, would require that "each organization shall arrange for local and backup hospital services having the capability for evaluation of radiation exposure and uptake, including assurance that persons providing these services are adequately prepared to handle contaminated individuals."

E-61. Standard (b)(12) and the evaluation criteria which elaborate on (b)(12) aim principally to secure adequate planning for emergency treatment of traumatic injury, not of severe radiation exposure. Only in extreme cases does such exposure require immediate treatment. San Onofre, 17 NRC at 535-36. Standard (b)(12) and the criteria under it are concerned with radiation exposure principally because medical personnel treating traumatic injury sustained in a radiological emergency may well have to reckon with contamination as an obstacle to adequate treatment of the traumatic injury.

E-62. The Applicant has made arrangements for the treatment of contaminated injured with two hospitals. Under these arrangements, Pottstown Memorial Medical Center (PMMC) would be the main receiving point for onsite personnel who are contaminated injured. See App. Ex. 42. Through an agreement with the Radiation Management Corporation (RMC), which is the Applicant's contractor, the hospital of the University of Pennsylvania (HUP) in Philadelphia would receive contaminated injured when it could provide specialized personnel and equipment PMMC could not. See App. Ex. 43. HUP would also assist with the treatment of persons suffering severe radiation exposure with no traumatic injury. Id.; Tr. 9804-05 (Linnemann); and App. Ex. 40.

E-63. However, PMMC is less than two miles from the Limerick plant (Tr. 9831 (Linnemann)), and HUP is a forty-five minute drive from the plant (Tr. 9844 (Linnemann)). LEA wants us to rule that the Applicant should also make arrangements for care of the contaminated injured with a hospital less vulnerable to evacuation than Pottstown is, but also closer than HUP is, and thus more accessible for the treatment of traumatic injury. LEA PF 103. The majority rules against LEA on this issue. As noted in Judge Brenner's dissent, he would find for LEA on this part of Contention VIII-12(a).

E-64. LEA also wants us to rule that the implementation of the Applicant's arrangements with PMMC is in its "utter infancy" and therefore that there is not yet reasonable assurance that in a radiological emergency PMMC would be able to give adequate care to the contaminated injured. LEA PF 102. We do not so rule. We discuss the implementation of the Applicant's arrangements with PMMC first.

E-65. As of late April 1984, the time of the evidentiary hearing on onsite emergency planning, and three months before the scheduled emergency preparedness exercises, PMMC personnel were neither trained nor equipped to perform their roles under the agreement between PMMC and the Applicant. Tr. 9813-14, 9818 (Linnemann). Thus, LEA speaks of the "infancy" of the implementation of that arrangement. However, on the record before us, it would appear that three months would be ample time for training and equipping PMMC personnel, given the training and equipment required and the experience of the trainer.

E-66. As to training, PMMC personnel will not be wholly unfamiliar with the plans for treating contaminated injured, for those plans are an elaboration of plans already in effect at PMMC for the treatment of traumatic injury. Trauma is the first concern of treatment of the contaminated injured. PMMC's current disaster plan is adequate for trauma and requires only an addition dealing with contamination. Tr. 9813-14 (Linnemann). The addition will cover such important, but not especially complicated, matters as selecting a radiation emergency area, limiting contamination to that area, and seeking consultation and dose evaluation. Tr. 9814-15 (Linnemann). Training in accord with the addition is a matter of days only. Although specialized treatment procedures for contaminated injury victims have not been finalized, Dr. Linnemann stated that RMC, PECo, and Pottstown Hospital are compiling these procedures which, along with training, will be completed by mid-July. Tr. 9812-13 (Linnemann). The training documents to be used at Pottstown will be similar to those used at HUP and other hospitals across the country. Tr. 9828-29, 9932 (Linnemann). The training for Pottstown Hospital employees shall include instruction in the biological effects of ionizing radiation, classification of acute radiation injuries, and in the initial and emergency room treatment of radiation injuries. Tr. 9830 (Linnemann). It is expected to consist of three sessions lasting two days each, three drills, and a field exercise, the drills and exercises to be evaluated by FEMA and the NRC. Tr. 9903, 9954 (Linnemann). The Pottstown Memorial Hospital will receive training on a semiannual basis. Tr. 9828 (Linnemann). Finally, the trainer, RMC, is experienced, maintaining, as it does, similar programs for a number of nuclear power plants. See Boyer et al., ff. Tr. 9972, at 9-10; see also Tr. 9915 (Linnemann).

E-67. As to equipment, again on the record it appears that, with one exception, nothing is required which is especially difficult to acquire: Radiation instrumentation, bath arrangements which permit collection of contaminated water, decontamination supplies such as soaps known to be effective in removing radiation from the skin, and containers for taking samples to determine a patient's dose.

Tr. 9816-18 (Linnemann). One piece of radiation instrumentation is both expensive and difficult to maintain: a whole-body counter, which is used to determine the dose a patient has received internally. However, RMC maintains a whole-body counter in a mobile unit in the Philadelphia area. Therefore, there is no need for PMMC to acquire such a counter as a prerequisite to implementation of the Applicant's arrangements with PMMC. As for the other equipment listed above, the Applicant has agreed to supply whatever is necessary and not already in PMMC's possession. Tr. 9818-21 (Boyer).

E-68. In conclusion, we see no obstacle to the timely completion of the training and equipping of PMMC personnel. LEA's sole argument in this part of Contention 12(a) appears to be that the three months between the hearings and the preparedness exercises would not be time enough for the training and equipping we've just described. However, LEA said nothing to counter the indications in the record that three months would be enough. Therefore, we find that there is reasonable assurance that PMMC will be trained and equipped to give adequate care to the contaminated injured in a radiological emergency. Of course, any particular deficiencies which may be disclosed by the emergency planning exercises will have to be corrected under the auspices of FEMA and the NRC Staff.

E-69. LEA's principal concern is about the locations of the hospitals with which the Applicant has made arrangements. PMMC, being less than two miles from the plant, appears to be potentially vulnerable to having to be evacuated in a general emergency, while HUP, being 45 minutes away, might appear, in LEA's view, to be too far away to be adequate backup for treatment of traumatic injury if PMMC had to be evacuated. 16/ LEA is contending that HUP should not be the sole backup for PMMC, not that either PMMC or HUP should not be among the hospitals assigned responsibility for the contaminated injured. The Applicant and the NRC Staff both agree that since traumatic injury is much more likely than evacuation, prudence requires that the hospital assigned the treatment of traumatic injury be reasonably close to the plant. See Tr. 9929-30 (Sears) and Tr. 9906 (Linnemann). Contamination is really the secondary part of the whole problem. It is the patient's life that is important. Tr. 9844-45 (Linnemann). LEA appears to acknowledge this counsel of prudence. See LEA PF 90. We agree.

E-70. Borrowing a phrase from the Staff, the Applicant argues that the probability of a hospital having to evacuate during a radiological emergency is "vanishingly small." See Tr. 9941 (Linnemann) and Tr. 9930 (Sears). The Applicant's chief witness on this contention, one of the officers of RMC and a medical doctor as well as an Associate Professor at the University of Pennsylvania's School of Medicine, says,

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16/ We do not assume availability of helicopter med-evac transport for this purpose, given the testimony on such availability which the Board relies on in its findings on Contention VIII-12(b).

"Evacuating a hospital is a pretty serious matter, or an immediate life-threatening situation, and I don't see a release from a nuclear power plant that would be life-threatening." Tr. 9941 (Linnemann).

E-71. The Applicant further argues that even if PMMC had to evacuate, adequate backup would exist. If time permitted, the contaminated injured could be taken to HUP (Tr. 9906-07 (Linnemann)), and if the injury required earlier treatment than HUP could provide, the patient could be taken to one of the several hospitals which are nearer the plant than HUP is. Tr. 9912-14 (Linnemann); See also Tr. 9906-11 (Linnemann). Neither the Applicant nor RMC have made arrangements with any of these other hospitals to receive contaminated injured from the plant, but the Applicant argues that, even so, none of these hospitals would refuse to accept a contaminated injured patient, for all of them are accredited by the principal national accrediting organization, the Joint Committee on Hospital Accreditation (JCHA). The JCHA requires that each accredited hospital have some plans for treating contaminated injured patients. Tr. 9912-14 (Linnemann).

b. Majority Findings by Judges Cole and Morris

E-72. While the Commission's decision in San Onofre is directed primarily to consideration of offsite emergency response plans, important guidance is given that is relevant here. In discussion of Section 50.47(b)(12), the Commission teaches that:

> The emphasis is on prudent risk reduction measures. The regulation does not require dedication of resources to handle every possible accident that can be imagined. The concept of the regulation is that there should be core planning with sufficient planning flexibility to develop a reasonable *ad hoc* response to those very serious low probability accidents which could affect the general public. (Emphasis in original.) CLI-83-10, 17 NRC 528, 533 (1983).

The Commission explicitly noted that NUREG-0396, "Planning Basis for the Development of State and Local Government Radiological Emergency Response Plans in Support of Light Water Nuclear Power Plants," and NUREG-0654 were considered in its examination of this regulation. Also, the Commission noted the conclusion of the Appeal Board that "relatively few people [one to 25] are expected to be both contaminated and traumatically injured in a nuclear accident." *Id.* at 532. *See* ALAB-680, 16 NRC 127, 137 (1982). *See also*, Tr. 9806 (Linnemann).

E-73. Regarding the availability of other hospitals in the highly unlikely event that Pottstown Memorial is evacuated, the County Radiological Emergency Response Plans (RERPs) show that there are twenty hospitals in the three county risk areas listed with radiation exposure/contamination treatment capability (Montgomery County-12, Berks County-3, Chester County-5). While the Board has no detailed knowledge of the specific abilities and training of the emergency medical service personnel at these potential alternative receiving hospitals, who might handle "contaminated injured," it is not unreasonable to assume that they are adequately prepared. Also, when a contaminated injured individual is transported, a health physicist would accompany him and provide assistance in controlling any radiological hazard both during transport and at the receiving facility. Tr. 9842-43 (Boyer). In the event of a large number of casualties, it is not unreasonable to assume that other hospitals and trained personnel, including particularly University of Pennsylvania and RMC specialists, will provide direct assistance. It may also be reasonably assumed that in the event of a hospital evacuation, trained personnel and some equipment would travel to the receiving hospital and provide assistance.

E-74. While the Board majority agrees that it would be prudent to make more formal arrangements with a third hospital, one less vulnerable to evacuation than Pottstown Memorial, and more accessible (closer) than the University of Pennsylvania, we decline to require such an arrangement. It is our view that the probability of Pottstown Memorial being unavailable is remote, that there are nineteen other hospitals in the three county area with claimed capability for handling "contaminated injured" on an ad hoc basis in an emergency and the Pottstown Memorial Staff, RMC and University of Pennsylvania specialists can provide assistance to each other and other participating entities during an emergency. We also note that for the most severe emergency action level (a General Emergency), evacuation is not automatically recommended; sheltering is the first option and may be the preferred action. NUREG-0654, Appendix 1, at 1-16. These considerations militate against imposing any additional requirements. Applicant has met the requirements of Planning Standard (b) (12) in 10 C.F.R. § 50.47.

c. Partial Dissent of Judge Brenner

E-75. I respectfully disagree with my colleagues that there is no need for the emergency plans to include arrangements for the treatment of contaminated injured persons at a back-up hospital to Pottstown Memorial which is closer than the Hospital of the University of Pennsylvania (HUP), in the event Pottstown Memorial has to be evacuated due to an accident at the Limerick facility. As noted above, Pottstown Memorial is located within the plume exposure EPZ less than two miles from the Limerick nuclear plant.

E-76. I readily grant that evacuation of Pottstown Memorial is improbable, perhaps even less probable than the evacuation of the area around it, for, as the Applicant's witness says, evacuation of a hospital is a serious matter. Tr. 9941 (Linnemann). Nonetheless, the possibility, remote though it is, of life-threatening releases from nuclear power plants is assumed by the NRC's regulations and guidance on emergency planning. Thus, the regulations and guidance envision the possibility of evacuation of an area up to about ten miles in radius. Planning for medical care for even a small number of contaminated injured persons up to about 25 (per San Onofre, supra, ALAB-680, 16 NRC at 137 and CLI-83-10, 17 NRC at 532) should be consistent with this possibility.

E-77. Thus, the main issue under this contention becomes whether there are adequate arrangements for the care of the contaminated injured in a radiological emergency which requires the evacuation of Pottstown Memorial. I think there are not. As the Applicant itself says, HUP can provide backup for Pottstown Memorial only when the trauma victim can withstand the delay caused by going to HUP. See Tr. 9906-07 (Linnemann). [17/] Moreover, although JCHA accreditation may guarantee that any of the hospitals between HUP and Pottstown Memorial would accept contaminated injured victims, there is no reasonable assurance, due to the total absence of planning, that any of those hospitals is well-prepared to treat such victims, especially if there were to be more than one or two victims. If JCHA accreditation were sufficient to guarantee adequate care for the contaminated injured, there would be no need to provide Pottstown Memorial with special training and equipment.

E-78. Even the Applicant's chief witness, whom I found to be knowledgeable and forthright, agrees that it would be prudent to have at least skeletal arrangements with a hospital between PMMC and HUP.

17/ As noted above, and discussed under LEA Contention VIII-12(b), helicopter availability cannot be relied upon for med-evac purposes given the arrangements made by the Applicant.

Tr. 9914-15 (Linnemann). Even this has not been done. Moreover, I think that prudence suggests more than merely skeletal arrangements with a third hospital. I therefore conclude that the Applicant should assure that there is an emergency back-up to Pottstown Memorial in addition to, but closer than the large resources available at HUP. I note tnat my view is consistent with the uncontradicted testimony of the Applicant and Staff, and the views of all parties, that it is prudent and proper medical practice that a hospital being relied upon for treatment of traumatic injury, contaminated or not, be reasonably close (accessible) to the plant. <u>See</u> Finding E-69, above.

E-79. Accordingly, I would have required, as a condition for the full power operation of Limerick, that the Applicant make arrangements with an additional hospital in the Limerick area, similar to the ones it has made with Pottstown Memorial for the care of the contaminated injured, <u>e.g.</u>, similar arrangements for training, equipment, and NRC/FEMA-reviewed drills and exercises. Other than the obvious, namely that the third hospital should be less vulnerable to evacuation, and significantly more accessible than HUP, I can set out no simple rule for choosing this third hospital. It is not even required that the third hospital be outside the plume EPZ. Much depends on what hospitals the Applicant has to choose from, how accessible each is, and no doubt other factors which, on the record before us, I am in no position at this time to judge. As the majority notes, there are many candidate hospitals from which the Applicant could easily choose a satisfactory one with which to engage in such planning. I would have further directed the parties to discuss such arrangements after they were proposed, and advise the Board whether any important material issues remained in dispute. There would be no reason to require such further arrangements prior to issuance of a low power operating license, since the concern over emergencies which may cause offsite consequences and necessitate evacuation does not arise for power levels up to five percent. See 10 C.F.R. § 50.47(d).

E-80. In conclusion, I note that I believe it appropriate for decision-makers to put themselves in the place of one of the potentially affected persons -- in this instance a contaminated injured worker at the Limerick Generating Station -- when deciding whether proper and required emergency planning is being accomplished. In this instance, I believe proper and required emergency planning is not being accomplished, but readily could be by a utility presumably concerned for its nuclear power plant employees.

10. LEA Contention VIII-12(b): Adequacy of Transportation for the Contaminated Injured.

E-81. This is yet another contention on the adequacy of the Applicant's arrangements with Goodwill Ambulance Unit. See our discussions of Contentions VIII-6(a) and VIII-10(a). Evaluation Criterion L.4 of NUREG-0654, Chap. II says, "Each organization shall arrange for transporting victims of radiological accidents to medical support facilities." LEA contends that the Applicant's arrangements with Goodwill Ambulance do not assure adequate transportation from the plant site for those who are both traumatically injured and contaminated, and that the Applicant has not arranged for any adequate backup for Goodwill. We find that the arrangements with Goodwill are adequate for possible onsite needs, but that the possibility of competing offsite uses for the ambulances will have to be considered during the review of the offsite plans.

E-82. Goodwill has five ambulances. Tr. 9847 (Kankus). Each is designed to carry two and could carry more in an emergency. Boyer et al., ff. Tr. 9772, at 10-11. Thus, if in an emergency Goodwill's only responsibility was to transport contaminated injured persons from the plant site, there could be little question that the arrangements with Goodwill were adequate. The person responsible for establishing the Applicant's emergency medical program testified that, during his fifteen years of experience in establishing similar programs at about 25 nuclear power plants, there had never been at any one time more than two contaminated injured victims who required transportation to a local hospital (Tr. 9806 (Linnemann)), and that it was reasonable to expect the same number in the future, since not even a melted core would increase the number of traumatic, non-radiation, injuries (Tr. 9806-07 (Linnemann)). Goodwill's five ambulances clearly could deal with a much larger number of contaminated injured than the one or two expected.

E-83. However, Goodwill may also have offsite responsibilities. One of the Applicant's witnesses testified that current drafts of the offsite plans assign to Goodwill some responsibility for providing special assistance to persons in various townships -- twenty-four persons in Pottstown Township alone. Tr. 9936 (Kankus). The letter of agreement with Goodwill shows that Goodwill has agreed to furnish transportation for contaminated injured site personnel only "within the limits of [its] resources." Plan, Appendix A. The Applicant claims that it "would expect its call [to Goodwill] to take priority over another request, which would be assigned to one of the backup ambulances at the county level" (Tr. 9848-49 (Boyer)), but we have nothing more than the Applicant's expectation to support a finding that Goodwill would give priority to onsite needs. Thus, if the current offsite plan provision concerning Goodwill becomes final, it is possible that in an emergency Goodwill's offsite responsibilities would keep it from its onsite responsibilities.

E-84. Moreover, it appears that in such a situation the Applicant would be able to find only limited substitutes for Goodwill's services. Goodwill is the only ambulance company with which the Applicant has an agreement for the transportation of the contaminated injured. At the time of the hearing in April 1984, the Applicant was negotiating an agreement with a second company and expected to complete the agreement within a week (Tr. 9872-73 (Kankus)); but, apparently, even now, the agreement is not complete. The Applicant claims that there would be adequate backup ambulances at the county level, since if all of Goodwill's ambulances were occupied, "the Goodwill dispatcher would notify the county immediately and arrange for another ambulance to be dispatched for Limerick." Tr. 9937 (Boyer). It is not clear that this account is consistent with the Applicant's claim, noted in the preceding paragraph, that Goodwill would give priority to requests from Limerick. At any rate, we have too little evidence about the county dispatching system to conclude that in an emergency, backup ambulances would be available if Goodwill were not.

E-85. The Applicant also claims that private vehicles onsite would be available for transporting the contaminated injured, but the Applicant also notes that such vehicles could transport only those whose injuries did not require them to be transported in an ambulance. Boyer et al., ff. Tr. 9772, at 11.

E-86. Finally, a helicopter could also be used to transport the injured. The Applicant has an agreement with Keystone Helicopter which includes medical evacuation among the services Keystone is to be ready to provide. See App. Ex. 41, ¶ 1. However, for the same reason that HUP would be of limited use for treating the contaminated injured, Keystone would be of limited use for transporting them. As was noted in our discussion of LEA Contention VIII-12(a), HUP is a forty-five minute drive from Limerick. Keystone has agreed to provide a helicopter on two hours notice, if one is available, or one hour, if Radiation Management

Corporation, who entered into the agreement with Keystone on the Applicant's behalf, pays to have a helicopter on twenty-four hour standby. App. Ex. 41, ¶¶ 4-5. The treatment of some traumatic injuries probably should not be put off for forty-five minutes to two hours.

E-87. Thus, for transportation of the contaminated injured, the Applicant has to rely mainly on Goodwill. Yet Goodwill may have competing duties offsite. However, a determination by us about whether Goodwill could perform all the duties which the plans may finally assign it would be premature. To make such a determination, we would have to judge on the basis of speculation about the final state of the offsite plans. We think it preferable for us to judge on the basis of what we know: Considered apart from the final version of the offsite plans, the Applicant's agreement with Goodwill is adequate for onsite needs. Whether Goodwill can perform both its onsite duties and whatever offsite ones it may be assigned will be best determined at the time for consideration of the offsite plans, whether it be in a hearing as an issue in controversy or by authorities reviewing the offsite plans, for it will then be ascertainable on the basis of the final versions of both onsite and offsite plans.

11. LEA Contention VIII-14(c): Calculating and Monitoring Offsite Doses.

E-88. The first part of this contention alleges a deficiency in the Applicant's way of calculating potential offsite doses. The second part alleges a deficiency in the Applicant's way of monitoring actual offsite doses. We rule against LEA on both parts.

E-89. The first part of the contention relies on a contention we have already ruled against. LEA alleges that both the Applicant's computerized dose projection system -- the Radiological and Meteorological System (RMMS) -- and its manual backup system are deficient because some of the meteorological data they rely on come from a monitoring station, the Applicant's Met-Tower 1, whose proximity to the cooling towers can cause distortions in its data. LEA Contention VIII-3 was based on the Staff's continuing concern with the impact on emergency planning of Met-Tower 1's location. In our discussion of VIII-3, we ruled that since the state of the record put us in the position of merely reviewing the Staff's work, rather than adjudicating competing claims on which the Staff's work had bearing, the Staff, not the Board, was the proper body to determine whether data from Met-Tower 1 could be relied on in an emergency. Thus, we are not in a position to find that the RMMS and its manual backup are deficient because they rely on data from Met-Tower 1.

E-90. The second part of the contention misunderstands the purpose of the monitoring system it alleges is deficient. The system consists of forty-eight thermoluminescent dosimeter (TLD) stations, forty of which are arranged in two rings. The other eight are variously located, but three of them are located where atmospheric dispersion analysis indicates that annual concentrations of radioactive releases to the air are likely to be the greatest. Tr. 10,204, 10,202 (Daebeler). None of the forty-eight TLD stations is more than 5.5 miles from the plant site. Tr. 10,202 (Daebeler). The Applicant claims that the layout of the system conforms to the guidelines in Regulatory Guide 4.8. Tr. 10,203 (Daebeler).

E-91. LEA argues that the system may underestimate radiation dose in an emergency, because the TLD stations are located so that there is no assurance that any one of them would record the maximum concentration of radioactivity released in an emergency: The three stations which are located to record maximums are meant to record annual maximums only, and in fact do not necessarily record actual annual maximums at all, but only the doses at their locations, which may, or may not, be maximums, depending on the accuracy of the dispersion analysis. Moreover, the maximum dose may occur beyond 5.5 miles, for, although it is, on the average, true that the greater the distance from the plant, the less the concentration, unusual atmospheric conditions can cause greater concentrations at greater distances. See Tr. 10,201 (Murphy).

E-92. All that LEA says here is true, but LEA misconstrues the purpose of the TLD array. Its primary purpose is to provide routine monitoring which will determine annual doses to the environment. Tr. 10,208 (Daebeler). Thus, it aims for annual maximums instead of a one-time maximum, and can afford to overlook the occasional high concentration at a great distance, since such a concentration would have little effect on average dispersion patterns.

E-93. Of course, in an emergency, the actual maximum is more important than the average one, but it is also less easy to predict. Thus, it is not possible to post a few monitoring stations to lie in wait for it. The maximum can be caught only by a perhaps imprudently dense and extensive array of stations, or by a few mobile units. The Applicant will rely on field survey teams. Tr. 10,211 (Dubiel).

12. LEA Contention VIII-14(e): Continuing Accident Assessment Capabilities.

E-94. In Contention VIII-3, LEA alleged that three of the Applicant's onsite monitoring systems were inadequate for use in initiating emergency measures. Here, in Contention VIII-14(e), LEA alleges that for the reasons set out in the earlier contention, the same systems are also inadequate for use in continuing assessment throughout the course of an accident. In our discussion of the earlier contention, we found no deficiencies in one of the systems and ruled that, given the record, the Staff was the appropriate body to determine whether there were deficiencies in the other two systems. Thus, we cannot make a finding that any of the three systems is inadequate for use in continuing accident assessment.

13. LEA Contention VIII-14(h): Methodologies for Projecting Dose When Instrumentation is Inoperable.

E-95. Evaluation Criterion I.6 of NUREG-0654, Chap. II, calls for the Applicant to establish methods of projecting doses when the instrumentation used for assessment is offscale or inoperable. The methods are described in Boyer et al., ff. Tr. 9772, at 23. LEA contends that insofar as the methods rely on meteorological data from Met-Tower 1, whose proximity to the cooling towers can cause distortion in its data (see our discussion of Contention VIII-3), the methods are deficient. For the reason below, we rule against LEA.

E-96. Contention VIII-14(c) makes the same argument about the RMMS system and its backup. We ruled against LEA on Contention VIII-14(c) because we had decided earlier that given the state of the record, the Staff was the appropriate body to determine whether the location of Met-Tower 1 could have an adverse impact on emergency response. The same reasoning applies here.

14. LEA Contention VIII-15(b): Monitoring of Site Evacuees.

E-97. Evaluation Criterion J.3 in NUREG-0654, Chap. II, says, "Each licensee shall provide for radiological monitoring of people evacuated from the site." Though as admitted, this contention raised a number of issues, foremost among them then, and among the two issues LEA now puts before us for decision, is whether the time which might be required to monitor the evacuees for contamination would pose a threat to their health. We conclude that it would not.

E-98. We first describe how the monitoring would take place. Under the Applicant's onsite emergency plan, plant personnel not essential to operation of the plant would evacuate to offsite assembly areas, where any needed decontamination would take place. Implementing procedure document EP-305, Rev. 0 (App. Ex. 33) and Rev. 1, names two possible assembly areas. Id. at 3. The direction of the wind would determine which was used. Id.

E-99. However, to speed up the process of identifying personnel who needed to be decontaminated, and yet not slow down the evacuation, the Plan calls for evacuees to exit the site through portal monitors. These will sound alarms whenever contaminated persons walk through them. Tr. 10,238 (Dubiel). Any person who set off an alarm would be instructed to report to health physics personnel when he arrived at the offsite assembly area. EP-110, Rev. 2, at 5.

E-100. LEA's concern in this contention is about the procedures which would be followed if the portal monitors were not to work. The Applicant says that all evacuees would be monitored at the offsite assembly area unless they had all passed through functioning portal monitors. Tr. 10,227, 10,255 (Dubiel). LEA makes two claims about this alternate procedure. The first is that the Applicant's implementing procedures, which do not say that all site evacuees would be monitored at the assembly area, ought to, even though it may be "normal practice in health physics procedures" to monitor all the evacuees. Tr. 10,228 (Dubiel). The issue raised in this claim has been made moot by yet another revision of the implementing procedures which apparently has escaped the notice of the parties. See our discussion of LEA Contention VIII-6(c). EP-254, Rev. 2, in bold letters says that personnel monitoring at the assembly area must be completed before any vehicle monitoring is performed. Id. at 4. Secs. 9.1.3.8 and 9.2.1.1 speak respectively of monitoring "each individual," and "all personnel." Id.

E-101. The second claim LEA makes about the procedures the Applicant would follow if the portal monitors were not to work is that those procedures would take too long. Monitoring at the assembly areas would have to be done with hand-held survey instruments which require up to two minutes to monitor one person. Tr. 10,267-68 (Dubiel). LEA claims that the Applicant's procedures provide only one or two technicians to perform this monitoring at the offsite assembly areas. LEA PF 122 (citing Tr. 10,231 (Dubiel)). Thus, if, as would happen in a worst case, 3,000 plant personnel and construction workers evacuated to the offsite assembly area, one technician taking two minutes to monitor each of 3,000 personnel would take 100 hours to monitor them all. Moreover, each evacuee would have to stay at the assembly area until he had been monitored, even if the Commonwealth had ordered the evacuation of the plume exposure pathway emergency planning zone. Tr. 10,236 (Kankus).

E-102. LEA's figure of 100 hours is highly improbable. Perhaps it should be recalled at this point that the conditional assumption that enough portal monitors would fail, so as to prevent monitoring of all personnel as they leave the site, makes improbable that there would be a need for monitoring at the assembly areas. But there are reasons why 100 hours is especially improbable. First, it is not at all likely that 3,000 people would show up at an offsite assembly area. For one thing, there would be 3,000 _on_site only at a peak: The day shift of the operating personnel would number about 400 to 500, and the greatest number of construction personnel working on Unit 2 is expected to be about 2500. Tr. 10,230 (Boyer). Whatever number of construction workers there may be on site, they are to be evacuated at the Alert level of emergency response, before site evacuation, and therefore before they can be contaminated. Tr. 10,238 (Dubiel). Thus, they would not be sent to an offsite assembly area for monitoring and decontamination. Of the 400 to 500 operating personnel, LEA, relying on testimony by the Applicant, estimates that 100 or 200 might evacuate, the rest remaining onsite as emergency workers. LEA PF 143. According to these probabilities and estimates, one can reasonably predict that only 100 to 200 plant personnel would reassemble off site for monitoring. Thus, LEA's figure of 100 hours is reduced by a factor between 15 and 30.

E-103. That figure can be reduced even further. Sec. 9.1.2.1 of EP-254, Rev. 2 requires that at least two technicians be sent to the offsite assembly areas to do the monitoring. Two technicians would take 200 minutes to monitor 200 evacuees. Three would take a little over an hour to monitor 100. Cf. Tr. 10,262 (Dubiel). The Applicant plans to get some idea of how many technicians would be needed by randomly monitoring evacuees as they exit the site. Tr. 10,257 (Dubiel). The Applicant could, though it would not expect to have to, assemble as many as thirty technicians at an offsite assembly area. Tr. 10,261 (Dubiel). Finally, we note that choosing the assembly area according to the direction of the wind considerably reduces any health risk posed by holding evacuees at the area until they are monitored.

15. LEA Contentions VIII-15(d) and 16(g): Decontamination of Site Evacuees.

E-104. As admitted, VIII-15(d) and VIII-16(g) were distinct contentions which raised a number of issues. LEA now raises a single issue but retains both numbers. LEA alleges that the Applicant should provide for the contingency that offsite decontamination of site evacuees would require showering or bathing facilities. We do not agree.

E-105. As we explained in our discussion of Contention VIII-15(b), site evacuees would be monitored for contamination either at a site exit point or at an offsite assembly area. As the Plan now stands, decontamination at the assembly areas would rely on simple methods: removing contaminated clothing, washing exposed areas of the skin with a damp washcloth, and cutting off contaminated parts of the hair. The Applicant claims that showering or bathing, which are available for personnel who remain onsite, would be required for site evacuees only if the simple methods failed, and that the simple methods would not be likely to fail, since if the site evacuees encountered any contamination, it would very likely only be contamination of the clothing by the short-lived daughter products of some of the gases that would appear in a plume. Tr. 10,243 (Dubiel).

E-106. LEA says that the Applicant should plan for the contingency that the simple methods would not be enough by arranging for transporting site evacuees who need showers and baths to facilities which have them.

E-107. LEA does not dispute the Applicant's udgment that site evacuees are not likely to have to be decontaminated by showering and bathing. As we have said before in our discussions of the emergency planning contentions (see e.g., LEA Contention VIII-11), probabilities should be kept in mind, and the lesser of them should receive less attention in planning than the greater, especially when, as here, the more remote possibility is of the sort which, if it comes about, can be dealt with through ad hoc arrangements.

16. LEA Contention VIII-15(e): Applicant's Ability to Account for Personnel.

E-108. Again we must struggle with the implementing procedures. Evaluation Criterion J.5 of NUREG-0654, Chap. II, says, "each licensee shall provide for a capability to account for all individuals on site at the time of an emergency and ascertain the names of missing individuals within thirty minutes of the start of an emergency." LEA argues three reasons for concluding that the Applicant's implementing procedures do not conform to this Criterion. None of the three reasons are more than minimally argued, and we find them unpersuasive.

E-109. LEA's first reason is that since EP-110, Rev. 3, the implementing procedure document which covers personnel accountability, does not apply to Bechtel and subcontractor personnel, in particular Unit 2 construction workers (see id., sec. 1.0), and since the Applicant apparently is not familiar with Bechtel's accountability procedures, the Applicant cannot show that it can account, in the language of Criterion

J.5, for "all individuals onsite" within thirty minutes of the start of an emergency. (Emphasis supplied.)

E-110. The Applicant does not bear the burden of proving the adequacy of Bechtel's procedures, for LEA has proffered no basis for thinking that those procedures might be inadequate in some respects. Such a basis is especially needed here, for, on its face, the division of responsibility between the Applicant and Bechtel makes sense, since one would expect that Bechtel would know more about the deployment of the construction force than would the Applicant, and therefore would be in a better position to devise accountability procedures for that force.

E-111. We note also that the Staff, whose opinion on the interpretation of NUREG-0654 is to be accorded some weight, apparently does not read the "all" in Criterion J.5 to be as inclusive as LEA thinks it is, for the Staff raises no objection to the division of responsibility between the Applicant and Bechtel. See Staff PF 81-82. The Evaluation Criteria can be explicit when they want to include construction personnel in their provisions. See Criterion J.1. 18/

18/ The Applicant's argument against this first reason of LEA's cannot be squared with the text of the implementing procedures. The Applicant argues that construction personnel would be evacuated before accountability procedures would be put into effect. Applicant's Reply Findings at 18. However, the relevant implementing procedure document, according to its own terms, "should" be implemented whenever an Alert or
(Footnote Continued)

E-112. The second reason LEA puts forward for concluding that the Applicant does not conform to the thirty minute limit called for in J.5 is that, according to LEA, the Applicant measures the thirty minutes from too late a moment. EP-110, Rev. 2 measures thirty minutes from the time of the evacuation or assembly announcement (id., sec. 9.1.5.1.E), not from the "start of an emergency," as J.5 calls for. But LEA argues that an assembly announcement could come as much as an hour after the start of an emergency, because verification of the emergency classification must precede an assembly announcement (see, e.g., EP-103, Rev. 3, at 2, 4), and verification could take up to an hour. Thus, an accounting for the locations of all personnel, if not completed until thirty minutes after an assembly announcement, could come as much as an hour and a half after the start of an emergency.

E-113. This claim that the Applicant measures the thirty minutes from too late a moment has the same form as the claim in LEA Contention VIII-6(c) that the Applicant measures the time to notification of offsite authorities from too late a moment, and it has one of that earlier contention's weaknesses too: The argument that verification could take up to an hour is without basis. See our discussion of LEA

(Footnote Continued)
higher response level is declared, and can be implemented even at the Unusual Event level. EP-110, Rev. 2, sec. 7.0. The same document explicitly calls for informing the Security Team Leader of any unaccounted for Bechtel personnel. Id., sec. 9.1.5.1.F. Besides, Bechtel does have accountability procedures.

Contention VIII-6(c). We note also that the Staff speaks of the start of an emergency and the moment assembly is announced as if there were no significant difference between the two times. See Staff PF 81-82. We see no basis for assuming a significant difference, if any.

E-114. LEA's third and last reason for concluding that the Applicant cannot conform to the thirty-minute limit in J.5 is that, according to LEA, during a site evacuation, there is no assurance that everything which must be accomplished before all personnel are accounted for can be accomplished in thirty minutes. First, the Emergency Director would have to perform not merely verification, but seven tasks before he announced assembly and evacuation. See EP-305, Rev. 1, at 2-4. Second, evacuees might have to be randomly monitored if the portal monitors were inoperable as they left the site, and, as we noted in our discussion of Contention VIII-15(b), the instrument which would be used in such random monitoring requires up to two minutes for monitoring one person. Third, the Personnel Security Group, using a master list of badge numbers, might have to check off by hand the numbers of all the badges evacuees are to deposit in buckets at the exit points. See EP-110, Rev. 2, sec. 9.1.4.2.D. Fourth, in order to compile a list of unaccounted for plant personnel, the Personnel Accountability Group would have to compile a similar list of personnel remaining on site and then compare that list with the evacuee list prepared by the Security Group. Id., sec. 9.1.5.1.C and D. Fifth and last, before it could compile a list of all those not accounted for -- both operating personnel and construction workers -- the Accountability Group would have to find out from Bechtel which of Bechtel's personnel were not accounted for. Id., sec. 9.1.5.1.F. If the evacuation were to take place during the day shift and at a period in the construction of Unit 2 when the construction force was at its predicted peak, as many as 2,700 persons might be evacuating from the site. See our discussion of Contention VIII-15(b).

E-115. We think that any appearance of great length LEA's list may have is created largely by the explicitness inherent in implementing procedures, and not by the length of time the tasks in the list would require. The seven tasks which the Emergency Director must perform before he announces assembly and evacuation are simple tasks such as notifications by telephone. See EP-305, Rev. 1, at 2-4. The random monitoring of evacuees is random precisely so that monitoring will not interfere with evacuation. Tr. 10,257-58 (Dubiel). Checking off a number on a list does not take long, and the checking would probably begin when the first evacuees passed through an exit point. Finally, though it might require precision drill work to move 2,700 people through a single door in thirty minutes, a glance through EP-305, Rev. 1 shows that there would be more than one exit in a site evacuation.

E-116. In its approach to site evacuation, LEA has done little more than say that the Applicant would have a lot to do in thirty minutes. But to make a strong case, LEA would have had to show that, in light of the goals of rapid evacuation, rapid deployment of onsite emergency workers, and exact accounting of personnel, a significant part of what the Applicant was planning to do was unnecessary, or ill-timed, or best replaced. LEA having made no such case, we think it should be left to the emergency preparedness exercises to determine whether the Applicant can evacuate the site and account for all personnel in thirty minutes. See Sears, ff. Tr. 9772, at 22.

17. LEA Contention VIII-16(c): Information on Radiation Risks for Emergency Workers.

E-117. Originally concerned with all emergency workers who might be on site at some point in an emergency, whether they be employees of the Applicant or not, this contention is now concerned solely with workers who are employees of offsite organizations which would provide support on site. LEA alleges four deficiencies in the information on radiation risks which is given to such workers. We find no such deficiencies.

E-118. The first deficiency LEA alleges is that workers from offsite organizations which would provide support on site are not given information about the acute affects of high doses of radiation. It is true that they are not. Tr. 10,024 (Dubiel). The reason is simply that their tasks on site will not expose them to high levels of radiation. Tr. 10,048 (Dubiel). Table 6-1 of the Plan sets out dose limits no emergency worker would be allowed to exceed without specific authorization from the Emergency Director. Such authorization would be given only to those who had the appropriate training. Tr. 10,056 (Dubiel). But that particular training is available only to employees of the Applicant. Id. Therefore, no employee of an offsite support organization would be given permission to exceed those limits. Id. We note that such workers are told a great deal about the risks posed by the radiation levels they would encounter, including the increased probability of injury, illness, or death due to radiation, the latent effects, including genetic, of low levels of radiation, and even the risks posed by doses which are below regulatory levels. See Tr. 10,019-29 (Dubiel). Such information should be enough to enable these workers to make sober, informed decisions.

E-119. The second deficiency LEA alleges is that although the Applicant's witness on this subject testified that the minimum training program for these workers required that the information in Regulatory Guide 8.13 be presented them, the witness was so vague as to make it impossible to determine just what information will be provided. To support the allegation, LEA claims that the witness "could not testify whether particular information actually in Reg. Guide 8.13 [was] specifically presented." LEA PF 151 (citing Tr. 10,036-38 (Dubiel)).

E-120. LEA misconstrues the witness' response. The "particular information" LEA refers to was the information in Regulatory Guide 8.13 on the risks radiation poses to pregnant women. The Applicant's witness could not say how detailed the coverage of that information might be without knowing the composition of the group to which it was being presented. Only if the group contained women, would the presentation of the information on the risks for pregnant women be detailed. Tr. 10,037 (Dubiel). We do not find this response vague, but rather, pedagogically sensible, since it shows that trainers will be emphasizing for each group what it most needs to know. The same pedagogy appears to be behind the emphasis in the training of these workers on the effects of low-level radiation.

E-121. The third deficiency LEA alleges, and alleges as the most "disturbing" (LEA PF 152), is that the U.S. EPA Protective Action Guides (PAGs) are not explained to these workers. LEA PF 152 (citing 10,041 (Dubiel)). Thus, LEA alleges, "the workers will not know when 'permissible' doses are exceeded." Id.

E-122. LEA's allegation is factually incorrect. What the testimony LEA cites says is that the workers in question will not be informed about the PAGs specifically. Tr. 10,041 (Dubiel). They will, however, be informed about them indirectly, for they will be informed about the dose limits under which they would operate, and these limits, set out in Table 6-1 of App. Ex. 32 (Plan), are consistent with the PAGs. Evaluation Criterion K.1 of NUREG-0654 requires the Applicant to establish such guidelines. Thus, the workers would have a standard by which to judge whether they had exceeded regulatory doses.

E-123. The last deficiency LEA alleges is that for such workers, there are no methods of determining whether the worker has comprehended the training. LEA PF 153 (citing Tr. 10,052 (Dubiel)).

E-124. The cited testimony is in fact not so broad. The witness said that there was no formal examination required of fire department personnel. Id. The testimony does not preclude more informal ways sensible people teaching and studying about risks to their health may have for assuring that what is being taught is being learned. We note that the Evaluation Criteria in § O of NUREG-0654, Chap. II, set out with specificity means the Applicant is to use to assure that onsite personnel are properly trained (see Criterion O.2) but the same criteria say nothing similar about the training for the workers which are the object of this contention. LEA has not tried to argue that those workers should be trained to the depth onsite ones are. Nor do we see any basis for such a view point.

18. LEA Contention VIII-18: Training of Offsite Support Personnel.

E-125. Here LEA alleges that the deficiencies which Contention VIII-16(c) alleges exist in the program for informing offsite personnel about radiation risks show that the Applicant has not met the requirement in Planning Standard (b)(15) in 10 C.F.R. § 50.47 that adequate training be given those who may be called on to assist in an emergency. We did not agree that there were deficiencies in the program, and therefore rule against LEA on this last contention.

F. NEPA Severe Accident Risk Contentions: LEA Contentions DES-1, 2, 3, and 4

1. Summary.

F-1. LEA's four contentions considered in this section allege that the risks of severe accidents have not been considered properly under the National Environmental Policy Act (NEPA). The first contention discussed, DES-4, argues that the NRC Staff's Final Environmental Statement (FES) (which superseded the draft statement (DES) to which the contentions were originally directed) fails to adequately disclose or consider certain nonfatal latent health effects, the interdiction (denial of consumption or access) of cropland, milk and the population in such land areas, and the cost of medical treatment. Part B of this contention alleges that the FES format obscures the estimated total impact of severe accidents at Limerick. In general, the Board finds that it would have been helpful to lay members of the public if the FES had contained more complete disclosure and explicit consideration of the matters set forth in LEA's Contention DES-4A. However, we also find that the conclusions of the FES as to total risk are unchanged by the explicit consideration now provided by the evidence and decision in this case. The Board also finds that the FES did emphasize the dominant contributors to total risk and did disclose the means by which a professional could estimate the other forms of risk (although in some cases this would have required resort to extensive references).

Therefore, no further relief is required on the merits of the contentions. We find part B of the contention to be vague as litigated, and in any event we find the format of the FES adequate and proper given the state of the art of severe accident risk assessments.

F-2. LEA Contentions DES-3, 1 and 2 are discussed in that order after DES-4. They involve allegations that certain assumptions made about evacuation actions in the estimates of severe accident risks are not valid, i.e., that people will obey instructions to evacuate (DES-3), that people in certain areas beyond a ten mile radius zone can be relocated (DES-1), and that there will be only about a two hour delay from the time of the accident before people begin to evacuate (DES-2). As to each of these, the Board finds that the actual assumptions made in the severe accident analyses are not unreasonable. The Board also finds that, in any event, notwithstanding the large uncertainties in the way actual emergency actions would occur, sensitivity estimates of the effect of reasonable changes in the evacuation assumptions show the lack of significant effect of such changes on the risk estimates.

F-3. In a separate section after the decision on LEA's severe accident risk contentions, the Board explains why it rejects both LEA's and the City of Philadelphia's conclusions of law as applied to the severe accident risk contentions.

2. LEA-DES-4.

F-4. This contention, as admitted, states:

A. The DES Supplement fails to adequately disclose or consider:

1. Total latent health effects due to both initial and chronic radiation exposure, other than those resulting in fatalities, including genetic effects, non-fatal cancers, spontaneous abortions, and sterility (See, e.g., BEIR I-III);

2. The total land area in which crops will be interdicted;

3. The total land area in which milk will be interdicted;

4. The quantification of the cost of medical treatment of health effects.

5. The population within the land areas to be interdicted.

B. By treating some environmental costs in a CCDF format and treating other quantifiable costs in a non-quantitative, subjective manner, the DES format obscures the total impact of severe accidents at Limerick.

F-5. Both parts of this contention are directed to alleged deficiencies in the Supplement to the Draft Environmental Statement (DES) prepared (as required by NEPA) by the Staff. This document, NUREG-0974, Supplement No. 1, was issued in December 1983. The Final Environmental Statement, NUREG-0974, was issued by the Staff in April 1984. Staff Ex. 29. Both the Staff and Applicant presented testimony on this contention, LEA did not.

F-6. LEA would have us find that the Staff's Final Environmental Statement (FES) does not comply with the National Environmental Policy Act of 1969 (NEPA), with respect to the risk of severe accidents at the Limerick facility, largely due to alleged numerous material non-disclosures of environmental impacts, including health effects. LEA proposed findings (PF), at 1. (July 26, 1984). Moreover, LEA believes that any disclosure defects in the FES cannot be cured by discussion of such defects in this decision. In its view publication of the decision is no substitute for the full circulation and comment requirements of NEPA and 40 C.F.R. Parts 1502 and 1503. Id. With respect to the alleged deficiencies, we discuss them in the context of the individual contentions. With respect to the disclosure and public comment matter, we note the following. Even though an FES may be inadequate in certain respects, ultimate NEPA judgments with respect to any facility are to be made on the basis of the entire record before the adjudicatory tribunal. Philadelphia Electric Co. (Limerick Generating Station, Units 1 & 2), ALAB-262, 1 NRC 163, 197 n.54 (1975) (emphasis added). See also Public Service Electric and Gas Company (Hope Creek Generating Station, Units 1 and 2) ALAB-518, 9 NRC 14, 39 (1979). Since findings of the licensing tribunal are deemed to amend the FES, amendment and recirculation of the FES is not ipso facto necessary where findings of a licensing board differ from those of the FES, particularly where the hearing will provide the public ventilation that recirculation of an amended FES would otherwise provide. Philadelphia Electric Co., ALAB-262, supra, at 197 n.54. Thus, modification of the FES by Staff testimony or the licensing board's decision does not normally require recirculation of the FES, Niagara Mohawk Corp. (Nine Mile Point Nuclear Station, Unit 2), ALAB-264, 1 NRC 347, 371-72 (1975), unless the modifications are truly substantial. Allied-General Nuclear Services, ALAB-296, 2 NRC 671, 680 (1975). As we find below, the basic conclusions of the FES are unchanged by our findings. The modifications to the FES made by the record and decision in this case create no reason to recirculate the FES for further comments.

F-7. Two Courts of Appeals have approved the Commission's rule that the FES is deemed modified by subsequent NRC (AEC) administrative adjudications. Citizens for Safe Power v. NRC, 524 F.2d 1291, 1294 n.5 (D.C. Cir. 1975); Ecology Action v. AEC, 492 F.2d 998, 1001-02 (2nd Cir. 1974). See also Public Service Co. of New Hampshire, et al. (Seabrook Station, Units 1 & 2), CLI-78-1, 7 NRC 1, 29 n.43 (1978).

F-8. More recently, the NRC has adopted an amendment to 10 C.F.R. Part 51, Licensing and Regulatory Policy and Procedures for Environmental Protection, which provides that "[w]hen a hearing is held on the proposed action under the regulations in Subpart G of Part 2 of this Chapter or when the action can only be taken by the Commissioners acting as a collegial body, the initial decision of the presiding officer or the final decision of the Atomic Safety and Licensing Appeal Board or the final decision of the Commissioners acting as a collegial body will constitute the record of decision." 10 C.F.R. 51.102(c).

F-9. A second general complaint of LEA is that the FES discusses the environmental impact of severe accidents in terms of the risk of one reactor operating for one year rather than two reactors operating for the lifetimes of the reactors. LEA could not conclude that the lay reader would discern without instructions in the FES, that the total risk over the operating life of the entire facility could be obtained by multiplication. LEA PF, at 2-3. We need not speculate on what the lay reader might discern from the FES. The record is clear that the risk of both units is essentially double the risk from one unit. Tr. 11,194-96 (Acharya). Contrary to LEA's conclusion, one Staff witness did not reject this approach until corrected, but was somewhat ambiguous in maintaining the position that the risks from the two reactors would not be identical. He agreed that the accident frequencies at Limerick 1 would be approximately equal to the frequencies at Unit 2, but explained that the accident initiators would be different at the two units. Tr. 11,194-95 (Hulman). In any event, the importance of the units used for expressing risk is in the consistency with which comparisons are made. Tr. 11,456 (Levine). Thus, to compare the risks of the Limerick station over its lifetime, one should compare the risks of the reactor(s) when operating with the risks to which the public is otherwise exposed during such reactor operation.

a. Latent Health Effects (DES-4A-1).

F-10. The Staff asserts that the FES does disclose and consider total latent health effects in that it has assumed a dose-effect relationship for projection of radiation-induced genetic effects; i.e., it has assumed 2.6×10^{-4} genetic effects cases per person-rem. Hulman and Acharya, ff. Tr. 11,148, at 5. This value is equal to the sum of the geometric means of all forms of genetic effects and the risk of effects with complex etiology, and is consistent with values given in the BEIR I (1972), 19/ WASH-1400, 20/ and BEIR III (1980) 21/ reports. Id. at 5-6.

F-11. Using the Staff estimate for the risk of total population exposure from Limerick accidents and the risk estimator for genetic effects, one can obtain the estimated risk of genetic effects as 10^3 person-rem per reactor-year times $2.6.10^{-4}$ = 0.26 cases of genetic

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19/ National Academy of Sciences/National Research Council, "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," Committee on the Biological Effects of Ionizing Radiations (BEIR I), November 1922.

20/ NUREG-75-014, "Reactor Safety Study - An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants," October 1975.

21/ National Academy of Sciences/National Research Council, "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," Committee on the Biological Effects of Ionizing Radiations (BEIR III) July 1980.

effects per reactor-year. A complementary cumulative distribution function (CCDF) curve for genetic effects can be obtained from the CCDF 22/ for total person-rem (Figure 5.4c of the FES) by multiplying the consequence magnitudes (on the x-axis) by 2.6×10^{-4}. Id. at 6.

F-12. The Staff did admit that the risks of certain consequences of accidents at Limerick were not explicitly listed or displayed in the FES. These included genetic effects, spontaneous abortions, and sterility. Tr. 11,200-01 (Acharya, Hulman). The Staff asserts, however, as follows: The fact that genetic effects are not shown (explicitly) does not mean that the Staff did not allude to or make a statement that genetic effects could be a consequence from the reactor accidents, since it is stated that the genetic effect can be scaled from the population exposure and the population exposure and the conversion factor are given. Tr. 11,200 (Acharya). The (risk of) spontaneous abortions is not in the FES, but it is stated in the FES that such effects can be scaled from the population exposure. Most of the health consequences that were considered important are included. Tr. 11,201 (Acharya). Some of the ones ... not mentioned, such as spontaneous abortions or sterility ... (the Staff) would have estimates for but they

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22/ In probabilistic risk assessments for nuclear plants CCDF curves usually display in a log-log plot the probability per reactor year of exceeding a certain consequence versus the magnitude of that consequence (e.g., number of early fatalities).

were not considered as important as those discussed in the FES. The Staff noted that sterility would be temporary and that spontaneous abortions would occur among a large number of normally occurring spontaneous abortions. Staff referenced documents, principally WASH-1400, were stated to indeed contain the various other types of health consequences. Tr. 11,203-04 (Acharya). The Staff believes there are so many different categories of consequences and so many different probabilities, it tried to strike a balance in the FES, providing as much information as it thought important to the assessment. It did not provide it all. Tr. 11,205 (Hulman).

F-13. The Staff also agreed that the dose-effect relationship for genetic effects (2.6×10^{-4}) could be four to five times greater and still be consistent with the range of values given in the BEIR I, WASH-1400, and BEIR III reports. Tr. 11,212-13 (Acharya). Constructing a CCDF curve for genetic effects from the CCDF curve for total population exposure would not indicate that the curve might be four to five times too low, but the statement of the range of uncertainty would say so. Tr. 11,216 (Acharya).

F-14. With respect to the risk from genetic effects, 0.26 cases per reactor-year, it is in fact (numerically) greater than any other health effect analyzed (listed in Table 5.11 h) in the FES. Tr. 11,211-12 (Acharya). With respect to non-fatal cancers, the Staff agreed that this risk also is (numerically) greater than any other health effect analyzed in the FES and is the highest risk. Tr. 11,248 (Hulman). The Staff agrees that if a reader knew nothing more than what is explicit in the FES he wouldn't know that there is a risk of benign thyroid nodules, but that, indirectly, the references to the FES provide that level of information. The Staff believes the informed reader of the FES should also consult the references. Tr. 11,250 (Hulman). The Staff recognizes that the state of the art for the precise quantification of the uncertainty (in its risk calculations) is not well developed. Tr. 11,286 (Acharya). The uncertainty assessment is based on three components, probability, source term, and consequences. Tr. 11,290 (Hulman). Thus, its risk estimate could be too low by a factor of 40 or too high by a factor of 400. Tr. 11,286 (Acharya).

F-15. Spontaneous abortions in women exposed to radiation is a possible risk of severe accidents at Limerick, but this risk was not included in the risk estimator for genetic effects. Tr. 11,252 (Acharya, Hulman). The Staff explained that the majority (whether 90% or just more than 50%) of spontaneous abortions would lead to loss of fetus during the first trimester. Genetic effects in live births are included in the Staff risk estimator for genetic effects in succeeding generations. Spontaneous abortion is estimated as 15% of the total genetic effects. Tr. 11,253 (Acharya). The Staff's estimate per reactor-year of spontaneous abortions is 0.15, which is higher than any health effect risk estimated in (Table 5.11 h of) the FES, but less than the estimated risk (0.26 per reactor-year) of genetic effects based on live births. Tr. 11,258 (Acharya).

F-16. With respect to temporary sterility for males, the Staff estimate is 0.16 per reactor-year (0.03 for females), which also is higher than any health effect risk estimated in (Table 5.11 h of) the FES. Tr. 11,261 (Branagan). The estimated risk from genetic effects is higher than this, however. Tr. 11,261 (Acharya). No cases of permanent sterility would be expected, because doses necessary to induce permanent sterility would be accompanied by lethal doses to other organs. Temporary sterility is less serious than other early radiation illnesses. Hulman and Acharya, ff. Tr. 11,148, at 10.

F-17. The risk with respect to benign thyroid modules is 15 times higher than that of thyroid cancer fatalities. (Tr. 11,261 (Acharya). Thus, this risk (0.15 per reactor-year) also is higher than any other listed in (Table 5.11 h of) the FES. Tr. 11,262 (Hulman).

F-18. Hypothyroidism - a decrease in activity of the thyroid -- is a possible consequence of irradiation. Medical treatment, administration of thyroid hormones or removal of the thyroid, would not impair the activity of a person in a measured way. Tr. 11,262 (Branagan, Acharya).

F-19. In addition to the health effects considered in the FES and in addition to benign thyroid nodules and hypothyroidism, other forms of health consequences not already accounted for in the FES or in this contention could be the early fatality dose to the exposure of the embryo and in utero exposures. The early fatality of such exposure could be within 5 to 10 percent of the early fatalities already reported. Also, there could be an early health effect due to excessive exposure of the thyroid organ, called thyroid ablation, in which case the thyroid could be destroyed. The number of such is very small compared to early fatality. Tr. 11,263 (Acharya).

F-20. With respect to impairment of or defects in the development of children due to in utero exposure of embryos and fetuses -- e.g., microcephaly, mental retardation, growth retardation, blindness, cleft palate, spina bifida -- the Staff did not explicitly calculate their risks. The Staff believes, however, that the bases for its estimates of early injuries are more conservative than the WASH-1400 basis and therefore provide a bounding calculation, including all other small impairment risks. Tr. 11,264-72 (Acharya, Hulman, Branagan). The Staff did not think that all of the health impacts that could be associated with reactor accidents were not important, but it did not feel that it was necessary to describe, in great detail, every single one of them in the FES. It thought that what it did was an adequate representation of and the more important types (of impacts). Tr. 11,274 (Hulman). The Staff could have listed the health effects not considered explicitly in the FES, and stated that they were subsumed by the other effects that were analyzed in some detail. However, that would not have changed any of the numbers in the CCDFs or the table expressions of risk that are present in the FES. Tr. 11,282 (Hulman). In its final judgment on whether the risks were low, the Staff did consider the health effects explicitly neglected and also did consider the fact that the risks from the neglected effects were a small percentage of the kinds of risk that were described. Tr. 11,281 (Hulman).

F-21. For perspective, the Staff compared the calculated risk of genetic effects resulting from severe accidents at Limerick to the natural incidence of genetic effects. The accident risk to the first generation of descendants of people irradiated was 0.05 genetic effects per reactor-year of operation. For a population of 8.1 million people, and a natural incidence fraction of approximately 11%, approximately 880,000 genetic effects would occur in the first generation of descendants. Tr. 11,278 (Branagan).

F-22. As stated earlier, the specific section of this contention that we are discussing, DES-4A-1, is limited to the adequacy of the Staff's FES with respect to disclosure and discussion of total non-fatal latent health effects resulting from severe accidents at Limerick. The Applicant, however, also submitted testimony on this matter which we find helpful in reaching our conclusion. Although the public impacts presented in the FES are somewhat higher than those presented in the

Applicant's Severe Accident Risk Assessment (SARA) report, the differences are within the range of uncertainties of such analyses. Daebeler _et al_., ff. Tr. 11,114, at 1. _See also_ Tr. 11,458-59 (Hulman, Levine). Thus, the Applicant agrees that potential accident risks from Limerick are expected to be a small fraction of the risks the general public incurs from other sources. Daebeler _et al_., ff. Tr. 11,114, at 1.

F-23. The Applicant notes that, except for cancer fatalities, latent health effects (including non-fatal concerns, genetic effects, spontaneous abortions and temporary or permanent sterility) are generally not included in the numerical results of risk assessments, but that they can be estimated from available information. Tr. 11,329-31 (Levine). The Applicant's estimates of the public risk of latent health effects may be summarized as follows:

Latent cancer fatalities excluding thyroid cancers - 0.033 per reactor-year.

Thyroid cancer fatalities - 0.0064 per reactor-year.

Total cancer fatalities - 0.04 per reactor-year.

(Applicant estimates, for comparison, that the expected number of cancer fatalities per year from all causes in the population around Limerick out to 50 miles to be approximately 20,000 per year).

Non-fatal latent cancers (including thyroid cancers) - 0.091 per reactor-year.

Genetic defects in the population surrounding Limerick - 0.13 per year (compared to 6,000 per year from other causes, in the population out to 50 miles). Using the most recent genetic risk estimator (i.e., dose conversion factor) of 45 per 150 million man-rem, the equilibrium damage (i.e., steady state rate of occurrence) was calculated to be 0.067 per reactor-year.

Spontaneous abortions are estimated to be on the order of 33 to 76% of total genetic effects for live births (i.e., less than 0.10 per year).

Sterility consequence effects are viewed as subordinate to more serious radiation effects, such as acute fatality or early radiation illnesses. In general, doses either produce temporary sterility, or if large enough, mortality.

Daebeler et al., ff. Tr. 11,114, at 29-34.

F-24. The Applicant, based on its calculations of estimated risks, made some approximate comparisons of risks predicted for Limerick severe accidents and risks to the various population areas around Limerick from all other causes. The individual risks at one mile from the reactors of early fatality from Limerick accidents is 10^{-5} of those that already exist from other causes. At 10 miles it is 10^{-7}. For cancer fatality risks within 50 miles of the reactor, the ratio of those predicted from Limerick (accidents) to those which exist within 50 miles to the general population from all (other) causes is 10^{-6}. In the Applicant's view, the (Limerick accident) risks are, in fact, vanishingly small compared to other risks, and are trivial. Further, Applicant believes that to take the worst possible (value for a) parameter or condition in each of the various choices and combining (these to) get a very, very (worst) possible case as a measure of the disclosure of risk to the population would be an irrational procedure. Applicant's witness believed that the chance of all these parameters, be they weather, be they reactor accident scenarios, whatever ... all happening, in the very worst way, at the same time ... is an irrational combination. The probabilities of such things happening are even smaller than the vanishingly small probabilities already discussed. Inclusion of factors that might affect these values by (up to) a factor of 2 or 3 is not going to change (the conclusions). Tr. 11,442-45 (Levine).

F-25. With respect to such comparison, the Staff noted that it estimates approximately 700 person-rems per year of operation of "the Limerick reactor." It estimates the natural background radiation that the population receives within 50 miles of the (Limerick) site as 800,000 person-rem per year. The Staff concludes that the ratio 700 to 800,000 (i.e., approximately 10^{-3}) is small. The Staff agrees with the general conclusion of the Applicant. Tr. 11,450-52 (Acharya).

F-26. We turn now to the merits of this specific contention, i.e., whether the FES has failed to disclose or consider adequately the total latent health effects of severe accidents at Limerick.

F-27. The record is clear that not <u>all</u> latent health effects of severe accidents at Limerick were explicitly disclosed in the FES. Among those not explicitly disclosed were those identified in the contention, <u>i.e.</u>, genetic effects, non-fatal cancers, spontaneous abortions, and sterility, due to both initial and chronic radiation exposure, other than those resulting in fatalities. The reasons the Staff did not include explicit disclosure of these and other latent health effects also are evident. First, the Staff believed that such disclosure was implicit by citing authoritative references which treat these matters in detail, <u>e.g.</u>, BEIR I, BEIR III, UNSCEAR, NUREG-75/014 (formerly WASH-1400). Second, the Staff considered that for the purposes of the FES it was not necessary to disclose explicitly those latent health effects that it believed to be relatively unimportant in its best estimate calculations of the risks of potential reactor accidents at Limerick. This approach, <u>i.e.</u>, characterizing reactor accident health risks by reference to early fatalities, latent cancer fatalities and man-rem, although not complete, appears not to be inconsistent with both industry practice and Commission policy. Tr. 11,329-30 (Levine). We do believe an explicit discussion of all the health effects in the DES and FES would better permit the public (as opposed to an informed professional) to understand all factors considered in the risk assessment. We find, however, that the nonfatal latent health effects have been adequately disclosed and considered in this proceeding. This explicit consideration has not changed the basic conclusions of the FES regarding the radiological risk associated with operation of the Limerick station.

b. Crop, Milk and Population Interdiction (DES-4A-2, 3 and 8).

F-28. The FES does include disclosure and consideration of land interdiction, but land areas for which crops alone, or milk alone would be interdicted (i.e., consumption or access denied), and the population in such land areas, is not explicit. Staff Ex. 29 (FES), at 5-93, Fig. 5.4 h, Table 5.11 g. The Staff described its interdiction model as consisting of four successively increasing areas, based on successively decreasing levels of radionuclide concentration. The first area (most highly contaminated) would require interdiction for more than 30 years. The second area (which would include the first) would require decontamination. The third area (which would include the first two) would require crop impoundment. The fourth area (which would include the first three) would require milk impoundment. Hulman and Acharya, ff. Tr. 11,148, at 12-13 and attached figure. Estimates of the risks of interdiction of the various areas were calculated for the FES analysis using the CRAC (Calculation of Reactor Accident Consequences) computer program. The CRAC code was developed for the Reactor Safety Study, WASH-1400, (NUREG-75/014) and generates CCDFs taking into account changing weather conditions and chronic pathways for radionuclides. The results, in terms of square meters per reactor-year interdicted (for the four different levels of contamination), are presented in Table 1 of the

Staff's direct testimony. Id. at Table 1. The corresponding probability distributions (CCDFs) are defined by values listed in Tables 2 and 3 of this testimony.

F-29. The Applicant notes that both the CRAC and CRAC 2 computer programs are capable of estimating the different areas affected by contamination, and are routinely used to estimate associated costs. Daebeler et al., ff. Tr. 11,114, at 35. The predicted frequency with which areas of various sizes would be contaminated above the levels set for crop interdiction was calculated by the Applicant using CRAC 2 and is shown in Applicant's Table 5. Id. at 61. Applicant states that the total land area within which crops are interdicted is generally not explicitly presented because the principal contributor to economic risk is the cost of decontaminating land, and crop interdiction is expected to last (only) one year. Id. at 38.

F-30. The predicted frequency with which areas of various sizes will be contaminated above the levels set for milk interdiction was calculated by the Applicant using CRAC 2; the results are tabulated in Table 7. Id. at 38, 63. The time for milk interdiction, i.e., loss in dairy output, is only two months. Staff Ex. 29 (FES), at 5-106. Applicant finds that interdiction of milk products is not a dominant contributor to economic risks. Daebeler et al., ff. Tr. 11,114, at 39, 59.

F-31. The Applicant also calculated the frequency with which various numbers of people would need to be relocated for long periods of time. Relocation costs also are found to be a relatively small contributor to total economic risk. Id. at 39, 59, 63.

F-32. Again, the Board finds that the FES did not explicitly disclose and consider the total land area in which crops would be interdicted, the total land area in which milk would be interdicted, or the population within the land areas to be interdicted. Here again, both Staff and Applicant appear to have done the societal risk analyses (in this case the estimation economic impacts) according to general industry and Commission practice, emphasizing the dominant, but not neglecting the lesser, contributions to risk (in some cases more conservatively than realistically). We again find that the FES would have been more helpful to the public (as opposed to the informed professional) had more complete disclosure and explicit consideration been given to the interdiction question. We conclude, however, based on the information provided by the Staff and corroborated by the Applicant in this proceeding that the conclusions of the FES with respect to interdiction are correct.

c. Cost of Medical Treatment (DES-4A-4).

F-33. The cost of medical treatment of health effects was not expressed quantitatively in the FES. Richter, ff. Tr. 11,148, at 6.

The FES says only that the Staff has considered the health care costs resulting from hypothetical accidents in a generic model developed by Pacific Northwest Laboratory (Nieves, 1982) and that, based on this generic model, the Staff concluded that such costs may be a fraction of the offsite costs evaluated (in the FES), but that the model is not sufficiently constituted for application to a specific reactor site. Staff Ex. 29 (FES), at 5-102.

F-34. Staff witness Richter testified that he estimated the health care costs of 37 different accident sequences, as defined in Table 5.11d of the FES, obtaining direct, indirect and total costs. Richter, ff. Tr. 11,148, at 2. Actually, Table 5.11 d of the FES lists the mean probabilities of 37 release categories. Staff Ex. 29, at 5-77. He then calculated the risk on a reactor-year basis by multiplying the costs times the probabilities per reactor-year of accident sequences (presumably he meant release categories) occurring. Richter, ff. Tr. 11,148, at 2. His results are tabulated in Tables 1, 2 and 3 of his testimony. Id., Attachments 1, 2 and 3. Table 1 lists the three types of costs resulting from 20 release categories initiated by internal causes, fires, and low to moderately severe earthquakes. Table 2 lists the three types of costs resulting from 17 release categories initiated by severe earthquakes. Table 3 lists the totals for the three types of costs per reactor-year. Direct costs are all costs associated with the treatment of the patient, e.g., physician fees, hospital charges, costs of medicines. Indirect costs are the losses due to the reduced productivity caused by disability or premature death. Id. at 2. The costs were estimated using the Health Effects Costs Model (HECOM), using the health effects data from CRAC calculations as input and using standard health economics cost of disease estimation techniques, along with some key assumptions in arriving at the cost estimates of acute radiation injuries and fatalities and latent cancers. The major assumptions used in deriving cost estimates using HECOM are described in the testimony. Id. at 3-4. The data provided in the testimony were not included in the FES because they give a likely magnitude of cost rather than precise estimates. Direct and indirect cost factors are based on national data, not specific to the area surrounding Limerick and several costs unique to the health costs of nuclear power plant accidents are not included in HECOM. Id. at 4. Some of the estimated health costs are large, i.e., over two billion dollars. The probabilities of the severe releases leading to such costs are so low, however, that the risk per reactor-year of such costs, expressed in dollars per year, is relatively insignificant. Id. at 5.

F-35. The Applicant estimates the offsite economic risk of health effects at $1900 per reactor-year, compared to its estimate of $6000 per reactor-year for the median economic risk due to other offsite economic risks from reactor operation. These estimates indicate that offsite economic risk is increased by approximately one-third if the cost of health effects is considered. Daebeler et al., ff. Tr. 11,114, at 40. This conclusion is supported by the results of a recent study at the

Sandia National Laboratories that estimates the ratio of the cost of health effects to total offsite cost varies from 5 percent to 25 percent. App. Ex. 149, at 12 and Table 11.

F-36. The Board notes that the estimates of health costs are uncertain, at best. Assumptions of the cost of human life vary widely. Predictions of applicable discount rates are arbitrary. Some costs, e.g., screening of potentially exposed persons, transportation, genetic effects, were not considered. National averages of costs rather than Limerick-specific costs were used. Tr. 114,000-08 (Richter).

F-37. In sum, the Board finds that a more complete discussion in the FES of the quantification of the cost of medical treatment of health effects may have been arguably helpful to the public (as opposed to the informed professional). The Board concludes, however, that the FES adequately considers the quantification of the cost of economic effects of severe accidents, since the addition of quantified costs of medical treatment is both so uncertain and so low when the probabilities of occurrence are factored in. In any event, the record and decision in this proceeding now adequately disclose such costs.

d. FES Format (DES-4B).

F-38. The FES, itself, provides some data in the complementary cumulative distribution function (CCDF) format and other data is expressed as a risk, e.g., cost per reactor-year. Reactor accident consequences are calculated using the CRAC computer program, which provides the CCDFs as output. No similar computer program exists for calculating health care costs and regional economic costs of accidents. These costs are expressed as average values and the risks are expressed on a per reactor-year basis, using the CRAC-generated data as input. While the FES did not express health care costs quantitatively, Staff testimony relating to LEA Contention DES-4A-6 explains the analysis that was performed. Additional economic impacts that were quantified in the FES or the Staff testimony include health effects, regional industrial impacts, decontamination and replacement power. Richter, ff. Tr. 11,148, at 6.

F-39. The Applicant asserts that while not all aspects of the analysis of costs and risks are currently amenable to a fully rigorous probabilistic treatment, both the Staff and the Applicant have treated them using the current state-of-the-art in risk assessment to provide full disclosure. The Applicant believes that we must look at the entire discussion, both its quantitative and qualitative aspects, to understand the risks associated with the operation of Limerick. Daebeler et al., ff. Tr. 11,114, at 41-42.

F-40. Since LEA provided no testimony or witness on this contention, it is difficult to understand exactly what LEA means by the "format obscures the total impact of severe accidents at Limerick."

Judging from LEA's proposed findings 110-117, it would appear that the concern is not with structure, but with content and manner of presenting results. We agree with the Applicant that to understand the risks associated with the operation of Limerick one must look at the entire discussion, both its quantitative and qualitative aspects. As we have concluded with respect to part A of this contention, so we conclude with respect to part B, that the FES and the record in this proceeding adequately disclose and consider the risk of severe accidents at Limerick. To the extent that LEA believes that the FES consideration of total impact of severe accidents at Limerick should include something in addition to what is already there, we find no basis for such a conclusion. We find this part of the contention, DES-4B, without merit.

2. LEA-DES-3: People Will Decline to Evacuate.

F-41. This contention states:

> The DES' severe accident consequence modeling fails to account for the probability that a portion of the population will fail to take protective action despite planning and instructions, thus understating the actual consequences of a severe accident at Limerick.

F-42. LEA's basis for this contention was an EPA sponsored study of evacuations. Hans and Sell, "Evacuation Risks - An Evaluation," EPA-520/6-74-002, U.S. E.P.A. (June 1974). LEA asserted in its basis that the Hans and Sell study showed that a percentage of the population ranging from 6% to 50% would not evacuate despite instructions to do so. Actually, as now apparently conceded in LEA's findings (LEA PF 28, at 11), the referenced study stated that approximately 6% of the population refused to evacuate in the cases studied. The 50% figure was taken from a separate report quoted by Hans and Sell studying the response to Hurricane Carla in 1961. That report considered the evacuation behavior of people not only in the Texas county in which the hurricane came ashore, but also another Texas county, two cities located 100 miles to the northeast and a county in Louisiana located 200 miles from where the storm came ashore. Daebeler et al., ff. Tr. 11,114, at 24-25. We agree with the testimony that the inclusion of people living great distances from the eye of the hurricane, and the fact that a majority of people in the affected area were not advised to evacuate, make the 50% non-evacuation figure invalid as a guide for a postulated evacuation at Limerick. Id. at 25.

F-43. In sum, there is no basis to assume that with the required emergency plan in place, including prompt notification systems and follow-ups, that more than a small percentage of the population -- perhaps, for all we know, about 5-6% -- would initially fail to evacuate. It requires, however, further speculation to assume that such persons would continue to refuse to do so in the face of follow-up evacuation efforts by authorities and the evident evacuation of the rest of the population. See Hulman and Acharya, ff. Tr. 11,148, at 5;

Tr. 11,513-14 (Hulman). The evidence that only a very small percentage of the population in the plume exposure Emergency Planning Zone (EPZ) would fail to evacuate was buttressed by the report of an evacuation that took place in 1982 in the vicinity of the Waterford Nuclear Station in Louisiana. In that case, an area of approximately 60 square miles, with the reactor situated fairly close to the center, was evacuated as a result of a non-nuclear chemical plant accident. The emergency response took place in the context of the planning that had been done for the nuclear power plant. The nonevacuating fraction of the population was approximately 0.2%, or 50 people out of 16,000. Significantly, the authorities knew the names and addresses of all nonevacuating individuals shortly after the accident. Tr. 11,514-16 (Kaiser); Tr. 11,517 (Hulman).

F-44. The Board does not believe it is clear that persons who, in the exercise of their individual liberty refuse to evacuate, even after follow-up efforts, should be considered as part of the total societal risk of a severe accident. Nevertheless, the record also discloses the effect on the risk estimates if a small percentage of the population refuses to evacuate. The Applicant's assumed base case protective actions, for its risk calculations in SARA, are those of evacuation of the entire population within ten miles of the Limerick plant, and normal activities for twelve hours after plume passage with subsequent relocation for people between ten and twenty-five miles from the plant. It modified this computer run for this base case to assume that 6% of the population would not take those evacuation and relocation actions. Daebeler et al., ff. Tr. 11,114, at 27.

F-45. The Applicant's sensitivity analysis assumed that the 6% nonparticipating fraction of the population was uniformly dispersed throughout the area. Tr. 11,503-04 (Kaiser). The Board believes that this is probably conservative, since persons closer to the accident are more likely to heed the advice of authorities to evacuate (or take other recommended protective actions). The nonparticipating 6% were assumed to remain outdoors for 24 hours after the declaration of an emergency, and then to rapidly relocate. This assumption is the equivalent of exposures that would be accumulated in two to three days of normal activities following plume passage. Daebeler et al., ff. Tr. 11,114, at 27-28; Tr. 11,504-06 (Kaiser). We find the sensitivity analysis to reasonably bound the speculative element of a nonparticipating percentage of the population. We find no basis to accept LEA's unsupported view (LEA PF 32-34), that even a much smaller percentage of the population, let alone 6%, would continue to fail to follow the advice of authorities to leave the area after two to three days.

F-46. The results of Applicant's sensitivity analysis increased the predicted public risk of early fatalities by 49%. We agree with the testimony of the Applicant and the view of the NRC Staff (Staff PF 36), that this 49% increase is relatively small for calculations of this type. Other uncertainties in the assessment of severe accidents, such as uncertainties in source terms, are much more significant. Daebeler et al., ff Tr. 11,114, at 28. The uncertainties in the results of a PRA are large. It is stated in the FES that the risk estimates could be "too low by a factor of 40 or too high by a factor of 400." Tr. 11,286-90 (Acharya, Hulman). Typically, the area under the upper estimate CCDFs in SARA are on the order of a factor of one hundred greater than the area under the lower estimate CCDFs. Any comparison of the results of sensitivity studies, or of other PRAs must be made with this large range of uncertainty in mind. If the uncertainty ranges of two estimates are large and overlap to a large extent, then the two results cannot be regarded as being significantly different. Thus, for instance, changes of a factor of two in estimates of public risk are insignificant in view of the large range of uncertainty. Daebeler et al., ff. Tr. 11,114, at 9. See also Id. at 8, and Staff Ex. 29 (FES), at 5-91 and 5-108 to 5-115.

F-47. There is no basis for LEA's assumption (LEA PF 38-39), that persons would remain in "hot spots" for seven days so as to receive high (200 rem) bone marrow ground doses, thereby increasing the 49% increase calculated by the Applicant. Our findings above are to the contrary; again we believe the assumption of a two to three day period of failure for 6% of the population to take protective action to be more than reasonable -- it is likely quite conservative.

F-48. The NRC Staff's base case in the FES, as will be further discussed in our findings below on other NEPA severe accident contentions, assumed a 100% evacuation of a 10 mile plume exposure pathway EPZ, after an average delay time of two hours and an average evacuation speed of 2.5 miles per hour. The Staff, consistent with our own view above, believes the vast majority of people would heed instructions to evacuate. Hulman and Acharya, ff. Tr. 11,148, at 4. However, the FES (Staff Ex. 29), also presents an alternative analysis in Appendix M, using a postulated "Early Reloc" model of emergency response. The Staff did not perform this alternative analysis in response to this contention. Therefore, LEA's criticism that the Staff's alternative analysis is not a direct sensitivity analysis varying the factor of nonparticipation of the population is superficially valid. See LEA PF 35-37. However, LEA misses the point that, rather than studying the effects of small variations around the average values of all the different evacuation parameters, the "Early Reloc" model was used to reasonably bound the effect of different levels of effectiveness of offsite emergency response. Hulman and Acharya, ff. Tr. 11,148, at 4; Tr. 11,519-20 (Acharya). Staff Ex. 29 (FES), at 5-100.

F-49. In the "Early Reloc" alternative Staff model, it was assumed that all people in areas contaminated within the plume within a 10 mile EPZ would not evacuate until six hours after passage of the plume. Beyond the 10 mile EPZ, just as in the Staff's base case, people were assumed to relocate twelve hours after plume passage if they are in highly contaminated "hot spot" areas (projected seven-day ground dose of 200 rems to the bone marrow); if not, persons beyond the 10 mile EPZ were assumed to relocate after seven days. Staff Ex. 29 (FES), at 5-80 and 5-82. Tr. 11,511, 11,534 (Acharya). Therefore, this model assumes that all people in the 10 mile EPZ receive a ground dose for six hours in addition to the plume dose (and for larger periods for people outside the assumed ten mile EPZ). Tr. 11,521 (Acharya). For this reason, even though a percentage of nonevacuating people was not one of the varied parameters, the results of the Staff's alternative analysis bonds the results of the Applicant's sensitivity analysis, which we have already found to be reasonable. Tr. 11,529-34 (Hulman).

F-50. For the reasons stated, the FES adequately presents a range of consequences in the event 6% of the population declines to participate in an evacuation for the first two to three days after being advised to evacuate. This is further supported and made more explicit by the Applicant's analysis and our findings in this proceeding.

3. LEA-DES-1: Relocation of People Beyond Ten Miles Implausible.

F-51. DES-1 states:

> The DES' severe accident consequence modeling assumes the relocation of the public from contaminated areas beyond the 10 mile plume exposure EPZ. (DES, Supp. 1, pp. 5-21 to 5-22). Such an

assumption in Limerick's case is implausible and without foundation in fact.

F-52. LEA asserts, as basis, that no planning exists or is presently contemplated for such a "relocation." It notes that NRC planning guidance contemplates the possibility of ad hoc response beyond the approximate 10-mile plume exposure EPZ, but believes in the case of Limerick such an ad hoc relocation beyond the 10-mile radius, is impractical, particularly in the SE and SSE sectors (towards Philadelphia) in which the year 2000 population between 10 and 25 miles will be 680,330 and 505,011, respectively. LEA states that no precedent exists for the ad hoc "relocation" of such numbers of people.

F-53. The Staff's severe accident modeling does, in fact, assume that those persons whose projected 7-day dose to the bone marrow would be more than 200 rems, would be relocated. Hulman and Acharya, ff. Tr. 11,525, at 4. Such potential evacuation is not considered in isolation, however. Rather, the Staff, using the CRAC computer program, calculated the complementary cumulative distribution function values for the number of people to be relocated under this criterion. Id. From this calculation it can be determined that for relocation from the hot spots outside the 10-mile EPZ the probability that 5000 or more persons would be affected is approximately 10^{-6} per reactor-year, the probability that 50,000 or more persons would be affected is approximately 10^{-7} per reactor-year and the probability that 300,000 or more persons would be affected is approximately 10^{-8} per reactor-year. Finally, the probability that 500,000 or more persons would be affected is approximately 2×10^{-11} per reactor-year. These estimates include the probabilities of accidents, the probabilities of the weather sequences and the probabilities of the wind blowing toward the various population sectors. Id. at 4-5.

F-54. The basis for assuming that ad hoc relocation of individuals outside of the 10-mile EPZ is discussed in NUREG-0396, "Planning Basis for the Development of State and Local Government Radiological Emergency Response Plans in Support of Light Water Nuclear Power Plants," App. Ex. 139, which states on page 16 that for distances exceeding ten miles, "actions could be taken on an ad hoc basis using the same considerations that went into the initial action determinations." Also, NUREG-0654 "Criteria for Preparation of Emergency Response Plan and Preparedness in Support of Nuclear Power Plants," App. Ex. 140, states on page 12 that "detailed planning within 10 miles would provide a substantial base for expansion of response efforts in the event that this proved necessary." Daebeler et al., ff. Tr. 11,114, at 10-11.

F-55. The Applicant carried out a series of sensitivity studies to determine the effects of alternative modeling assumptions concerning shielding and relocation of individuals outside of the 10-mile EPZ. Id. at 14-16. From these studies it is concluded that the results are insensitive (within a factor of two or less) to a variety of assumptions. Id. at 14. The probabilities for early fatality to individuals between 10 and 25 miles range from 4.5×10^{-5} to 9.3×10^{-5}. Id. at Table 1.

F-56. Evacuation of large numbers of people have in fact taken place expeditiously. Baton Rouge, Louisiana, population 150,000, was almost totally evacuated in two hours after a decision was made to evacuate the city following an accident involving a chlorine barge. Wilkes Barre, Pennsylvania, population 75,000, was effectively evacuated to a level of 96 percent in one hour because of a flood warning. Downtown Portland, Oregon, with a population of 100,000 was evacuated in one hour during a civil defense test exercise. One of the largest recent public evacuations occurred in Canada. Late in the evening of November 10, 1979, a freight train transporting both flammable and toxic materials derailed in downtown Mississauga, Ontario, Canada's ninth largest city. During the next 24 hours, 216,000 people were evacuated from homes and hospitals in a 50 square mile area around the accident site. Id. at 16-17.

F-57. The contention is therefore incorrect in its assertion that there is no precedent for the ad hoc relocation of large numbers of people.

4. LEA-DES-2.

F-58. This contention states:

> The DES' severe accident consequence modeling uses an assumption of a uniform two hour evacuation delay time in its emergency response model. (DES, Supp.1, pp. 5-21 to 5-22). This assumption understates the likely delay time for a high population density site such as Limerick. This understatement of delay time results in an understatement of Limerick's risk, because accident sequence calculations are sensitive to evacuation time delay assumptions.

F-59. The FES considers three types of response to severe accidents at Limerick. Only the first type assumes evacuation. This response, identified as Evac-Reloc (evacuation of the plume exposure pathway emergency planning zone (EPZ) followed, if necessary, by relocation of persons outside of this zone), assumes an evacuation distance of ten miles, a delay time of two hours, an effective evacuation speed of 2.5 miles per hour and a 15 mile path-length for each evacuee over which radiation exposure is calculated. Staff Ex. 29 (FES), at 5-81. Risk calculations may, in some cases, be sensitive to evacuation time estimates, which depend not only on the assumed delay time, but on the evacuation speed and effective downwind distance to be traversed. Hulman and Acharya, ff. Tr. 11,525, at 5-6, 9. For some accidents there would be sufficient warning time to allow the public to evacuate before the plume could reach them, even if the evacuation time were relatively long. For others, the warning time could be short and many persons in the (plume exposure pathway) EPZ could not evacuate before being overtaken by the plume (even if the evacuation time were relatively short). The FES considers a range of risk assuming a two hour delay time before evacuation to no evacuation at all. Id. at 6.

F-60. The Staff's basis for a two hour delay time does assume that there is a well established emergency response plan, periodic testing of the notification system and procedures, and exercises and drills to maintain the plan in readiness. Hulman and Acharya, ff. Tr. 11,525, at 6. Such assumptions are not unreasonable, given that these actions are required by the Commission's regulations. 10 C.F.R. § 50.47, and Appendix E to 10 C.F.R. Part 50.

F-61. The two hour delay time is assumed to result from three time increments; 15 minutes (from the reactor operator's warning) for the authorities to interpret the plant data and decide to promptly notify people to evacuate, 15 minutes to notify most of the people in the ten mile EPZ to evacuate, and 90 minutes for people to prepare to evacuate and to get underway. Id. at 7. There would likely be variations in the delay time around the two hours in either direction, but the impact of these variations on risk estimates would not be expected to be substantial. Id. at 6.

F-62. The two hour delay time assumed for Limerick is the same as that assumed for the Indian Point site, which was based on two evacuation time studies--one prepared for the Indian Point licensees and one prepared for the Federal Emergency Management Agency (FEMA), by different contractors. This delay time was characterized by the Indian Point Atomic Safety and Licensing Board (ASLB) as reasonable. Consolidated Edison Company of New York (Indian Point, Unit No. 2), Power Authority of the State of New York (Indian Point, Unit No. 3), 18 NRC 811, 888 (1983). Because the population within the ten mile EPZ at Indian Point (0.25 million people projected in 1990) is larger than the population within the ten mile EPZ at Limerick (0.16 million people projected in 2000), the Staff considers the two hour delay time at Limerick as reasonable. Id. at 7-8. The evidence additionally indicated that this delay time is appropriate even for moderately adverse site conditions such as light snow, ice, and moderately severe hurricanes and earthquakes. Id. at 6-7.

F-63. LEA, in its basis for this contention, concludes that a more appropriate delay time would be in excess of three hours, based on the evacuation model developed at Sandia National Laboratories. App. Ex. 138. This model, based on historical data on experience with unplanned or impromptu evacuation following transportation accidents, derived values of one hour, three hours, and five hours for 15%, mean, and 85% likely delay times. Instead of 2.5 miles per hour, however, ten miles per hour or higher evacuation speeds were assumed. The Staff does not consider an evacuation speed of ten miles per hour appropriate for

Limerick, however, based on its estimate of required travel time to evacuate the ten mile EPZ. Id. at 9.

F-64. Based on the two hour delay time and 2.5 mile per hour evacuation speed, compared to the Sandia model using a three hour mean likely delay time and a ten mile per hour evacuation speed, the Staff believes that it should be inferred that the Staff's evacuation parameters have not resulted in understatement of Limerick risks. Id. at 10.

F-65. To examine the effects of changes in delay times and evacuation speeds on the final risk results, the Applicant performed sensitivity analyses using various models and various values for the delay time and evacuation speed parameters. These studies used the CRAC 2 computer code and the radioactivity release source terms developed by the Applicant in its Severe Accident Risk Assessment (SARA) study. The SARA evacuation model incorporates the results of the Sandia study (on delay times) explicitly with delay times weighted as follows: one hour--30%, three hours--40%, and five hours--30%. The Applicant found that the FES risk estimates do not differ greatly from those in the Sandia model, even though the delay times and evacuation speeds are different in the two models. Daebeler et al., ff. Tr. 11,114, at 22-23, 58. Applicant's sensitivity studies included variation of evacuation clear times from 4 to 13 hours and delay times of one, three and five hours combined with a 2.5 mile per hour evacuation speed. All of the results were within a factor of three of the result for the FES Evac-Reloc Model. The Applicant concludes that the Staff use of a two hour time in the FES does not lead to a significant understatement of Limerick's risk. Daebeler et al., ff. Tr. 11,114, at 23.

F-66. LEA implies that a longer delay time for Limerick would be incurred because of its higher than average population density. To the contrary, the Hans and Sell report, upon which the Sandia Generic Study is based, contains examples of evacuation from areas with population densities greatly exceeding the 700 persons per square mile located within 10 miles of Limerick. Daebeler et al., ff. Tr. 11,114, at 21.

F-67. Based on the record in this proceeding we find no basis for the assertion that the assumption of a two hour delay time for evacuation of the ten mile EPZ at Limerick understates the likely delay time. It is clear that some people will evacuate earlier and some later, but the use of two hours versus, say, three or more hours is reasonable for the purposes of estimating risk provided the evacuation speed assumed also is reasonable. The assumption in the FES of a 2.5 mile per hour, rather than a ten mile per hour, evacuation speed compensates, even though not completely, for the shorter delay time. Tr. 11,556 (Kaiser). Based on the uncertainties of postulating actual evacuation conditions, and the sensitivity analyses described above, we find that the FES assumption of a two hour delay time, together with the assumption of a 2.5 mile per hour evacuation speed, does not result in any significant understatement of Limerick's risk, if indeed there is any understatement. Consequently, this contention is without merit.

5. Conclusions of Law as Applied to LEA and City Severe Accident Contentions.

a. LEA's Proposed Conclusions of Law.

F-68. LEA has summarized its position as to the defects in the FES in its proposed Conclusions of Law. Proposed findings (July 26, 1984). It first cites Baltimore Gas and Electric Co., et al. v. National Resources Defense Council, __ U.S. ___, (1983) slip op. at 9, 19, to the effect that:

> The National Environmental Policy Act (NEPA) places upon an agency the obligation to consider every significant aspect of the environmental impact of a proposed action, and requires an EIS to disclose the significant health, socioeconomic and cumulative consequences of the environmental impact of a proposed action.

F-69. It then quotes from the NRC Statement of Interim Policy on Nuclear Power Plant Accident Considerations under the National Environmental Policy Act, 45 Fed. Reg. 40101 (June 13, 1980), as follows:

> Environmental Impact Statements shall include a reasoned consideration of the environmental risks (impacts) attributable to accidents at the particular facility ... within the scope of each

such statement. In the analysis and discussion of such risks, approximately equal attention shall be given to the probability of occurrence of releases and to the probability of occurrence of the environmental consequences of those releases.

* * *

The environmental consequences of releases whose probability of occurrence has been estimated shall also be discussed in probabilistic terms. Such consequences shall be characterized in terms of potential radiological exposures to individuals, to population groups, and where applicable, to biota. Health and safety risks that may be associated with exposures to people shall be discussed in a manner that fairly reflects the current state of knowledge regarding such risks.

F-70. Finally, LEA concludes that the FES fails to comply with these mandates for eight reasons. We have already discussed the fact that compliance with NEPA need not be restricted to the content of the FES alone. Rather, our findings and conclusions, based on the entire record before us, are deemed to amend the FES.

F-71. Generally, with respect to Baltimore Gas and Electric, we note that the key word is "significant." As all parties agree, the estimates of environmental, including health, effects resulting from low probability, high consequence accidents are attended by large uncertainties. Where such estimates are clearly small, as they are here, compared to the risks to which the environment and the population are otherwise exposed, second order effects cannot reasonably be considered significant. Further, whatever significance such second order risks may have, they may reasonably be considered as enveloped by the uncertainty in the estimates of the dominant risks. Similarly, the precision of the estimates of the dominant risks is not important where the risks are clearly small -- taking into account the uncertainty of the estimate -- compared to the risks otherwise extant.

F-72. With respect to the first paragraph quoted from the Statement of Interim Policy, the Board certainly agrees that the FES and this decision should give equal attention to the probability of occurrence of releases and to the probability of the environmental consequences of those releases. This, we believe the Staff, the Applicant and we have done. With respect to the second paragraph, we believe Staff and Applicant testimony and our own familiarity with the subject supports the conclusion that the health and safety risks that may be associated with exposures to people have been discussed in the FES and on the record of this proceeding in a manner that fairly reflects the current state of knowledge regarding such risks.

F-73. Notwithstanding the above, we have found in a number of instances that the FES might have led to easier comprehension by the public (as opposed to the informed professional) had there been explicit discussion in the FES itself of the rationale for including some matters and excluding others. Perhaps this was a consequence of using state-of-the-art knowledge and methodology.

F-74. Based on the above, and the record before us, we find

(a) Certain health effects which may be caused by a severe accident at Limerick and their associated probabilities, including genetic effects, non-fatal cancers, child developmental impairment caused by in-utero radiation exposure, spontaneous abortions, sterility, benign thyroid nodules, and hypothyroidism, have been adequately disclosed.

(b) The total land area in which crops and milk will be interdicted and the probabilities associated with such interdiction, have been adequately considered and disclosed.

(c) The population in the areas to be interdicted, and the probabilities associated with such population interdiction due to severe accidents at Limerick, have been adequately considered and disclosed.

(d) The economic cost of medical treatment of all health effects of severe accidents at Limerick, and the probabilities associated with such costs, have been adequately considered and disclosed.

(e) The assumption used for population relocation beyond the plume exposure EPZ in the calculation of health effects is not inappropriate.

(f) The evacuation delay time used in the emergency response model for calculating health effects is not inappropriate.

(g) The probability that a portion of the population will fail to take protective action has been adequately taken into account, thus the risk of health effects of severe accidents has not been understated.

(h) The total risk of a two-unit facility over 30 years of operation is adequately disclosed by disclosing the risk per reactor-year of a single unit and the fact that the risk from two units is approximately twice that of one unit.

b. City's Proposed Conclusions of Law.

F-75. The City does not propose specific conclusions of law with respect to its three admitted contentions. We have carefully considered each contention and have denied them for the reasons discussed in sections of this decision following this one. The City, however, concludes that further NEPA assessment in terms of weighing environmental costs versus benefits of the project is warranted for Unit No. 2, and a stay by t Nuclear Regulatory Commission of any determination of licensing of Unit No. 2, in terms of the acceptability of environmental impacts, is appropriate. City PF, at 19-21 (July 26, 1984). We discuss the City's basis, as set out in its proposed conclusions of law.

> 1. The National Environmental Policy Act of 1970 ("NEPA") directed federal officials "to use all practicable means, consistent with other essential considerations of national policy," to protect the environment. 42 U.S.C.A. § 4331. Consistent with that mandate, the Nuclear Regulatory Commission, prior to issuance of an operating licensing for both Limerick units, must fully disclose the environmental impacts of the units' operation and must factor into its licensing decision consideration of NEPA's mandate.

F-76. We have found that the FES and the record in this proceeding fully disclose the environmental impacts of the operation of both units and we have taken NEPA's mandate into consideration in reaching our conclusions. The City, by its cross-examination, has not controverted the evidence of the Staff and the Applicant in this regard.

> 2. The informative uses of the environmental impact study are to provide information to the general public and public officials at all levels of government, 40 C.F.R. § 1500.1(b), and to provide the basis for an informed decision on the part of the NRC. Sierra Club v. Froehlke, 345 F.Supp. 440, 444 (W.D. Wis. 1972), aff'd 486 F.2d 946 (7th Cir. 1973). On this count the study must be reasonably thorough and must take a "hard look" at the environmental consequences. Kleppe v. Sierra Club, 427 U.S. 390, 410, n.21 (1976).

F-77. Similarly, we find that the FES and the record in this proceeding provide information to the general public and public officials at all levels of government, and, together, are reasonably thorough and do take a "hard look" at the environmental consequences of severe accidents at Limerick. Neither has the City, by its cross-examination, controverted the evidence of the Staff and the Applicant in this regard.

> 3. NEPA does not mandate informational requirements only, however. NEPA injects environmental considerations into the decision making process itself. Weinberger v. Catholic Action of Hawaii, 454 U.S. 139, 143 (1981). An essential element of decision making is whether alternatives should be considered in light of any benefits of the action in relation to the measured environmental impacts of the action. 42 U.S.C.A. § 4332(2)(c)(iii).

F-78. The Commission, in its Statement of Consideration accompanying the change in 10 C.F.R. Part 51, relating to Need for Power and Alternative Energy Issues in Operating Licensing Proceedings (47 Fed. Reg. 12940, (1982)) stated that it is not necessary, absent a showing of special circumstances, to consider the issues of need for power and alternative energy sources at the operating license stage of a licensing proceeding. (See also 10 C.F.R. Section 51.53(c)). The City has not made a showing of special circumstances in this proceeding and therefore the issue is not a proper subject for review by this Board. Further, the City now raises essentially the same issue that was the subject of its Contention City 17. That contention was opposed by the Staff and the Applicant and was rejected by the Board. (Memorandum and Order Confirming Rulings and Schedules Made at Special Prehearing Conference on NEPA Severe Accident Contentions (April 20, 1984), Slip Op. at 4).

4. In keeping with the National Environmental Policy Act, 40 CFR 1502.22(b) and the Commission's Environmental Protection Regulations, 49 Fed. Reg. 9352, 9347 (March 12, 1984), the Board has considered a full range of both the probabilities of various accident scenarios and their associated consequences. Given the developmental status of these types of analyses and their high degree of uncertainty, a reasoned approach is to review and consider this range, including the calculated uncertainty range. We have considered on this record a reasonable range of dose conversion factors, exposure levels (protective action effectiveness), bad weather, and the probability calculation uncertainty range. Although upper bound results were not portrayed here in every instance, we have compensated for that lacking by giving greater weight to the uncertainty range, especially the upper bounds.

F-79. It is inherent, perforce, that estimates of very low probability, severe consequence accident risk, for which there is no direct experience, will have large uncertainty. It is correct that we have considered the uncertainty range, but we find there is no basis for giving greater weight especially to the upper bounds. Rather, we maintain that in consideration of risk it is not only proper, but mandatory, to consider the combination of probability with the magnitude of the consequence.

5. Based on our consideration of this record in the above described framework and what has been thereby disclosed in terms of the environmental impacts of potential severe accidents and the uncertainty in measuring both the probabilities and consequences associated therewith, we conclude that further NEPA assessment in terms of weighing environmental costs versus benefits of the project is warranted for Unit No. 2. A stay by our Commission of any determination of licensing of Unit No. 2, in terms of the acceptability of environmental impacts, is appropriate for the following additional reasons:

(a) The pending availability, for NRC review, of the Pennsylvania Public utility Commission's investigation results will precisely focus on and develop the economic issues associated with Unit No. 2's potential operation.

(b) Unit No. 2 is only partially completed, with in-service not scheduled until the 1990s. A stay of licensing now will not have the construction scheduling impact associated with such a stay for a nearly completed plant.

(c) There have been vastly changed circumstances since 1973, when this issue was last examined by the Commission in an adjudicatory context. These changes will affect the economics of the plant's operation. Also the partial nature of construction completion will affect the economic analysis when comparing Unit No. 2 to alternatives, in contrast to comparing the economics of a completed plant to the economics of alternatives.

(d) The lack of previous consideration at the construction stage of conservation, cogeneration, etc., as alternatives also compels reconsideration. Conservation, good management, cogeneration, and rate structures to promote efficient use of production are now an essential component of the Nation's energy policy. National Energy Act of 1978. They are no longer viewed as "remote and speculative" possibilities.

In conclusion, before doubling the potential for the public's exposure to these environmental impacts in such a high density population area, NEPA requires us, as federal officials charged with the protecting environment, to stay a decision on Unit No. 2 until the Pennsylvania Public Utility has completed its investigation.

F-80. City's reasons to stay a decision on Unit No. 2 simply will not wash. First, the fact that there are uncertainties in estimating (of course they cannot be "measured") both the probabilities and consequences of potential severe accidents in no way supports the conclusion that further NEPA assessments are required. The record is complete and adequate with respect to environmental costs. The benefits (a reconsideration of need for power and alternative energy sources) are not a proper subject for litigation before this Board. No special circumstances have been shown or are apparent to call into question at this late date the environmental judgments reached many years ago, at the construction permit stage, on the benefits of the proposed action. This is not affected by economic considerations of: 23/

(a) the pending availability of the Pennsylvania Public Utility Commission's investigation results of economic issues,

(b) a change in construction scheduling impact,

(c) possible changes in the economics of the plant's operation.

F-81. Finally, we do not accept the conclusion that the public's exposure to the environmental impacts of severe impacts has been doubled. Philadelphia Electric's application has been and is for

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23/ See Consumers Power Company (Midland Plant, Units 1 and 2), ALAB-458, 7 NRC 155, 161-63 (1978) (economic cost of the proposed action is only material under NEPA when there are environmentally superior alternatives).

operating licenses for two units at Limerick. The fact that risk estimates have been expressed in terms of reactor-years of operation certainly has not obscured the fact that risk will attend operation of both units.

F-82. City's proposed Conclusions of Law are rejected, for the reasons given above.

6. City-14: Evacuation Speed, Backups and Bad Weather.

F-83. This contention, as admitted, alleges three reasons why the FES does not accurately reflect either the median or upper estimates of the radiological effects which would result from an accident at Limerick because several key input assumptions associated with human activity after a severe accident are not realistic: (a) incorrect assumption of evacuation speed, (b) failure to correctly consider backup of evacuees at Philadelphia's outskirts, and (c) failure to adequately consider bad weather scenarios. We discuss them in turn.

a. Evacuation Speed.

a. The base case average evacuation time (speed) of 2.5 mph is based on an 1980 study which is now inaccurate. City, as part of this section of the contention, refers to the Statement of Issues of the Commonwealth of Pennsylvania with Respect to Offsite Emergency Planning, January 30, 1984.

F-84. In its Statement the Commonwealth asserted that the Applicant must prepare an updated evacuation time estimate study for the Limerick plume exposure pathway EPZ; the evacuation time study the Applicant has submitted to the NRC for approval is outdated and based on inaccurate information. Deficiencies in the study include, but are not necessarily limited to, reliance on out-of-date and inconsistent census data, use of incorrect evacuation routes, use of a concept of "maximum evacuation time" that does not accurately reflect the size of the plume EPZ, and failure to account for the notification system to be installed by the Applicant.

F-85. The Staff did derive the mean effective radial speed of 2.5 mph using an Applicant's consultant 1980 report estimate of four hours travel time to clear the 10-mile EPZ. This was not the only basis for this rate of travel. The Staff, in its risk analysis for the Indian Point site, derived an effective evacuation speed of 1.5 mph on the basis of a mean estimate of 6.7 hours of travel time to clear the 10-mile EPZ. This was based on two evacuation time studies made for Indian Point, as reviewed in NUREG/CR-1856, An Analysis of Evacuation Time Estimates Around 52 Nuclear Power Plant Sites, Vol. 1, May 1981. This speed, equivalent to a slow walk, was considered reasonable by the Indian Point Licensing Board. Hulman and Acharya, ff. Tr. 11,525, at 12; Consolidated Edison Company of New York (Indian Point, Unit No. 2), Power Authority of the State of New York (Indian Point, Unit No. 3), 18 NRC 811, 888 (1983). Because the population within the Limerick 10-mile

EPZ (0.16 million projected for the year 2000) is considerably less than the population within the Indian Point 10-mile EPZ (0.25 million projected for the year 1990) the Staff judged the effective evacuation speed of 2.5 mph for Limerick to be consistent with the 1.5 mph for Indian Point. The Staff recognized there could be other factors, such as terrain differences, differences in capacities of road networks, etc., which could influence the effective evacuation speeds. Hulman and Acharya, ff. Tr. 11,525, at 12.

F-86. The Staff did not presuppose great accuracy in the 2.5 mph speed estimate or in other parameters used in the risk analysis. It asserts that a reasonable bounding of risk estimates due to minor perturbations in evacuation model parameters is provided by the use of the "Early Reloc" mode of emergency response discussed in an alternative risk analysis of Appendix M of the FES. Finally, the Staff notes that the risks of early fatality are dominated by Limerick reactor accidents initiated by severe earthquakes for which evacuation is unlikely, and only the "Late Reloc" mode of emergency response would apply. Hulman and Acharya, ff. Tr. 11,525, at 10-13.

F-87. To examine the effects of changes in delay times and evacuation speeds on the final risk results, the Applicant performed sensitivity analyses using various models and various values for the delay time and evacuation speed parameters. The results of these calculations were summarized as estimates of the public risk of early fatality, from which it was concluded that the predictions of public risk do not differ significantly when the evacuation speed is varied from 2.5 to 10 mph. Daebeler et al., ff. Tr. 11,114, at 22-23, and Table 2.

F-88. The Board finds that the value of 2.5 mph for the average evacuation time may, indeed, not be accurate. We note, however, that comparison of the FES results with the results of an extreme case of a three hour delay time and a one mph effective evacuation speed would change the estimate of the predicted public risk of early fatality from 3.5×10^{-5} to 9.9×10^{-5}, a factor of less than three, which is insignificant compared to the uncertainty of the estimate itself. Id. Table 2. See also our findings above on DES-2. This part of the contention (City 14a) is without merit.

b. Evacuee Backups at the Outskirts of Philadelphia.

> b. Not included in the base case is the known phenomenon that as evacuees approach the City outskirts, their speeds would reduce, backups would occur and consequences due to trapped evacuees would increase.

F-89. Philadelphia, at is nearest outskirts, is approximately 21 miles from the Limerick reactors. The Staff does not disagree with the City assertion, but concludes that there would be no appreciable changes in the results of the risk calculations, taking the backup phenomenon into account, for the following reasons. First, an accident would have to occur, of low probability, that would release a large amount of radioactivity to result in high radiological doses substantially beyond the 10-mile EPZ. Second, the wind blows toward Philadelphia only 27 percent of the time. Third, given the above, the atmospheric diffusion conditions would have to be poor to allow sufficient concentrations of radioactivity to remain in the plume. Fourth, evacuees would be advised that after crossing the 10-mile EPZ boundary they should travel in a crosswind direction. Fifth, in an actual situation, contrary to the CRAC code assumptions, the plume direction would be variable, and the evacuees directions of motion would be variable. Sixth, the Staff made additional calculations assuming that all the evacuees in the plume exposure pathway within the 10-mile EPZ and in the SE and SSE sectors (toward Philadelphia) would wind up in those sectors between 20-25 miles before the plume arrived and remain there during plume passage. The results of the latter calculations allow the comparison of the estimated societal risks originally calculated for the FES with those calculated in response to the City contention. These comparisons show no increase in early fatalities (assuming supportive medical treatment), a five percent increase in early injuries, a four percent increase in latent cancer fatalities (excluding thyroid), a five percent increase in latent thyroid cancer fatalities, and a four percent increase in total person-rems, for the calculations based on the stated assumptions. Hulman and Acharya, ff. Tr. 11,525, at 13-17 and Tables 2, 3 and 4.

F-90. Given the magnitude of the uncertainties inherent in the risk analysis calculus, and the conservations of the CRAC model cited above, such low percentage changes in the public risk caused by a backup phenomenon have no significance. This part of the contention (City 14b) has no merit.

c. Bad Weather Scenarios.

> e. The DES does not separately portray the health consequences under bad weather scenarios. Many weather scenarios, including theoretically bad weather conditions, are averaged together.

F-91. The FES does not, in fact, provide a separate showing of the effects of bad weather scenarios on risks. The CCDFs in the FES implicitly portray the effects of bad weather, however, because these higher consequence situations (assuming large releases) have much lower probabilities than the better weather situations and show up in the tail ends of the CCDFs. The weather conditions, themselves, are not averaged. Rather, the consequence magnitudes associated with the 91 weather sequences are averaged to obtain the conditional mean value of the consequences. The Staff recognized, however, that bad weather scenarios might have an impact on evacuation. To provide a bounding calculation on the impacts of bad weather, the Staff provided, in Appendix M of the FES, an analysis of an alternative response mode, "Early Reloc," as an alternative calculation of public risk. Comparison of (a) the total societal risks within 50 miles of Limerick per reactor year for the case of Early Reloc for accident causes other than severe earthquakes and Late Reloc for accidents caused by severe earthquakes (Table M.1a) with (b) the case of Evac Reloc for accident causes other than severe earthquakes and Late Reloc for accidents caused by severe earthquakes (Table L.1a), shows an increase in early fatalities with supportive medical treatment of 20 percent, an increase in early fatalities with minimal medical treatment of 25 percent and no change in early injuries, latent cancer fatalities excluding thyroid, latent thyroid cancer fatalities, or total person-rems. Hulman and Acharya, ff. Tr. 11,525, at 17-20.

F-92. While it is true that the FES does not separately portray the health consequences under bad weather scenarios, the worst (weather) cases are included in the calculations of the CCDFs (Tr. 11,672 (Kaiser)) and the bounded changes in public risk due to such conditions can be inferred from the results of the analyses presented. Moreover, such changes, while not a result of not considering bad weather, per se, but a result of assumed changes in emergency response, are found not to be significant compared to the uncertainties inherent in the risk analysis.

F-93. This part of the contention (City-14e) has no merit.

7. City-13: Dose-Distance Calculations for Philadelphia.

F-94. The essence of this contention is that the FES does not explicitly provide curves of calculated radiation dose resulting from postulated severe accidents at Limerick, as a function of distance, specifically for distances including the City of Philadelphia (City). City asserts that the absence of this explicit data makes it impossible for the Commission to accurately ascertain the likelihood of the public receiving doses in excess of Protective Action Guide (PAG) levels, or in excess of some other unacceptable level of societal risk. In particular, City believes that the high density population around the (Limerick) site should be taken into account and the probabilities of the occurrence of release and of occurrence of environmental consequences should be presented separately, to be separately understood and evaluated.

F-95. The Staff, in fact, did not separate out doses to individuals or population groups for presentation in the FES, since these were considered as only intermediate parameters in the assessment of the impacts of severe accidents at Limerick. What the Staff did present in the FES were curves of the risk of individual dose versus distance, the individual risk of early fatality versus distance, the individual risk of early injury versus distance, and the individual risk of latent cancer fatality versus distance. Staff Ex. 29, Figs. 5.4 i, 5.4 j, 5.4 k and 5.4 l.

F-96. The Staff also presented in the FES the results of its calculation of the probability distributions of the number of persons who would receive doses to the whole body, thyroid and bone marrow in excess of 25, 300 and 200 rems, respectively. Staff Ex. 29, Figs. 5.4 b, L-1, L-2, L-3 and Table 5.11 g. Included in the results were the people of Philadelphia who might be so affected. Calculation of the individual dose versus distance for each release category considered would have resulted in a substantial increase in the bulk of the FES without providing any additional perspective regarding the important health and economic impacts (resulting from severe accidents at Limerick). Acharya, ff. Tr. 11,525, at 22.

F-97. In response to the contention, however, the Staff made calculations of the conditional (i.e., assuming the occurrence of the low probability severe accident) downwind individual whole body dose from early exposure versus distance (using CRAC) for the release category II-T/WW, one of the worst consequence categories analyzed, whose probability of occurrence is calculated to be 2×10^{-6} per reactor year. Given the occurrence of this release, the mean values of downwind individual whole body dose from early exposure (inhalation dose integrated to 50 years) in the Philadelphia area would be:

Within 20-25 miles: 27 rems.

Within 25-30 miles: 16 rems.

The mean values of population exposures would be:

Within 20-30 miles in the SE sector: 18 million person-rems.

Within 20-30 miles in the ESE sector: 13 million person-rems.

The mean values of latent cancer fatality would be:

Within 20-30 miles in the SE direction: 1100.

Within 20-30 miles in the ESE direction: 800.

All of the above calculations assume the wind blowing toward the SE and ESE directions, which occurs 11 and 16 percent of the time, respectively. Based on the above, the probability of a II-T/WW type of release impacting people in the SE sector is 2×10^{-7} per reactor year and is 3×10^{-7} per reactor year for people in the ESE sector. The conditional person rem estimates are higher and the conditional latent cancer fatalities are lower than those presented by the City in its contention. Hulman and Acharya, ff. Tr. 11,525, at 23-24.

F-98. The Applicant asserts that it is not necessary to prepare dose-distance curves to disclose environmental risk, since such curves do not consider the effect of the doses on the population. To respond to the contention, the Applicant nevertheless developed dose-distance curves for the two sectors (SE and ESE) which encompass Philadelphia. These are presented as Figure 2, for whole body dose, and Figure 3, for thyroid dose, of the Applicant's testimony. Daebeler et al., ff. Tr. 11,114, at 45.

F-99. The results of preliminary dose-distance consequence calculations by the City for the II-T/WW release with the wind blowing toward the SE sector indicated that the chance of citizens of

Philadelphia receiving a whole body dose of 5 rems at the City boundary (21 miles downwind from Limerick) would be 70 percent; the chance of a 30 rem dose would be 40 percent. At the eastern boundary of the City the chance of receiving a whole body dose of 5 rems would be 55 percent; the chance of a 30 rem dose would be 15 percent. In 50 percent of such releases, given the wind direction toward Philadelphia, the total exposure within the SE sector in the 20-30 mile range could reach 10.5 million person rems. This, according to the City's Contention 13, could result in as many as 8,400 latent induced cancers including 4,200 latent cancer fatalities.

F-100. While the Applicant did not check the City's results by independent CRAC 2 calculations, it does not find them unreasonable. It does not believe that presenting the results in this way gives useful insight, however. For more helpful perspective it, like the Staff, factored in the probability of release category II-T/WW and the probability of the wind blowing towards Philadelphia to calculate the predicted frequency with which various dose levels are exceeded, as follows:

Dose	Distance	Predicted frequency with which dose level is exceeded per reactor year
5 rem	21 miles	one chance in 2 1/2 million
30 rem	21 miles	one chance in 5 million
5 rem	30 miles	one chance in 3 million
30 rem	30 miles	one chance in 12 million

These doses would not lead to clinically detectable early effects. Daebeler et al., ff. Tr. 11,114, at 46-47.

F-101. The Applicant also calculates a much smaller number of latent cancer fatalities. City's conversion of 10.5 million person-rem to 4,200 such fatalities implies a dose-response relationship of approximately 400 fatalities per million man-rem. Id. at 48. The predicted number of latent cancer fatalities is uncertain in the range 10 to 500 cases per 10^6 man-rem, with a probable value of 150. Staff Ex. 29 (FES), at 5-67. CRAC 2 uses 168 cases per 10^6 man-rem, modified by the central estimate, which, generally speaking, reduces the predicted effectiveness of the dose by a factor of 5 for individual doses under 30 rem. App. Ex. 152, at 10-25. Thus, the 10.5 million person-rem would lead to approximately 400 fatalities. These would be spread out over approximately 30 years, at a rate of approximately 13 per year. This compares with a death rate due to cancer from all causes of approximately 3,000 per year for a city of the size of Philadelphia. Furthermore, the 400 latent fatalities must be associated with their frequency of occurrence, 2×10^{-6} (probability of source term) times 0.27 (wind direction) times 0.5 (accounts for the less favorable diffusion conditions) equals 3×10^{-7}, i.e., approximately one chance in three million. Applicant believes the predicted societal and individual risks within the City of Philadelphia (from severe accidents at Limerick) are very small indeed. Daebeler et al., ff. Tr. 11,114, at 48-49.

F-102. Considerable cross-examination of the Applicant by the City related to the concept of "risk aversion." Specifically, the City asked whether the Applicant agreed that not all people weigh the consequences of accidents equally; that is, they do not give the same weight to an accident involving 10,000 deaths versus one death, assuming the same frequency. Applicant thought that people would weigh those things differently. It added that, "[o]n the other hand, if the frequencies were very low, and here in connection with the kind of large consequences that are considered in probabilistic risk assessments (PRAs) the frequencies are so low as to be almost beneath comprehension of the average person, when you start talking about probabilities of one in a million or one in a billion per year, it's very hard to conceive of what the consequence means, certainly independent of the absolute probability or even with the absolute probability, it's sometimes difficult to conceive of it." Tr. 11,787-88 (Levine). Asked whether it would be important to disclose those probabilities, separated from, but not isolated from the consequences, Applicant answered, "I don't think you can view them separately. I think you have to view probabilities and consequences jointly, whether it's with an 'and' or with a 'times'." Tr. 11,789-90 (Levine). Applicant agreed that certainly anyone who is rational would view that, at the same frequency, the larger consequence is a more serious event than the smaller consequence. Tr. 11,794 (Levine). See our discussion of risk aversion, at the end of this section.

F-103. To the extent that the adequacy of the FES might depend upon explicit disclosure of dose-distance relationships, particularly but not exclusively, for the population of Philadelphia, both the Applicant and the Staff have either provided such information in the record of this proceeding, or described how such information can be derived from the information available either in the FES or the record. In any event, we do not agree that such explicit data are necessary for the purpose of assessing the environmental impact of severe accidents at Limerick. That impact necessarily involves the total population surrounding Limerick, including that of Philadelphia. Average measures of environmental risks are obtained by combining the frequency (likelihood of occurrence) of accidents and their impacts (consequences). 24/ Such

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24/ This is in accord with the Commission's "Statement of Interim Policy" on severe accident risk analysis. 45 Fed. Reg. 40101, 40103, col. 1 (June 13, 1980). It requires that the NEPA analysis of the risks of severe accidents give equal attention "... to the probability of (Footnote Continued) averages are used as an aid to the comparison of radiological risks associated with the accident releases with risk associated with normal operational releases and with other forms of risk to which the public is exposed. A common way to combine the risk factors is simply to multiply the probabilities by the consequences (as done by both the Applicant and the Staff). The resultant risk is then expressed as a measure of consequences per unit time. Such a quantification of risk does not mean that there is universal agreement that peoples' attitudes about risks, or what constitutes an acceptable risk, can or should be governed solely by such a measure. It can be a contributing factor to a risk judgment, although not necessarily a decisive factor. Staff Ex. 29 (FES), at 5-98.

F-104. As an example of the kind of risk comparison made in the FES, it is noted that the largest risk in the entire region surrounding Limerick is associated with latent cancer fatalities (excluding thyroid persons) and is estimated to be 7×10^{-2} per reactor year. Using the American Cancer Society value for background cancer mortality rate in the U.S., and the year 2000 population estimate within 50 miles of Limerick, it is estimated that there would be 10,000 background cancer fatalities in that year. FES, at 5-99. Even if the FES estimate were

(Footnote Continued)
occurrence of release and to the probability of occurrence of the environmental consequences of those releases."

low by a factor of 40 (Tr. 11,286 (Acharya)), and the latent cancer fatality rate were 2.8 per reactor year, this would be only 2.8×10^{-4} (2.8/10,000) times the background rate. From comparisons like this, in the FES, it is concluded that the risk associated with severe accidents at Limerick is small compared to like risks to which the public is otherwise exposed. Staff Ex. 29 (FES), at 5-98 to 5-99.

F-105. For the reasons discussed above, we find this contention (City-13) without merit.

a. Risk Aversion.

F-106. In its findings and recommendations in the Indian Point proceeding, the majority of the Board recommended to the Commission that in assessing societal risk the Commission consider not only expected risks, defined as the arithmetical product of probability and consequences, but also the absolute value of the consequences. Consolidated Edison Company of New York (Indian Point, Unit No. 2), Power Authority of the State of New York (Indian Point, Unit No. 3), 18 NRC 811, 891 (1983). It stated that "[b]y focusing on expected risk values only, we may overlook other important social and ethical considerations." The majority then gave examples of one accident (sequence) with a probability of 1.5×10^{-5} of causing two fatalities (per reactor year) and another accident (sequence) with a probability of 2×10^{-8} of causing 10^5 fatalities, for (presumably) Unit 1, and one accident (sequence) with a probability of 4×10^{-6} of causing two fatalities and another accident (sequence) with a probability of 10^{-8} of causing 10^5 fatalities, for Unit 2. The risks are 3×10^{-5} and 2×10^{-3} fatalities per reactor year for Unit 1 and 0.8×10^{-5} and 10^{-3} fatalities per reactor year for Unit 2. The ratios of the risks for high consequence to low consequence are 0.7×10^2 and 1.2×10^2, respectively, for Units 1 and 2. On this basis the majority suggests that lower risk should be demanded as the potential consequences increase, analogously to insurance companies limiting their liability for very large accidents. Further, it specifically suggests that the Commission should not ignore the potential consequences of severe-consequence accidents by always multiplying those consequences by low-probability values.

F-107. Judge Gleason, in his dissent, referred to the Commission direction that any testimony on accident consequences for Indian Point must include a discussion of the probability of the accidents leading to the proposed consequences. (See 16 NRC 27, 36-37 (1982).

F-108. We observe the following: First, the Indian Point Hearing was a very special discretionary proceeding, in which the Commission provided specific guidance on the admission of contentions and the formulation of issues for hearing. 16 NRC 27 (1982). We do not find this guidance binding on us in consideration of severe accidents under NEPA in this proceeding. Rather, under NEPA and the guidance provided in the Commission's Statement of Interim Policy on Nuclear Power Plant Accident Considerations Under the National Environmental Policy Act of 1969 (45 Fed. Reg. 40101 (June 13, 1980)), we find, first, we must pay approximately equal attention to the probability of occurrence of releases and to the probability of occurrence of the environmental consequences of those releases. Id. at 40103, column 1. Second, while there may be some emotional appeal to attaching greater significance to the risks of high consequence, it is no less rational to argue that event probabilities of 10^{-8} per reactor year are so small they may be ignored.

F-109. In any event, we believe the proper approach is to characterize the risk of potential accidents at Limerick as meaningfully as possible and to compare this predicted risk to the actual risk (based on extrapolation of actual experience) to which members of the public are otherwise exposed. Thus, we are led to the value judgment of whether or not a societal gain resulting from the proposed action is acceptable knowing the magnitude of the incremental increase in risk attendant to that action.

8. City-15: Contamination of City's Water Supplies.

a. Introduction and Summary.

F-110. As admitted, this contention states that:

> The DES does not adequately analyze the contamination that could occur to nearby liquid pathways, and the City's water supplies sources therefrom, as a result of precipitation after a release. A reasoned decision as to environmental impacts cannot be made without a site specific analysis of such a scenario.
>
> The DES addresses at great length releases to groundwater (DES at 5-34 et seq.), but gives only a cursory and conclusory discussion of contamination of open water (DES at 5-33). This issue is of crucial concern here as the two major water bodies at and near the facility are the City's only water supplies. The City also has open reservoirs within its boundaries which could be contaminated through precipitation. For an issue of such great importance, insufficient consideration has been given here. The mandate of NEPA to take a hard look at environmental consequences has been ignored.

F-111. Evidentiary hearings on this contention were held in Philadelphia, Pennsylvania on June 19-20, 1984. Both the Applicant and the Staff provided qualified witnesses and written testimony. The City of Philadelphia (City) cross-examined the witnesses, but provided no witnesses of its own.

F-112. City's contention refers to the cursory and conclusory discussion of contamination of open water in the Staff's Draft Environmental Statement (DES). We note that the Final Environmental Statement (FES) expands the discussion of this subject somewhat, but, in fact, does not provide a site-specific analysis of the environmental impacts of contamination of open water for Limerick. Staff Ex. 29, at 5-92 - 5-93. Both the Applicant and the Staff provide such analyses in their testimony. Bartram et al., ff. Tr. 12,007; Acharya, ff. Tr. 12,141; Wescott and Fliegel, ff. Tr. 12,141; and Lehr, ff. Tr. 12,141.

It is the results of these analyses that we examine to determine the adequacy of disclosure and the contribution to risk from this source, in the context of NEPA requirements.

F-113. While the FES discussion of the risk from potential contamination of the Philadelphia drinking water supply resulting from a severe accident at Limerick largely dismisses this risk as being of small importance compared to the risk from radioactive fallout on land (FES, at 5-93), no site-specific analysis was reported in the FES. In response to the contention both the Staff and the Applicant presented the results of such analyses in testimony. Both parties used probabilistic risk assessment methodology to estimate the probabilities and quantities of release of fission products to the environment. Both parties also used versions of the same computer code to calculate the dispersion and deposition of radioactivity on the ground and open bodies of water below the traveling radioactive plume. The amount of deposition in the Delaware and Schuylkill watersheds was then determined. The concentrations of Sr-90, principally, in Philadelphia's water supply system were then calculated as a function of time. These concentrations (and also those for other nuclides of possible significance, i.e., Cs-137, Cs-134, I-131, I-133) were then compared to (a), Federal and State guidelines for consumption of contaminated drinking water, and (b), the health effects resulting from the airborne pathway for dispersion and deposition of radionuclides. Both the Staff and the Applicant conclude that the risk from the liquid pathway is small compared to the airborne pathway. We concur.

F-114. In addition, the record shows that there are a number of potential countermeasures that could be undertaken to reduce the risk from such a severe accident. These include interdiction and use of alternate sources and modification of water treatment processes to remove radioactivity.

b. Source of Potential Contamination.

F-115. Both the Staff and Applicant used probabilistic risk assessment methodology to estimate the probabilities and quantities of release of fission products to the environment as a result of severe accidents at Limerick. For a detailed analysis of liquid pathway contamination, one would use all of the release categories developed in the probabilistic risk assessment. Acharya, ff. Tr. 12,141, at 3. The Staff, however, chose a much simpler and reasonably bounding type of analysis, by selecting only one release category. This category, II-T/WW, whose specifications are listed in the FES Table 5.11C, Staff Ex. 30, and is described in Appendix H of the FES, at H-13, was selected because the quantities of radionuclides in the atmospheric release associated with it are among the highest of all release categories considered in the FES. The probability of this release was artificially assigned as the sum of the probabilities of all release categories, i.e., 9 x 10^{-5} per reactor year. Acharya, ff. Tr. 12,141, at 3-4; Tr. 12,147-48, 12,245-46 (Acharya). This accident sequence was selected because it provided the largest combination of probabilities and consequences. Other accidents might give more deposition, but would have a lower probability or, would be of higher probability, but would result in less deposition. Tr. 12,163-64 (Fliegel).

F-116. The Applicant used all of the accident sequences developed in its Severe Accident Risk Assessment ("SARA") to define the radioactive source terms. Bartram et al., ff. 12,007, at 4-5.

c. Transport of Radioactivity.

F-117. Both the Staff and the Applicant used versions of the CRAC computer code to calculate the dispersion and deposition of radioactivity following an atmospheric release from Limerick. The Staff used CRAC, which has the capability of calculating concentrations of radionuclides deposited on the ground and open water bodies below the traveling radioactive plume, in terms of curies per square meter (Ci/m^2) of the ground surface, due to the effects of dry and wet deposition processes. Acharya, ff. Tr. 12,141, at 4-5. Using actual site meteorological data and 91 different accident start times uniformly distributed throughout a one year period, the ground deposition of various radionuclides was calculated as a function of distance and direction from the plant site. Sixteen equal sectors and 34 spatial intervals extending up to 500 miles from the site were used. Id. at 5. The sampling scheme and meteorological data used are the same as used in the Limerick FES for probabilistic analysis of severe accidents. Id. at 6. Using the CRAC output and the location of the watersheds relative to the site, the amount of deposition on the watersheds for various wind directions and meteorologic dispersion conditions was determined. Wescott and Fliegel, ff. Tr. 12,141, at 5. The amount of area covered by free water was not considered specifically, because it is a very small percentage of the area of the watershed. Tr. 12,14/ (Fliegel).

F-118. The model used for washoff of radionuclides into the Schuylkill and Delaware rivers consists of three terms. One term describes the initial washoff (within a month or two after deposition) as a fraction of the total radionuclide deposited. Another term describes the annual washoff (primarily due to erosion) as a constant fraction of the total radionuclide inventory available for transport during the year. A third term accounts for radionuclide losses such as from radioactive decay. The model is limited to determining radionuclide transport over a period of years. The total washoff, however, is relatively unaffected by changes in the initial washoff coefficient. Id. at 7.

F-119. Because of the slow rates of washoff, determined most reliably for the New York City water supply for nuclear weapons fallout, and correlation to the Schuylkill and Delaware River watersheds, only the long-lived isotopes of Strontium-90 and Cesium-137 would contribute significantly to population dose from drinking water. Based on the amount of Cesium-137 released, the appropriate washoff coefficients and dose conversion factors, Cesium-137 would contribute less than 10 percent to the total dose. Consequently, only Strontium-90 dose estimates were made. Calculations were made assuming no treatment or interdiction of the Philadelphia water supply. Id. at 9-10.

F-120. The Schuylkill watershed has an area of almost 1900 square miles at Philadelphia and an average flow of approximately 3000 cubic feet per second. The Delaware watershed has an area of almost 7781 square miles at Philadelphia and an average flow estimated to be more than 12,000 cubic feet per second. Wescott and Fliegel, ff. Tr. 12,141, at 3. The long axis of the Schuylkill Basin runs in a northwest to southeast direction with the farthest point of the watershed approximately 50 miles northwest of the Limerick site. The long axis of the Delaware Basin runs in a north-northeast to south-southwest direction with the farthest point in the watershed about 160 miles north-northeast of the site. Because of the difference in orientation of the watersheds, a wind direction that could cause a high deposition on one watershed generally would preclude a high deposition on the other. Id. at 4.

F-121. Each calculated deposition has a probability of occurrence associated with it. By ranking the deposition by magnitude, the Staff determined the probability of nonexceedance for a given deposition and constructed curves of cumulative probability distributions for deposition of Sr-90 on the Schuylkill and Delaware watersheds. Id. at 5-6 and Attachment 1. From these curves the Staff determined that there is a 99 percent chance that less than 160,000 Ci of Sr-90 would be deposited in the Schuylkill watershed and less than 140,000 Ci in the Delaware watershed. Id. at 6.

F-122. The Applicant used CRAC 2 to calculate the amount of radioactive material deposited in the Schuylkill and Delaware watersheds for each combination of fission product source term, weather sequence and wind direction. Like the Staff, the Applicant found that Strontium and Cesium dominated the long term contamination of ingestion pathways, because of their potentially large release quantities, relatively long half lives, and recognized radiotoxicity. In consideration of population doses arising from drinking of contaminated water in the short term (e.g., one month), other radionuclides, such as Iodine-133 and -131 were included. Bartram et al., ff. Tr. 12,007, at 3-4. The results, expressed as Ci/m^2, together with information on the plume width as a function of distance downwind, are used in the computer code LIQPATH to calculate the total amount of Strontium and Cesium deposited in the two watersheds, including that deposited directly in the rivers. Id. at 5. LIQPATH also predicts the subsequent temporal variation of the concentration of each radionuclide. Physical phenomena modeled include radioactive decay, runoff, erosion, ground water transport, sediment scavenging, and possible removal of radionuclides by water treatment systems. Id. at 5-6.

d. Potential Consequences.

1. Staff Analysis.

F-123. To estimate the potential consequences of a II-T/WW release to the Philadelphia water supply and potential health effects, the Staff made a number of calculations, assumptions and observations. First, they constructed curves of the concentration of Sr-90 in the Schuylkill and Delaware rivers for the first year after the release as a function of nonexceedance probability. Wescott and Fliegel, ff. Tr. 12,141, at 10 and Attachment 3. From these curves, and the maximum permissible concentration (MPC) of Sr-90 permitted to be discharged to unrestricted areas, 300 picocuries per liter (10 C.F.R. Part 20, Appendix B, Table II), it is determined that the Schuylkill River is likely to be highly contaminated. There is only a two percent chance that the Delaware would be above the MPC, a 38 percent chance of no Sr-90 and a 50 percent chance of less than 15 picocuries per liter of Sr-90. Thus, it is highly probable that the Delaware would remain a safe drinking water source after the release. Id. at 10-11. With respect to the Schuylkill, the Staff constructed curves of the cumulative probability distribution of time after the release for the Schuylkill River to reach the MPC and 1/3 MPC. Id. at 11 and Attachment 4. From these curves it was determined that there is a 50 percent probability that the Sr-90 concentration would be reduced to the MPC in one to two months. For the most severe cases, it could take as long as 20 years to reach MPC and 53 years to reach 1/3 MPC. Id. at 11.

F-124. The radiation dose to the population using the Philadelphia drinking water system would depend upon the concentration limit for Sr-90 chosen for permitting consumption. For illustration, the Staff calculated the annual dose to people ingesting water at MPC, 1/3 MPC and at eight picocuries per liter. The results were as follows:

	MPC	1/3 MPC	8pCi/l
Person-rems(whole body)	1.6×10^5	6.4×10^4	5×10^3
Person-rems (bone)	7.2×10^5	2.4×10^5	1.9×10^4

F-125. Similarly, the Staff calculated the long term residual doses to people from ingesting water after it has receded to the same concentrations, as follows:

	MPC	1/3 MPC	8pCi/l
Person-rems(whole body)	5.4×10^6	1.8×10^6	1.4×10^5
Person-rems (bone)	2.2×10^7	7.2×10^6	6×10^5

Regulatory Guide 1.109 - "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating

Compliance with 10 C.F.R. Part 50, Appendix I," Rev. 1, Oct. 1977, was used in making these calculations. Id. at 11-14.

F-126. Deposition of radionuclides on open water bodies could result in immediate contamination, but the total amount of radioactivity entering the water supply in this manner would be very small compared to that entering the water supply as washoff from the upstream watersheds. Since Philadelphia is located such that a heavy deposition on the reservoirs within the City is not likely to coincide with high concentrations in the Schuylkill or Delaware Rivers, the replacement of contaminated reservoir water with relatively clean water prior to residential distribution would be expected. Id. at 15.

F-127. With respect to consequences for time periods less than one year, the Staff did a worst case analysis for only the Schuylkill River, since its flow is lower than the Delaware and concentrations of Sr-90 would therefore be higher. The deposition of 162,000 Ci of Sr-90 was assumed, although there is a probability of less than one percent that all of this would be deposited within the basin (there is a 50 percent probability that less than half of this quantity would be deposited in the basin). The Staff also considered a number of additional cases. First it considered situations with average Schuylkill River flow and two percent Sr-90 runoff. This runoff is consistent with measured data as a result of fallout from atmospheric weapons testing. Runoff was considered to occur in time periods of a day, a week and a month. The resulting concentrations ranged from less than 15,00? pCi/l for runoff in a month to about 440,000 pCi/l for runoff in a day. Id. at 15-18. For time periods less than a day, the entire Schuylkill drainage system would not have time to transmit flow and contaminants downstream to the point of interest. The high runoff scenario would flush a relatively large fraction of the radionuclides from the river system during a short period of time when, almost certainly, drinking water would not be withdrawn from the river. Since a smaller percentage of radionuclides would remain -- after high runoff -- the total long term population dose would be reduced. Id. at 18-20.

F-128. The Staff conservatively estimated the risk of population exposure from contaminated Philadelphia drinking water by multiplying the probability of all release categories (9×10^{-5} per reactor-year) times the consequences of residual population exposures for all time following the reduction of Sr-90 concentrations to 8 pCi/l (it being assumed that no consumption of water above this level would be permitted). Radiation doses associated with drinking water for a year at this contamination level would not result in early health effects. The risk of latent cancer fatalities over all time was estimated to be eight cases, excluding bone cancer, or at a rate of about 7×10^{-4} per reactor year. The risk of bone cancer fatalities was estimated to be four cases, or at a rate of about 5×10^{-4} per reactor year. This total rate of 1.2×10^{-3} latent cancer fatalities per reactor year was considered small compared to the estimate of 9×10^{-3} latent cancer fatalities per reactor-year resulting from the air and ground pathway results derived from Fig. 5.4 1 of the FES. Acharya, ff. Tr. 12,141, at 13-14.

2. Applicant Analysis.

F-129. The Applicant's analysis of the consequences of contamination of the Philadelphia water supply considered the potential health effects by developing a complementary cumulative distribution function for whole body dose resulting from contamination of the drinking water supply by Cesium-134, Cesium-137, Strontium-89, Strontium-90 and Iodine-131. The bases for its analyses included the following: Doses to the population resulting from water used outside the body were not considered since they would make a very small contribution to total exposure; time-dependent calculations of the concentrations of Cesium and Strontium nuclides in the river water were used; the population was assumed to consume the river water for 50 years; population doses were calculated using the methods of NRC Regulatory Guide 1.109, as implemented in the LADTAP computer code (App. Ex. 167; App. Ex. 168), with one exception; more recent dose conversion factors recommended by the ICRP were used, to be consistent with the analysis of ingestion pathways used in Applicant's SARA. Bartram et al., ff. Tr. 12,007, at 11-12.

F-130. Specific calculations were made for both the Schuylkill and Delaware Rivers, since the proportions of radionuclides would differ and because the Schuylkill would likely be more heavily contaminated than the Delaware. It was assumed that, in an emergency, 93 percent of the City's population would be served by the Delaware and seven percent by the Schuylkill. According to the City, the Baxter plant, which takes water from the Delaware, could supply all of the City's needs except for the Roxborough High Service District, which constitutes approximately seven percent of the needs. Id. at 12.

F-131. The calculations made on the basis of Strontium and Cesium contamination lead to the estimates of chronic or long term contributions to population dose. To take into account more short-lived radionuclides, such as radioiodine, a simplified, bounding calculation was made. For each source term, weather sequence and wind direction, the isotopes of Iodine deposited on the watersheds were assumed to pass into the rivers immediately, at a rate approximately 50 times that for Strontium (two percent of the Strontium is expected to pass directly into the rivers). The resulting increment in population dose was included in the CCDF for population dose. Id. at 13. A further contribution to the total CCDF for population dose was calculated for the potential contamination of the City's raw and finished water basins (reservoirs) even though in practice, much of this water could be disposed of. Id. at 13-14.

F-132. The area under the overall CCDF curve provides an estimate of radiation risk from drinking water contamination of 0.67 person-rem per reactor year. The three contributors are 0.49, 0.16 and 0.02 person-rem per reactor year from iodine deposited on the watershed, Strontium and Cesium deposited on the watershed and direct deposition into the system, respectively. This contribution to radiation risk, 0.67 person-rem per reactor year, may be compared to the radiation risk, 70 person-rem per reactor year, estimated by the Applicant in its SARA for the airborne pathway. Whereas airborne pathway analyses routinely assume protective actions such as interdiction of milk and crops and decontamination of land, the Applicant did not consider some possible counter-measures with respect to the drinking water pathway (discussed below) in the above comparison. Id. at 14-15.

F-133. To assess the significance of the person-rem per reactor year estimates, it would be possible (as the Staff did), on the basis of these results, to estimate early and late health effects. Also (as both the Staff and Applicant did), one may compare the estimated concentrations of nuclides with Federal and State guidelines for consumption of contaminated drinking water. The applicable guides (regulation, in the case of 10 C.F.R. Part 20) are listed in Table 1, below.

Table 1

Protective Action Guides for Drinking Water Concentrations (pCi/l)

	Sr-90	Cs-137	Cs-134	I-131	I-133
10 C.F.R. Part 20, Appendix B, Table II	3×10^2	2×10^4	9×10^3	3×10^2	1×10^3
PEMA 25/ - uncontrolled discharges to surface water and in circumstances where the water supply is influenced by contaminated run-off and fall-out -- exposure time not to exceed one year	9.6×10	2.4×10^3	2.4×10^5	3.6×10	1.2×10^2
PEMA - acute crisis conditions where no other water supply is available -- exposure time not to exceed 30 days	8×10^3	2×10^5	2×10^7	3×10^3	1×10^4

Bartram et al., ff. Tr. 12,007, Table 1.

F-134. The Commonwealth of Pennsylvania Emergency Management Agency (PEMA) Protective Action Guides (PAGs) are based on the U.S. Environmental Protection Agency (EPA) National Interim Drinking Water

25/ Pennsylvania Emergency Management Agency

Regulations, EPA-570/9-76-003, Appendix B. The NRC regulation, 10 C.F.R. Part 20, Appendix B, Table II, applies to the maximum permissible concentrations in effluents to unrestricted areas. Section 20.106(a). The PEMA PAG for uncontrolled discharges to surface water, and in circumstances where the water supply is influenced by contaminated run-off and fall-out, the U.S. EPA Appendix B concentrations multiplied by 12 will apply -- assuming that the exposure time will not exceed one year. The associated dose commitment to any organ is 50 millirem. Bartram et al., ff. Tr. 12,007, at 16. For the acute crisis conditions, where no other water supply is available and the duration is less than 30 days, the average concentration may reach 1,000 times the U.S. EPA Appendix B concentrations. The associated dose commitment to any organ is 330 millirem. Id. at 16-17.

F-135. The probability that the PAGs would be exceeded may be determined by use of the Applicant's CCDF curves. For example, considering Sr-90 as the principal contributor to the long term accumulation of radiation dose and the PAG for circumstances in which the water supply is influenced by contaminated run-off and fall-out, i.e., 96 pCi/l averaged over 12 months, the probability of exceedance in the Schuylkill is one in 300,000 per reactor-year. Id. at 17 and Fig. 4(a). The corresponding probability for the Delaware is one in seven million per reactor-year. Id. at 17 and Fig. 5(a). Similarly, it may be determined, for the same circumstances, that the probability of exceeding the radiocesium PAG is less than one chance in a billion per reactor-year. Id. at 18.

F-136. For the short term, the one month PAG for Sr-90, 8×10^3 pCi/l, would apply. Considering Sr-90 alone, the probability of exceedance is approximately one in three million per reactor-year in the Schuylkill and less than one in one billion per reactor-year in the Delaware. For the short term, however, other radionuclides, such as I-131 cannot be neglected. Using the simplified, bounding calculation for Iodine deposition described above, the probability of exceedance would be approximately one in 100,000 per reactor-year in the Schuylkill and approximately one in 150,000 per reactor-year in the Delaware. Id. at 19.

F-137. None of the above estimates take into account the possibility of countermeasures, except for the assumption that the use of the Delaware River was maximized to supply the water needs of the City of Philadelphia.

e. Potential Countermeasures.

F-138. Following potential contamination of the Philadelphia water supply, a number of potential countermeasures could be undertaken to reduce the risks presented by such an accident. Such countermeasures, depending on the nature and level of contamination, location and timing could include interdiction (e.g., by bypassing a reservoir and using alternative sources), modification of water treatment processes (e.g., use of activated charcoal to reduce iodine content, use of a lime-soda softening process to remove strontium). Bartram et al., ff. Tr. 12,007, at 21-25; Lehr, ff. Tr. 12,141, at 13. In this decision we do not discuss possible countermeasures from the point of view of offsite emergency planning, or in the detail necessary for that subject. That matter is a subject for future hearings. Our discussion here is simply to provide some perspective on the potential to reduce the risk from contaminated drinking water in the event of a low probability, severe accident at Limerick. Whether the potential is realized could depend on emergency preparedness measures.

F-139. Approximately half of the City's water requirement is supplied by the Delaware River and half by the Schuylkill River. All water withdrawn by the City from the Delaware is treated at the Samuel S. Baxter Plant. Water withdrawn from the Schuylkill is treated either at the Queen Lane Plant or the Belmont Plant. The Queen Lane Plant is located on the east side of the Schuylkill and the Belmont Plant is located on the west side of the river. All withdrawal locations are within the city limits. Lehr, ff. Tr. 12,141, at 3. The City Water Department distributed an average of approximately 345 million gallons per day to 1.69 million people and to industry within the City limits in 1982. An additional 11 million gallons per day were distributed for use in lower Bucks County. Id. at 3-4. The total filtered water storage capacity of the system was approximately 1.1 billion gallons in 1982. Plant retention capacity of untreated and in-process water in 1982 was 86 million gallons at the Belmont Plant, 201 million gallons at Queen Lane Plant and 216 million gallons at the Baxter Plant, for a total of 503 million gallons. Id. at 4.

F-140. The Baxter Plant normally provides water to the area of the City east of Broad Street (and east of the Schuylkill). The Queen Lane Plant normally serves the area west of Broad Street and east of the Schuylkill. The Belmont Plant serves the area of the City west of the Schuylkill. Flexibility exists in the system such that the entire City area, except for an area west of the Schuylkill known as the "Belmont High Service District," may be served by the Baxter Plant (Delaware River water), provided it is fully available, based on average daily demand. The demand of the Belmont High Service District is about 12 million gallons per day (i.e., approximately three percent of total daily demand). Id. at 4-5.

F-141. To adjust the valve line-ups from the normal situation to use the full capacity of the Baxter Plant could be done in 24 hours. Tr. 12,113 (Guarino). The water system has covered filtered water storage facilities with approximately two days supply of water (at normal usage rate). Bartram, et al., ff. Tr. 12,007, at 22. The City has the authority to limit the use of water in its system and in an emergency situation should be able to cut water consumption by more than 50 percent and would have the ability to make sure that the industries that use a tremendous amount of water would be shut down. Tr. 12,113-13 (Guarino).

F-142. Trucking of drinking water is an option for an alternate source (e.g., to the Belmont High Service District). Assuming a need for approximately a gallon per day per person for 100,000 people would require approximately 50 truckloads, which is not a large number. Tr. 12,126-27 (Schmidt).

F-143. The decontamination factor provided by current drinking water treatment processes can be anticipated to be no more than two (i.e., 50 percent removal) for total radioactivity, and less than that for dissolved Strontium, Cesium and Iodine. The addition of activated carbon prior to flocculation would give a decontamination factor for iodine of from four to five. Adding a layer of activated carbon to the surfaces of the sand filters would provide an additional factor of two, for a total decontamination factor of from eight to ten. Bartram et al., ff. Tr. 12,007, at 23-24. Decontamination factors for Strontium of from five to ten can be obtained by co-precipitation with dosages of soda ash (sodium carbonate). Additional decontamination could be achieved by repeating the process, albeit reducing the throughput, in the absence of construction of a major plant addition. Id. at 24-25. See also Lehr, ff. Tr. 12,141, at 8-13.

f. Conclusion.

F-144. We do not conclude that specific countermeasures would or could be implemented, nor what quantitative reductions in risk could be achieved. We do conclude that a number of alternatives to consumption of contaminated drinking water could be considered should the City of Philadelphia water supply become contaminated. These alternatives include water rationing, use of stored or bottled water, construction of temporary or permanent pipelines from the points of use to a safe and adequate supply, dilution by a known safe water supply, delivery of safe water by auxiliary means (e.g., tank truck) or use of special decontamination equipment or procedures. Lehr, ff. Tr. 12,141, at 13.

F-145. We do conclude that the the record before us, which supplements the FES, does adequately consider and analyze the contamination that could occur to nearby liquid pathways and the City's water supplies sources therefrom, as a result of precipitation after a release (from a severe accident at Limerick). This includes consideration of the City's two only water supplies (the Delaware and the Schuylkill) and the open reservoirs within the City boundaries.

F-146. For the reasons given above, this contention requires no further relief.

III. CONCLUSIONS OF LAW

In reaching this decision, the Board has considered all the evidence submitted by the parties and the entire record of this proceeding. That record consists of the Commission's Notice of Hearing, the pleadings filed by the parties, the transcripts of the hearing, and the exhibits received into evidence. All issues, arguments, or proposed findings presented by the parties, but not addressed in this decision, have been found to be without merit or unnecessary to this decision. Based upon the foregoing Findings which are supported by reliable, probative, and substantial evidence as required by the Administrative Procedure Act and the Commission's Rules of Practice, and upon consideration of the entire evidentiary record in this proceeding, the Board, with respect to the issues in controversy before us;

CONCLUDES that the Applicant, Philadelphia Electric Company, has fully met its burden of proof on each of the contentions decided in this P.I.D. As to these issues, there is reasonable assurance that the Limerick Generating Station, Units 1 and 2, can be operated without endangering the health and safety of the public, and further that all requirements applicable to these issues under the National Environmental Policy Act have been met.

IV. ORDER

WHEREFORE, in accordance with the Atomic Energy Act of 1954, as amended, and the rules of the Commission, and based on the foregoing Findings of Fact and Conclusions of Law, IT IS ORDERED THAT:

The Director of Nuclear Reactor Regulation is authorized, upon making the findings on all applicable matters specified in 10 C.F.R. § 50.57(a), as to each respective reactor unit, to issue to the Applicant, Philadelphia Electric Company, a license or licenses to authorize low power testing (up to five percent of rated power of each unit) of the Limerick Generating Station, Units 1 and 2.

Pursuant to 10 C.F.R. § 2.760 of the Commission's Rules of Practice, this Partial Initial Decision shall become effective immediately. It will constitute the final decision of the Commission forty-five (45) days from the date of issuance, unless an appeal is taken in accordance with 10 C.F.R. § 2.762 or the Commission directs otherwise. See also 10 C.F.R. §§ 2.764, 2.785 and 2.786.

Any party may take an appeal from this decision by filing a Notice of Appeal within ten (10) days after service of this Partial Initial Decision. Each appellant must file a brief supporting its position on appeal within thirty (30) days after filing its Notice of Appeal, (forty (40) days if the Staff is the appellant). Within thirty (30) days after the period has expired for the filing and service of the briefs of all appellants, (forty (40) days in the case of the Staff), a party who is not an appellant may file a brief in support of or in opposition to the appeal of any other party. A responding party shall file a single, responsive brief only regardless of the number of appellants' briefs filed. (See 10 C.F.R. § 2.762).

IT IS SO ORDERED.

THE ATOMIC SAFETY AND
AND LICENSING BOARD

Lawrence Brenner
Lawrence Brenner, Chairman
ADMINISTRATIVE JUDGE

Richard F. Cole
Dr. Richard F. Cole
ADMINISTRATIVE JUDGE

Peter A. Morris
Dr. Peter A. Morris
ADMINISTRATIVE JUDGE

Bethesda, Maryland
August 29, 1984

Attachments (unpublished):
Appendix A: Witness List
Appendix B: Exhibit List

APPENDIX A

WITNESS LIST

APPENDIX A

WITNESS LIST

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APPENDIX B

EXHIBIT LIST

APPLICANT

APPENDIX B

Exhibit List

Applicant

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PECO Ex. 7	Limerick Generating Station Site Plan, AB-207392-5, August 31, 1970.	5357	5357
PECO Ex. 8	Color Photograph of Cooling Tower Plumes Coming from the John Amos Plant.	6236	6236
PECO Ex. 9	Cooling Towers and the Environment, Major Contributors: Maynard Smith, Mark Kramer and David Seymour, October 1974.	6413	6413
PECO Ex. 10	Amos Cooling Tower Flight Program, Test No. 48A, March 11, 1975.	6649	6649
PECO Ex. 11	Douglas Point Power Plant Site Evaluation Final Report, Vol. 1, Part 2, L.C. Kohlenstein, Project Engineer, Published by the Johns Hopkins University Applied Physics Laboratory, January 1976.	6650	

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PECO Ex. 13	Environmental Measurements of Power Plant Cooling Tower and Stack Plumes, Final Report for AEC, ERDA and DOE, Conducted by the Department of Meteorology, Pennsylvania State University, Edited by D.W. Thomson, R.G. de Pena, J.A. Pena, Updated.	6868	
PECO Ex. 14	Table 2.2-3 of the Limerick Generating Station Final Safety Analysis Report, "Airports Within Ten Miles of the Site," Rev. 4, 05/82.	6972	
PECO Ex. 15	Figure 1, One page document, Free Air-Burst Blast Environment.	8214	8214
PECO Ex. 16	Figure 1, One page document entitled "Air-Burst Blast Environment."	8214	8214
PECO Ex. 17	Figure 2, One page document entitled "Surface-Burst Blast	8214	8214

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PECO Ex. 19	Figure 4, one page document entitled "Cooling Tower General Arrangement."	8214	8214
PECO Ex. 20	Figure 5, One page document entitled "Cooling Tower Section Looking North."	8214	8214
PECO Ex. 21	Figure 6, One page document entitled "Cooling Tower Looking West."	8214	8214
PECO Ex. 22	Figure 7, Single page, large scale drawing entitled "Seismic Category I Underground Facilities."	8214	8214
PECO Ex. 23	Figure 8, single page, large scale sheet entitled "Profiles of RHR & ESQ Pipes Showing Ground Cover."	8214	8214
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PECO Ex. 25	Figure 10, one page document entitled "Intense Storm Site Runoff Pattern: General Plan," Figure 2.4-4, LGS FSAR.	8214	8214
PECO Ex. 26	Figure 11, one page document entitled "Intense Storm Site Runoff Pattern: Spary Pond and Cooling Tower Areas," Figure 2.4-5, LGS FSAR.	8214	8214
PECO Ex. 27	Figure 12, one page document entitled "Duct Bank Sections."	8214	8214
PECO Ex. 28	Figure 13, one page document entitled "Buried Pipe Bedding."	8214	8214
PECO Ex. 29	Environmental Qualification Report for Limerick Generating Station, Units 1 and 2. October 1983.	9531	9532
PECO Ex. 30	Letter dated January 16, 1984 transmitting document entitled "Additional Information Required for Limerick Environmental Qualification Program."	9534	9534
PECO Ex. 31	Letter dated February 16, 1984 from J.S.	9537	9537

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	Kemper to A.S. Schwencer conveying Figure 4, "Calculated Reactor Enclosure LOCA Temperature Profile" and Enclosures 1 and 2.		
PECO Ex. 32	Emergency Plan, Limerick Generating Station, Units 1 and 2 (through Rev. 8), Section 3, Section 4, Section 5.2.2, Section 5.3.2, Section 5.3.3 (Table 5-5), Section 6, Section 7.1, Section 7.3, Section 7.4, Section 7.5 (Table 7-3, Table 7-4, Table 7-5, Figure 7-2), Section 8.1.1, Section 8.3 (Table 8-1), Appendices A, B, E, I, Answers to NRC Questions 810.5b, 810.13, 810.18, 810.24, 810.30, 810.32, 810.33, 810.35, 810.37, 810.40, 810.41, 810.45, 810.46, 810.47, 810.48, 810.49, 810.53, 810.54, 810.55, 810.57 and 810.59.	9772	9773, 9996
PECO Ex. 33	Emergency Plan Implementing Procedures, Limerick Generating Station, EP-101 (Classification of Emergencies), EP-102 (Unusual Event Response), EP-103 (Alert Response), EP-104 (Site Emergency Response),	9772	9773, 9996

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PECO Ex. 34	Revised Table 4-2 Emergency Plan.	9772	9773
PECO Ex. 35	Emergency Procedure Corporate, EP-C-326.	9772	9773
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PECO Ex. 37	Surveillance Test Procedure ST-7-EPP-351-0, Limerick Generating Station.	9772	9773
PECO Ex. 38	Final Safety Analysis Report, Limerick Generating Station, Sections 1.3 (page 1.13-18b), 2.1.2.3, 2.3.3, 2.3.3.2, 3.7.4, 7.5.1.4.2.1.5, 7.5.2.5.1.1.2, 7.6.1.1.6, 11.5, 11.5.2.2.1, 11.5.2.2.11, 11.5.2.3.1, 11.5.4, 11.5.5, 12.3.4,	9772	9773

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PECO Ex. 39	Environmental Report - Operating License Stage, Limerick Generating Station, Section 6.1.5.	9772	9773
PECO Ex. 40	Letter of Agreement dated August 16, 1983 between Hospital of the University of Pennsylvania and Radiation Management Corporation (including attached Radiation Plan entitled "Decontamination and Treatment of Radioactively Contaminated Patient at Hospital of the University of Pennsylvania").	9772	9773
PECO Ex. 41	Letter of Agreement dated June 25, 1982 between Keystone Helicopter Corporation and Radiation Management Corporation.	9772	9773
PECO Ex. 42	Letter of Agreement dated January 1, 1984 between Radiation Management Corporation and Applicant.	9772	9773
PECO Ex. 43	Letter of Agreement dated April 5, 1984	9772	9773

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PECO Ex. 46	Applicant's Analysis of Minimum Staffing Requirements for NRC Licensees for Nuclear Power Plant Emergencies as required under NUREG-0654, Table B-1.	10173	10220
PECO Ex. 47	PECO Letter to NRC dated 6/10/84.	10328	10328
PECO Ex. 48	PECO Letter to NRC dated 9/15/83.	10328	10328
PECO Ex. 49	NRC IE Report 50-352/82-06 (Weld Inspection-Mobile NDE Lab).	10328	10328
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PECO Ex. 51	NRC 1982 SALP Report (pages 7 through 10).	10328	10328
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PECO Ex. 70	Bechtel FIR C-63-18.	10328	10328

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PECO Ex. 71	Bechtel FIR C-63-19.	10328	10328
PECO Ex. 72	NRC IE Report 50-353/77-01.	10328	10328
PECO Ex. 73	Bechtel FIR C-63-20.	10328	10328
PECO Ex. 74	Bechtel FIR C-63-21.	10328	10328
PECO Ex. 75	Bechtel FIR C-63-22.	10328	10328
PECO Ex. 76	NRC IE Report 50-353/77-06, page 5.	10328	10328
PECO Ex. 77	Bechtel FIR C-63-24.	10328	10328
PECO Ex. 78	Bechtel FIR C-63-25.	10328	10328
PECO Ex. 79	Bechtel FIR C-63-26.	10328	10328
PECO Ex. 80	Bechtel FIR C-63-27.	10328	10328
PECO Ex. 81	Bechtel FIR C-63-28.	10328	10328
PECO Ex. 82	Bechtel FIR C-63-29.	10328	10328
PECO Ex. 83	Bechtel FIR C-63-30.	10328	10328
PECO Ex. 84	Bechtel FIR C-63-31.	10328	10328
PECO Ex. 85	Bechtel FIR C-63-32.	10328	10328
PECO Ex. 86	Bechtel FIR C-63-33.	10328	10328
PECO Ex. 87	Bechtel FIR C-41-493.	10328	10328
PECO Ex. 88	Bechtel NCR	10328	10328

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PECO Ex. 89	Bechtel NCR 2710.	10328	10328
PECO Ex. 90	NRC IE Report 50-353/77-14, page 4.	10328	10328
PECO Ex. 91	NRC IE Report 50-353/77-02, page 6.	10328	10328
PECO Ex. 92	PECO Response to NRC dated 5/13/77 (77-02).	10328	10328
PECO Ex. 93	NRC IE Report 50-352/77-07, pages 3 and 4.	10328	10328
PECO Ex. 94	NRC IE Report 50-352/78-03, pages 14 and 15.	10328	10328
PECO Ex. 95	PECO Letter to NRC dated 6/12/78.	10328	10328
PECO Ex. 96	PECO Letter to NRC dated 9/18/78.	10328	10328
PECO Ex. 97	NRC IE Report 50-352/78-07, page 4.	10328	10328
PECO Ex. 98	PECO Letter to NRC dated 12/4/78.	10328	10328
PECO Ex. 99	NRC IE Report 50-352/79-11, page 7.	10328	10328
PECO Ex. 100	NRC IE Report 50-352/78-04 pages 10 and 11.	10328	10328
PECO Ex. 101	PECO Letter to NRC dated 7/20/78.	10328	10328

Exhibit Number	Description	Identified at Transcript Page	Admitted at Transcript Page
PECO Ex. 102	NRC IE Report 50-352/79-94, page 2.	10328	10328
PECO Ex. 103	PECO Letter to NRC dated 3/2/79.	10328	10328
PECO Ex. 104	NRC IE Report 50-352/79-12, page 6.	10328	10328
PECO Ex. 105	PECO Letter to NRC dated 10/31/79.	10328	10328
PECO Ex. 106	NRC IE Report 50-352/80-02, page 5.	10328	10328
PECO Ex. 107	NRC IE Report 50-352/81-06, page 3.	10328	10328
PECO Ex. 108	NRC IE Report 50-352/81-16, page 4.	10328	10328
PECO Ex. 109	NRC IE Report 50-352/80-03, page 12.	10328	10328
PECO Ex. 110	NRC IE Report 50-352/79-11, pages 9 and 10.	10328	10328
PECO Ex. 111	PECO QA Field Office Memorandum No. 882 dated 1/23/80.	10328	10328
PECO Ex. 112	NRC IE Report 50-352/80-12, pages 17 and 18.	10328	10328
PECO Ex. 113	PECO Letter to NRC dated 9/26/80.	10328	10328
PECO Ex. 114	NRC IE Report 50-352/81-04, pages 11 and 12.	10328	10328

Exhibit Number	Description	Identified at Transcript Page	Admitted at Transcript Page
PECO Ex. 115	NRC IE Report 50-352/77-12, pages 3, 4 and 5.	10328	10328
PECO Ex. 116	PECO Letter to NRC dated 12/9/77.	10328	10328
PECO Ex. 117	NRC IE Report 50-352/80-20 (entire).	10328	10328
PECO Ex. 118	NRC IE Report 50-352/81-12, page 4.	10328	10328
PECO Ex. 119	PECO Letter to NRC dated 1/20/81.	10328	10328
PECO Ex. 120	NRC IE Report 50-352/82-05, page 4.	10328	10328
PECO Ex. 121	NRC IE Report 50-352/81-01, page 5.	10328	10328
PECO Ex. 122	PECO Letter to NRC dated 3/12/81.	10328	10328
PECO Ex. 123	NRC IE Report 50-352/80-21, page 6.	10328	10328
PECO Ex. 124	PECO Letter to NRC dated 7/17/81.	10328	10328
PECO Ex. 125	PECO Letter to NRC dated 7/17/81.	10328	10328
PECO Ex. 126	NRC Letter to PECO dated 8/27/81.	10328	10328
PECO Ex. 127	NRC IE Report 50-352/82-05, page 5.	10328	10328

Exhibit Number	Description	Identified at Transcript Page	Admitted at Transcript Page
PECO Ex. 128	PECO Letter to NRC dated 3/21/81.	10328	10328
PECO Ex. 129	NRC IE Report 50-352/81-12, pages 6 and 7.	10328	10328
PECO Ex. 130	PECO Letter to NRC dated 6/26/81.	10328	10328
PECO Ex. 131	NRC IE Report 50-352/82-04, pages 3 and 4.	10328	10328
PECO Ex. 132	NRC IE Report 50-352/81-06, page 7.	10328	10328
PECO Ex. 133	NRC IE Report 50-352/82-03, pages 3 and 4.	10328	10328
PECO Ex. 134	PECO Letter to NRC dated 3/11/82.	10328	10328
PECO Ex. 135	NRC IE Report 50-352/82-10, page 3.	10328	10328
PECO Ex. 136	Cover page of Bechtel NCR 1366 (Also identified as AWPP 180B).	10992	
PECO Ex. 137	"Calculation of Accident Consequences," Appendix VI of Reactor Safety Study - An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants, WASH-1400 (Appendix VI, Sections 9.3, 9.4, including Tables 9-10, 9-11, 9-12, Sections 11.1, 11.2, 11.3, including Table 11-6 and	11116	

Exhibit Number	Description	Identified at Transcript Page	Admitted at Transcript Page
	Figures 11-6, 11-7, Appendix J, including Table J-1, Appendix I).		
PECO Ex. 138	"A Model of Public Evacuation for Atmospheric Radiological Releases," SAND 78-0092 (Entire).	11116	
PECO Ex. 139	"Planning Basis for the Development of State and Local Government Radiological Emergency Response Plans in Support of Light Water Nuclear Power Plants" (pages 15-17, App. I-7, I-46, Figure I-11, p. I-38).	11116	
PECO Ex. 140	"Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants" (page 12).	11116	
PECO Ex. 141	"Examination of Offsite Emergency Protective Measures for Core Melt Accidents" (III 7-4 and 7-5).	11116	
PECO Ex. 142	"Evacuation Risks-An Evaluation" (pages 40, 41, 42, 48, App. B).	11116	
PECO Ex. 143	"Mississauga Evacuates: A Report on the Closing of Canada's Ninth Largest City"	11116	

Exhibit Number	Description	Identified at Transcript Page	Admitted at Transcript Page
	(page VIII).		
PECO Ex. 144	"Before the Wind-A Study of the Response to Hurricane Carla."	11116	
PECO Ex. 145	"Health-MARC: The Health Effects Module in the Methodology for Assessing the Radiological Consequences of Accidental Releases" (Table 1).	11116	
PECO Ex. 146	UNSCEAR, "Sources and Effects of Ionizing Radiation" (Annex G, page 385).	11116	
PECO Ex. 147	BEIR III, "The Effects of Populations of Exposures to Low Levels of Ionizing Radiation" (Tables IV-2, V-15, pp. 498-99).	11116	
PECO Ex. 148	UNSCEAR, "Ionizing Radiation, Sources and Biological Effects" (Annex I, Section E; Section II, paragraph 45).	11116	
PECO Ex. 149	"Estimates of the Financial Consequences of Nuclear Power Reactor Accidents" (pages 1-17).	11116	
PECO Ex. 150	"PRA Procedures Guide, NUREG/CR-2300" (pages 9-53 and 9-54).		
PECO Ex. 151	"CRAC2 Model		

Exhibit Number	Description	Identified at Transcript Page	Admitted at Transcript Page
	Description" (pages 3-2 through 3-5).		
PECO Ex. 152	"Severe Accident Risk Assessment" (Chapter 10, pages 11, 12, 15, 25; Tables 2, 4, 8, 9, 11; Chapter 12, page 18, Tables 7, 8, 9; Appendix F, page 10; Supplement 3, Table 1. All except Supplement 3-Table 1 and Table 12.8 from original submittal).	11117	11119 (Bound in ff. 11119)
PECO Ex. 153	Direct Testimony of Richard Codell before the ASLB concerning Commission Question No. 1.	12010	
PECO Ex. 154	Richard B. Codell, 1984. Potential Contamination of Surface Water Supplies by Atmospheric Releases from Nuclear Plants.	12010	
PECO Ex. 155	T.C. Helton, A.B. Muller and A. Bayer, Contamination of Surface Water Bodies After Reactor Accidents by Erosion of Atmospherically Deposited Radionuclides.	12010	
PECO Ex. 156	USNRC, 1975 Calculation of Reactor Accident Consequences - Appendix VI of Reactor Safety Study.	12010	
PECO Ex. 157	Health and Safety Laboratory, U.S.	12010	

Exhibit Number	Description	Identified at Transcript Page	Admitted at Transcript Page
	Energy Research and Development Administration, 1977. Final Tabulation of Monthly 90 Sr Fallout Data: 1954-1976.		
PECO Ex. 158	Richard J. Larsen, 1983. Worldwide Deposition of 90 Sr through 1981.	12010	
PECO Ex. 159	USEPA, 1976. Radiological Quality of the Environment.	12010	
PECO Ex. 160	E.P. Hardy and L.E. Toonkel, 1982. Environmental Measurements Laboratory Environmental Report.	12010	
PECO Ex. 161	USHEW, 1960-68. Radiological Health Data, Volumes 1-9.	12010	
PECO Ex. 162	Limerick Generating Station Radiological Environmental Monitoring Program, 1971-1977, Prepared for Philadelphia Electric Company by Radiation Management Corporation, May, 1979.	12010	
PECO Ex. 163	USEPA, 1976-1982, Environmental Radiation Data, Reports 6, 10, 15, 18, 23-24, 25-26, and 29.	12010	
PECO Ex. 164	Donald G. Menzel, 1975. Land Surface Erosion and Rainfall as Sources of Strontium-90 in	12010	

Exhibit Number	Description	Identified at Transcript Page	Admitted at Transcript Page
	streams.		
PECO Ex. 165	US Geological Survey, 1982. Water Resources Data for Pennsylvania Water Year 1982 Volume 1-Delaware River Basin and Volume 2-Susquehanna and Potomac River Basins.	12010	
PECO Ex. 166	City of Phildelphia Water Department, 1982. How Water in Phildelphia is treated and distributed.	12010	
PECO Ex. 167	USNRC, 1977. Calculations of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 C.F.R. Part 50.	12010	
PECO Ex. 168	D.B. Simpson and B.L. McGill, 1980. User's Manual for LADTAPII - A Computer Program for Calculating Radiation Exposure to Man from Routine Releases of Nuclear Reactor Liquid Effluents.	12010	
PECO Ex. 169	Bruce S. Aptowicz, 1984. Letter to Robert E. Martin, USNRC, dated 4/23/84 and private communication, S. Gibbon, PECO and B. Aptowicz, City of Philadelphia, 5/25/84.	12010	
PECO Ex. 170	Philadelphia Water	12010	

Exhibit Number	Description	Identified at Transcript Page	Admitted at Transcript Page
	Department, 1982. Table of Pumping, Treatment, and Consumption Rates for FY '82.		
PECO Ex. 171	Commonwealth of Pennsylvania Disaster Operations Plan, Annex E, Fixed Nuclear Facility Incidents, February, 1984.	12010	
PECO Ex. 172	C.P. Straub, 1964. Level Radioactive Wastes, Their Handling, Treatment and Disposal.	12010	
PECO Ex. 173	E.P. Hardy, Jr., 1981. Environmental Measurements Laboratory Environmental Report, EML-390.	12010	
	Limerick Ecology Action		
LEA Ex. 1	Compilation of Attachment P's from Draft #5 of Municipal RERP's regarding service by Goodwill Ambulance.	10283	
	Staff		
Staff Ex. 6	NUREG-0911 "Safety Evaluation Report Related to the Operation of Limerick Generating Station," Section 2.2.2, August 1983.	6137	6138 (Bound in ff. 6138)
Staff Ex. 7	Regulatory Guide 1.91 (Revision 1), "Evaluations	6150	6153

Exhibit Number	Description	Identified at Transcript Page	Admitted at Transcript Page
	of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants,." February 1978.		
Staff Ex. 8	VFR Terminal Area Chart for the Philadelphia Area, 18th Edition, September 2, 1983.	7104	
Staff Ex. 9	National Transportation Safety Board Pipelines Accident Report. No. NTSB-PAR-76-8, Los Angeles, California, cover pg. and fig. 3, June 16, 1976.	7145	
Staff Ex. 10	NUREG-0570, "Toxic Vapor Concentrations Control Room Following a Postulated Accidental Release," June 1979.	7145	
Staff Ex. 11	Army Technical Manual, TM 5-1300, "Structures to Resist the Effects of Accidental Explosions," TM 5-1300, cover pg., fig.4-4 and 4-12, June 1969.	7146	
Staff Ex. 12	National Transportation Safety Board Pipeline Accident Report No. NTSB-DAR-80-6. Bayamon, Puerto. Rico, cover pg., summary pg. and pgs. 5,12, January 30, 1980.	7147	

Exhibit Number	Description	Identified at Transcript Page	Admitted at Transcript Page
Staff Ex. 13	U.S. Atomic Energy Commission, "Meteorology and Atomic Energy 1968," July 1968.	7147	
Staff Ex. 14	NUREG/CR-1748, "Hazards to Nuclear Power Plants from Nearby Accidents Including Hazardous Materials - Preliminary Assessment," Chemical Engineering, cover page and pgs. F-2, F-4, F-8 and F-11, Undated.	7148	
Staff Ex. 15	"Unconfined-Vapor Cloud Explosions," V.C. Marshall, June 14, 1982.	7148	
Staff Ex. 16	"Conditions of External Loading of Nuclear Power Plant Structures by Vapor Cloud Explosions and Design Requirements," W. Geiger, Undated.	7149	
Staff Ex. 17	"Transactions of the 4th International Conference on Structural Mechanics in Reactor Technology," August 19, 1977.	7151	
Staff Ex. 18	Department of Transportation, "Explosions Hazards Associated with Spills of Large Quantities of Hazardous Materials Phase II," Report No. CG-D-85-77, C.D. Lind and J.C. Whitson, November 1977.	7151	

Exhibit Number	Description	Identified at Transcript Page	Admitted at Transcript Page
Staff Ex. 19	NRC Testimony of Jacques B.J. Read Relating to Safety Implications of the Natural Gas Pipelines which Passes by the Hartsville Site, In the Matter of Tennessee Valley Authority (Hartsville Nuclear Plants Units 1A, 2A, 1B, and 2B), Undated.	7152	
Staff Ex. 20	Army Technical Manual, TM 5-1300, "Structures to Resist the Effects of Accidental Explosions," dover page and figures 4-3, 4-4, 4-5, 4-6, 4-7 and 4-12, June 1969.	9050 (Bound in ff. 9055)	
Staff Ex. 21	One page graph, "Limerick Peak Positive Reflected Overpressure and Positive Phase Pulse Time Due to 56 Tons of TNT," Undated.	9051	9054 (Bound in ff. 9055)
Staff Ex. 22	U.S. Atomic Energy Commission, "The Effects of Nuclear Weapons," Samuel Gladstone, Editor, cover page and pgs. 147 and 151, April 1962.	9051 (Bound in ff. 9055)	
Staff Ex. 23	Table I, "Summary of Accidental Explosion Pressures," Undated.	9051	9055 (Bound in ff. 9055)
Sfaff Ex. 24	Figure 1 "Selection of Critical Element for Purpose of	9052 (Bound in ff. 9055)	

Exhibit Number	Description	Identified at Transcript Page	Admitted at Transcript Page
	Analysis and Design," February 8, 1984.		
Staff Ex. 25	Figure 2, "Typical Load Deformation Curve Idealized Elastic-Plastic System," February 13, 1984.	9052	
Staff Ex. 26	1979 Supplement "Code Requirements for Nuclear Safety Related Concrete Structures (ACI 349-76) and Commentary on Code Requirements for Nuclear Safety Concrete Structures (ACI 349-76), Appendix C, Undated.	9053 (Bound in ff. 9055)	
Staff Ex. 27	Memorandum from Norman D. Romney, Structural Engineer, NRC, to George Lear, Chief, Structural and Geotechnical Engineer Branch, NRC, "Limerick Conference Call Between NRC Staff, Bechtel Corporation and Philadelphia Electric Company," March 13, 1984.	9071	9073 (Bound in ff. 9073)
Staff Ex. 28	Regulatory Guide 1.142 (Revision 1) "Safety-Related Concrete Structures for Nuclear Power Plants (Other Than Reactor Vessels and Containments)," October 1981.	9211	
Staff Ex. 29	Portions from	111154	111154

Exhibit Number	Description	Identified at Transcript Page	Admitted at Transcript Page
	the Staff FES, Section 5.9.4, page 5-51, through Section 5.9.4.6, page 5-126, Appendices H, I, J, K, L, M and N, and Section 6		
Staff Ex. 30	FES Table 5.11c "Summary of the Atmospheric Release Specifications Used in Consequence analysis for Limerick Units 1 and 2."	11360 (bound in ff. 11360)	11368
	FOE		
FOE Ex. 1	Nuclear Power, Armory Lovins, pg. 161, Undated.	5542 (Rejected)	
FOE Ex. 2	National Transportation Safety Board Pipeline Accident Report No. NTSB-PAR-73-2, Hearne, Texas. August 1, 1973.	5257	5258
FOE Ex. 3	National Transportation Safety Board Pipeline Accident Report No. NTSB-PAR-75-3, Farmington, New Mexico, March 15, 1974.	5758	5759
FOE Ex. 4	Transactions of the ASME "Decompression of Gas Pipelines During Longitudinal Ductile Fractures," G.G. King, March 1979.	5768 (Rejected)	
FOE Ex. 10	Journal of the Soil Mechanics and Founda-	8881	

Exhibit Number	Description	Identified at Transcript Page	Admitted at Transcript Page
	tion Division, "Depth Prediction for Earth-Penetrating Projectiles" C. Wayne Young, May 1969.		
FOE Ex. 5	Figure 6-2, "Structures to Resist the Effects of Accidental Explosions," Undated.	8979	
FOE Ex. 11	"Nuclear Safety-Related Concrete Structures, ACI-349-80," pg 349-83, Undated.	9007	
FOE Ex. 9	LGS FSAR Table 3.5-5, "Railroad-Accident-Generated Missile Parameters," Undated.	9009	
FOE Ex. 6	Post Card Depicting Limerick Generating Station.	9253	

AWPP

Exhibit Number	Description	Identified at Transcript Page	Admitted at Transcript Page
AWPP Ex. 1	The New Private Pilot, Published by Pan American Navigation Service, 8th Edition, Cover Page and Pages 53-54.	6949	
AWPP Ex. 2	Those Icy Fingers in Your Carburetor, Aviation Consumer Magazine, January 1, 1982.	7046	
AWPP Ex. 3	Letter from Dr. Gudmund R. Iverson to Frank Romano, dated April 26, 1984, containing	10436 (Rejected)	

Exhibit Number	Description	Identified at Transcript Page	Admitted at Transcript Page
	professional qualifications of Dr. Iverson, and a four page attachment entitled "Testimony of Gudmund R. Iverson Concerning Auditing and Sampling as it relates to Quality Assurance Re Welding at the Limerick Generating Station."		
AWPP Ex. 4	"Testimony of Air and Water Pollution Patrol (Romano) Concerning Contention VI-1 (Infractions Related to Welding)" consisting of pages A-J and attachments AWPP-30 through AWPP-49.	10533 (Rejected)	
AWPP Ex. 5	NRC Combined Inspection Report 352/84-14 and 353/84-04, pp. 10-12.	10973	10973
	CITY		
City Ex. 1	One page document entitled "Frequency Distributions II-T/WW. WB.DS.VS. Distances."	11874	11883
City Ex. 2	Map entitled "Ingestion Exposure Pathway EPZ Limerick Generating Station Pennsylvania Emergency Management Agency August 1983."	11880	11881

*U.S. GOVERNMENT PRINTING OFFICE : 1984 0-421-297/4130

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

DOCKETED
USNRC

BEFORE ADMINISTRATIVE JUDGES:

Lawrence Brenner, Chairman
Dr. Richard F. Cole
Dr. Peter A. Morris

'84 AGO 29 A8:50

OFFICE OF SECRETARY
DOCKETING & SERVICE
BRANCH

In the Matter of	)	Docket Nos. 50-352-OL
	)	50-353-OL
PHILADELPHIA ELECTRIC COMPANY	)	
	)	
(Limerick Generating Station, Units 1 and 2)	)	August 28, 1984

SERVED AUG 29 1984

COURTESY NOTIFICATION

As circumstances warrant from time to time, the Board will mail copies of its memoranda and orders and decisions directly to each party, petitioner or other interested participant. This is intended solely as a courtesy and convenience to those served to provide extra time. Official service will be separate from the courtesy notification and will continue to be made by the Office of the Secretary of the Commission. Unless otherwise stated, time periods will be computed from the official service.

I hereby certify that I have today mailed copies of the Board's "Second Partial Initial Decision" to the persons designated on the attached Courtesy Notification List.

Valarie M. Lane
Valarie M. Lane
Secretary to Judge Brenner
Atomic Safety and Licensing
Board Panel

Bethesda, Maryland

Attachment

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