Proposed Findings of Fact and Conclusions of Law

on LEA Contentions DES-1,2,3, and 4

General Introduction

1. LEA's contentions challenge the adequacy of the NRC Staff's Environmental Impact Statement (EIS or FES) under the National Environmental Policy Acto of 1969 (hereafter, NEPA), with respect to the risk of severe accidents at the Limerick facility.[1/]

2. We conclude below that the EIS does not comply with the mandates of NEPA, largely due to numerous material non-disclosures of environmental impacts, including health effects. We also conclude that, contrary to Applicant's assertions in its Proposed Findings of Fact, No. 6, these disclosure defects in the FES cannot be cured by the discussion of those defects in this decision, notwithstanding 10 C.F.R. §§ 51.102(c). The publication of this decision is simply no substitute for the full circulation and comment requirements of NEPA and 40 C.F.R. Parts 1502 and 1503.

1/ Applicant would have us observe that LEA and the City did not comment on the draft supplement to the Environmental Statement and thus did not "put the Staff on notice as to the specific areas which they felt should be modified or improved. The litigation could have been simplified and shortened had this been done." (Applicant's Proposed Findings, fn. 5.) This position is utterly untenable. LEA's and City's litigation contentions were admitted long before the issuance of the FES and put the Staff on adequate notice. Indeed, Staff's testimony was generally responsive to the contentions. But the Staff made no changes to the DES responsive to any of the contentions. The opportunity for informal and formal discovery in the litigation provided the Staff with even greater opportunity to determine areas of concern than that afforded by public comments. The Staff did not avail itself of its opportunity to include in the FES the information it provided in testimony, even though the information was apparently available, and the contentions were long known to it.

3. Applicant has suggested that various tables, diagrams and figures referenced in the decision "should be considered a part of it for all purposes". (Proposed Findings of Fact, Fn. 6). Similarly, Staff's witness suggested at hearing that the materials referenced by the FES should somehow be deemed "included" within the FES. (Hulman, Tr. 11,295). We reject such suggestions. While incorporation of some materials by reference may be appropriate under some circumstances (See 40 C.F.R. § 1502.21), we conclude that specific risk calculations for the non-disclosed impacts for the Limerick site were not publicly available for inpection; and that these and the other matters not disclosed could have been easily set forth in the FES without unnecessary length. See also, Baltimore Gas and Electric Co., et.al. v. Natural Resources Defense Council, Inc. ___ US ___ (1983) slip. op. pp. 11-12, fn. 12. (criticism of excessive reliance on information outside of the FES).

Risk of Total Facility Operational Life

4. Throughout the FES' discussion of the environmental impact of severe accidents, the discussion of risk is limited to "annualized" values, i.e., the risk presented by one year of operation of a single reactor. However, the severe accident probabilities at one unit must be approximately multiplied by the number of years of plant operation to obtain the total probability of a severe accident from operation of one unit of the Limerick facility. (Acharya, Hulman, Tr. 11,298-299). Because Applicant's operating license application is for both units of a two-unit facility, the risk posed by the entire facility must be roughly multiplied by two, assuming a low probability of interaction between the two units. (Acharya, Tr. 11,195-6).

5. We find that the FES does not adequately disclose the impacts of total facility operation over its operating life in the context of any of the matters

embraced by LEA's DES-4, because in each case the risk is presented either in terms of a "per reactor-year" risk value or by the presentation of a CCDF curve which similarly is limited to annual probabilities. We cannot conclude that a 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 the multiplication process described above. Indeed, one Staff expert witness, Mr. Hulman, consistently rejected this approach until he was finally corrected by another witness. (Hulman, Tr. 11,194-5).

DES-1

6. LEA's Contention 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.

7. While Staff's witness Mr. Hulman testified that "some discussions" of a generic nature have taken place between the NRC and the Federal Emergency Management Agency concerning relocation of populations beyond the 10 mile plume exposure pathway (Hulman, Tr. 11,544; 11,558), the witness admitted that no such planning for Limerick is in place (Hulman, Tr. 11,544), and while the witness spoke in terms of "planning", he denied that "planning" even contemplates the presence or existence of a plan. (Hulman, Tr. 11,566).

8. Indeed, not even any formal planning document has been issued by the appropriate agencies, and the Staff witness refused to speculate on when such a document might ever be issued. (Hulman, Tr. 11,567). We therefore place no credence in suggestions of such "relocation planning".

9. The Staff performed no analysis of the consequences of a severe accident at Limerick in which relocation of the population outside of the 10 mile plume exposure emergency planning zone does not take place. (Acharya, Tr. 11, 545).

10. However, if no relocation is assumed, early fatalities would occur at distances farther from the plant than those calculated in the Staff's Final Environmental Statement analyses. (Acharya, Tr. 11,547-8).

11. Indeed, the Staff's own analysis performed in the context of another LEA contention showed that at a probability level of 1.18×10^{-6}/reactor year, 5,000 persons are expected to be located in an area in which those persons, unless relocated, would receive in seven days a bone marrow dose of 200 rems,[1/] the dose threshold for early fatalities assuming no medical treatment. (Hulman, et.al. ff. Tr. 11,555, Table 1; Id. ff. Tr. 11,543, pp. 4-5). Thus, it is apparent that the "relocation" assumption eliminated from the Staff's analysis many hundreds if not thousands of "early fatalities", on the basis of an assumption of relocation which was supported only by a thin evidentiary thread.

12. With respect to the possibility of such relocation, we note that the NRC Staff written testimony on this point was limited to the plausibility of radiological monitoring for the identification of such areas, and the formulation of "advisories". (Hulman, et.al., ff. Tr. 11,543, p. 3-4). There is an understandable, but conspicuous absence of any testimony whatsoever on how such relocations beyond the planning zones would be carried out for Limerick.

1/ Indeed, while the probability drops to very low levels, the number of such persons rises to as many as 500,000, all of which represent potential early fatalities if no relocation takes place. (Hulman, et.al., ff. Tr. 11, 555, Table 1).

13. Applicant and the Staff also attempted to rely upon various references in NUREG-0654, FEMA-REP-1 to support their conceptions of an "ad hoc" relocation beyond the 10 mile plume exposure EPZ. (Hulman, et.al., ff. Tr. 11,543 pp. 3-4; Daebler, et.al., ff. 11,114, p. 11). We find this reliance to be misplaced.

14. Both the Staff's and the Applicant's consequences analyses assumed that persons between 10 and 25 miles from Limerick would be "rapidly relocated", i.e., would be physically removed from contaminated areas so quickly as to virtually cease dose accumulation 12 hours after plume passage. (Daebler, et.al.,ff. Tr. 11,114, p. 12-13; FES p. 5-80). Obviously, the radiological monitoring and identification of contaminated areas relied upon by Staff (Finding of Fact No.12) could not occur until after plume passage. Thus, to support the Applicant's ad hoc "relocation" assumption, we would have to conclude that the process of (1)completing field measurements of ground radioactivity over an area large than the areas actually contaminated by plume passage fall out, (2) identifying those specific areas meeting the relocation criterion of 200 rems to the bone marrow in a 7-day period; (3)formulating advisories to such persons, (4)communicating them to those persons (probably on a door to door basis) (5)preparation of the affected population for relocation, and (6)the physical removal of such persons, would all occur with a 12 hour period, without any advance planning for such a disaster. On the basis of the record before us, we cannot so conclude.

15. The contaminated land area over which the plume would pass, and which would thus require field measurements of ground radioactivity is reflected by Applicant's Tables 5 and 6, although the total area of plume passage would be even larger. (See Kaiser, Levine, Tr. 11,389-391). Those tables show land areas ranging from 300 square miles to 30,000 square miles, depending upon the probability and contamination level. (Daebler, et.al., ff. Tr. 11,114, Tables 5 and 6). While the areas so highly contaminated as to require population relocation would doubtless be much smaller, these areas are indicative of the size of the area over which field measurements will be required, and thus of the resources and time necessary to perform such field measurements. In the absence of some explanation for how this entire process could possibly be done in such a short time period, on an ad hoc basis simultaneously with and in addition to the entire process required to complete and support the evacuation of the entire plume exposure EPZ, such an assumption of a 12 hour "relocation" strains credibility, and we reject it.

16. Therefore, we find Staff's and Applicant's assumption of ad hoc population "relocation" to be inappropriate, and a defect in the FES.

DES-2

17. LEA's Contention DES-2 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 consequence calculations are sensitive to evacuation time delay assumptions.

18. Out of 27 release categories analyzed by the Staff in the FES, only 6 have warning times for evacuation in excess of two hours. (FES p. 5-76, Table 5.11(c); Hulman, Tr. 11,552).

19. Accidents with short warning times are most sensitive to evacuation delay times, and some of the release categories analyzed by the Staff are highly sensitive to evacuation delay times. (Hulman, Tr. 11,552).

20. The generic evacuation time study performed by Sandia National Laboratories, and which is used in Applicant's consequence modeling concluded that the mean evacuation delay time of the observed evacuations was 3 hours. (Daebler, et.al., ff. Tr. 11,114 p. 21). 30% of the population was observed to "delay" for 1 hour, 40% was observed to "delay" for 3 hours, and 30% were observed to delay for 5 hours. (Id., p. 22).

21. If the evacuation delay time is increased to three or more hours,

the calculation of early health effects would increase. (Hulman, Tr. 11,554).

22. The Staff did not use the nuclear evacuation generic model delay times of 1, 3, and 5 hours because it used a 2.5 mph evacuation speed rather than the 10 mph evacuation speed of the generic model.

23. However, the delay time (including warning and preparation times) and evacuation speed (actual speed of persons moving away from the reactor) are largely independent in reality - the only "dependence" the Staff could think of had nothing to do with the actual speed of evacuation away from the reactor area: "What role will the travel speed play in determining the time people will take to prepare after being notified to evacuate, whatever traffic might be involved. It is not the traveling in the evacuation routes....so the speed involved there is not the speed of evacuation which comes after the people have already prepared for evacuation and when they get in their car and take these routes." (Hulman, Tr. 11,555).

24. While for modeling considerations, use of a shorter delay time can be compensated for by a slower speed, this "compensation" is incomplete. In fact, where the delay time is in excess of 3 hours (as would be the case for between 30-70% of the population, according to the Sandia generic model), CCDF risk curves are generally insensitive to evacuation speeds ranging from 5-40 mph. (Kaiser, Tr. 11,556). We therefore find the 2-hour delay time to be an inappropriate understatement.

25. LEA contended that the Staff's analysis failed 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.

26. Indeed, the base case for the Staff's consequences analysis assumed that 100% of the population within the 10 mile EPZ would be evacuated after an average delay time of 2 hours.

27. The CRAC code can be modified to determine the effect of a non-participating percentage of the population in emergency response, and indeed Applicant somewhat modified its analysis to consider this possiblity; however, even its modified analysis is defective and not fully responsive to LEA's issue, for reasons we discuss hereafter.

28. Applicant's testimony states that while a non-participating fraction of the population up to 50% is an inappropriate value (Daebler, et.al. ff. Tr. 11,114 at p. 26), the Sandia generic evacuation model, which was specifically developed for nuclear power plant studies and was used in SARA, states that civil defense personnel observed 5 percent as the fraction of non-participating people in actual evacuations, and the Hans and Sell study [1/]

1/ Hans, J.M. Jr. and T.C. Sell, 1974. Evacuation Risks - Air Evaluation, EPA-520/6-74-002, U.S. EPA

upon which the Sandia generic model was based, considered 6 percent to be an appropriate value. Indeed, Applicant provided an analysis assuming a 6% "non-participating" fraction, although its analysis, as we have said, is defective and not fully responsive to LEA's issue. (Daebler, et.al., ff. Tr. 11,114, at pp. 26-27).

29. Applicant's alternative analysis assumed that "6% of the population out to 25 miles does not take the protective actions which the remainder of the affected population is assumed to take, i.e., evacuation within 10 miles of LGS or normal activities for 12 hours after plume passage with subsequent relocation for people between 10 and 25 miles from the plant. The individuals who did not participate were assumed to remain outdoors for 24 hours after the declaration of a general emergency and then to rapidly relocate. This is the equivalent of exposures that would be accumulated in over two days of normal activities following plume passage." Under this variation, the public risk of early fatalities increases by 49%. (Daebler, et.al. ff. Tr. 11,114 at pp. 27-28).

30. Applicant testified that this variation had a small effect on the results, well within the estimated uncertainties, and that the incorporation of this omission in the analysis does not change the overall conclusions. (Daebler, et.al., id at p. 24).

31. However, this opinion was entirely based upon the Applicant's sensitivity analysis with the assumption as described in our finding of fact No 29 . (Kaiser, Tr. 11,502).

32. Based upon the testimony, we find Applicant's characterization of its variation assumption of 6% of the population as a "non-participating" fraction to be manifestly false, because the model still assumes cooperation in evacuation, albeit delayed for 24 hours, and assumes cessation of radiation dose accumulation after 24 hours. (Kaiser, Tr. 11,504). Persons who in fact do not participate in evacuation or relocation as LEA contended would continue to receive radiation doses after the 24 hour timeline at which Applicant's model assumes dose accumulation ends. (Kaiser, Tr. 11,504).

33. Applicant admits that the net affect of Applicant's modeling assumptions is that the "non-participating" fraction of the population in fact take protective action after 2-3 days. (Kaiser, Tr. 11,505).

34. This assumption eliminates the contribution to early fatalities of any persons whose doses would exceed the lethal dose threshold after 2-3 days. For example some persons would accumulate a lethal dose in a period up to 7 days. (Kaiser, Tr. 11,506).

35. The Staff's "alternative" analysis is even more seriously defective. The Staff relied upon its "Early Reloc" model of emergency response to respond to LEA's contention that it had failed to account for the non-participating fraction of the population. (Hulman, Acharya, ff. Tr. 11,148, at p. 4).

36. In this "Early Reloc" model of emergency response, all persons outside

of the 10 mile plume exposure EPZ are assumed not to receive a dose 12 hours after passage of the plume. Within 10 miles of the plant, persons are assumed to be relocated from contaminated areas 6 hours after the passage of the plume. (Acharya, Tr. 11,511).

37. Thus, Staff's "alternative" analysis, which Staff offered to demonstrate the impact on consequences of a non-participating percentage of the population, assumes cooperative participation of 100% of the population with emergency measures and their complete removal from contaminated areas 6 hours after plume passage. We fail to understand how this assumption models "non-participating" persons.

38. Nor can we conclude that this is merely a "minor variation". Both Applicant and Staff "alternative" models almost completely eliminate from consideration the dose to a non-participating fraction of the population resulting from ground exposure. Other testimony of the Staff calculated areas of contamination requiring land interdiction for periods up to, and exceeding, 30 years, the population within those areas and, the population located in highly contaminated areas beyond the 10 mile EPZ in which persons would receive a 200 rem bone marrow dose over a 7 day period. This dose is believed to be the threshold for early fatalities, absent medical treatment. (Hulman, Acharya, ff. Tr. 11,555 and Table 1). For example, even beyond the 10 mile plume exposure EPZ, where doses are anticipated to be lower than within the 10 mile plume exposure EPZ due to plume depletion and decay, at a probability level of

1×10^{-6}/reactor year, 5,000 or more persons would receive a 200 rem bone marrow dose unless removed from the contaminated areas within 7 days. A 5% non-participating fraction of the population only within those small "hot spot" areas beyond the EPZ identified to trigger the 200 rem 7 day bone marrow dose threshold, is suggestive of an additional 250 fatalities that Staff's analysis ignores. Within the 10 mile EPZ, significantly more persons can be expected to receive such projected 7 day doses due to the higher levels of contamination expected closer to the plant. Even if we conservatively assume the same number of persons (5,000) again within the EPZ projected to receive such a 7 day dose, a 5% non-participating fraction would mean an additional 250 early fatalities, for a total of 500 additional early fatalities at that probability level. The FES p. 5-87, Figure 5.4(e) shows that at a probability level of 10^{-6}/reactor year, some 1,000 early fatalities are expected. The addition of 500 more fatalities, to 1500, represents a 50% increase ignored by the Staff, for only the population in the small "hot spots" calculated by CRAC.

39. While Applicant's witness testified that other uncertainties were more significant than a 49% increase in early fatalities, and that such an increase is "small" for calculations of this type (Daebler, et.al. ff. Tr. 11,114 at p. 28), we find such a conclusion irrelevant for two reasons. One, it is clear that the proper inclusion of a non-participating fraction of the population would increase early fatalities by more than 50%, inasmuch as such inclusion causes that much of an increase in early fatalities for the "hot spot" population alone. Second, NEPA is not bound by the risk assessment community's notion of what a "small" increase is, and NEPA's disclosure purposes are ill-served by omissions of human deaths in environmental assessments. The omission is particularly inappropriate in view of the fact that state-of-the-art accident consequence computer modeling could easily accommodate the disclosure.

DES-4(A)(1)

40. LEA's Contention DES-4(A)(1) states:

> 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 eg., BEIR I-III).

Genetic Effects

41. While the Staff admits that various types of genetic effects are among the health risks posed by severe reactor accidents, the main mention of the risk of genetic effects caused by severe accidents at Limerick in the FES consists of two sentences at p. 5-67:

> In addition, approximately 220 genetic changes per million person-rems would be projected over succeeding generations by models suggested in the BEIR III report. This also compares well with the value of about 260 per million person-rems used by the NRC staff, which was computed as the sum of the risk of specific genetic defects and the risk of defects with complex etiology.

42. The Staff's testimony proved to be considerably more informative than the FES. The Staff witnesses testified that it calculated an estimated risk of 2.6 x 10-1 cases of genetic effects per reactor year, and that a CCDF for genetic effects could be obtained by multiplying the consequences magnitude on the X-axis of FES Figure 5.4(c) for total person-rem by a

factor of 2.6 x 10-4. (Hulman, et. al., ff. Tr. 11,148, p. 5-6).

43. On a per reactor-year basis, the risk of genetic effects is higher than any other health effect analyzed in the FES (Acharya, Tr. 11,211-212).

44. However, the Staff neither created nor presented any CCDF curve for the risk of genetic effects, as it did for other lower risk health effects, and the per reactor year risk value appeared nowhere in the FES (Id.). The Staff instead relied upon the reader to perform his own calculations to arrive at a risk value, (Id.) but even failed to provide any instructions on how to do so. (Acharya, Tr. 11,215).

45. The Staff's risk estimate for genetic effects may be low by a factor of 4 to 5 (FES p. 5-43). If raised by a factor of 4-5, the risk estimate would still be consistent with the range of values used by the Staff as a basis for its own estimate. (Acharya, Tr. 11,213).

46. Even if one constructed a CCDF curve in accordance with the instructions given by the Staff in its testimony, (which, we repeat, were not available to a reader of the FES, who did not have the Staff's testimony), such a construction would not tell you that the curve may be 4 to 5 times too low. (Hulman, Tr. 11,215 ; Levine, Tr. 11,315).

47. Although it is customary for CCDFs to reflect the uncertainty of the estimates upon which the CCDF was constructed by showing an upper bound and a lower bound curve (Acharya, Tr. 11,216), constructing a single curve

according to the information in the testimony and the FES would obviously not reflect the uncertainty.

48. The FES estimates for genetic effects were those integrated over all succeeding generations, which Staff witness Branagan testified were limited to five generations. (Branagan, Tr. 11,246).

49. However, Dr. Branagan also testified that for genetic effects that are more irregularly inherited than those caused by dominant mutations, the mean persistence would be 10 generations. (Branagan, Tr. 11,244-11,247).

50. While Staff relied upon FES Table K.1 as the basis for asserting that the FES permits a reader to determine the health effects associated with a particular release category, Table K.1 fails to include genetic effects. (Hulman, Tr. 11,284-5; 11,296-7).[1/]

51. For all the above reasons, we find that the FES did not adequately disclose even the bare numbers associated with the risk of genetic effects of severe accidents at Limerick. We also find that the FES's bare reference to genetic "changes" does not adequately convey the impact of this risk. Nowhere is a genetic "change" explained, defined, or described in the FES.

1/ Indeed, Table k.1 omits all the other health effects alleged in LEA's Contention DES 4(A), including non-fatal cancers, spontaneous abortions, and sterility.

The word "change" is apparently a carefully chosen, neutral term which does not suggest the true nature of the health risks involved. Indeed, in this context, the word "change" is essentially meaningless.

52. This is so particularly in view of the Staff's testimony concerning the catastrophic nature of some of the physical expressions in livebirths of these genetic "changes":

> By genetic effects estimates that were included in the value of 260 potential genetic defects per million person-rem, that included all disorders that could cause some serious handicap during the lifetime of an individual. Examples of genetic effects that are included in the risk estimator are diseases and abnormalities caused by a dominant mutation. For example, extra fingers, extra toes. Diseases caused by recessive mutations. For example, sickle cell anemia. Abnormalities caused by chromosomal aberration. For example, Downs syndrome, congenital anomalies, anemia, diabetes, and schizophrenia.
>
> These are examples of the types of things that are included. (Branagan, Tr. 11,255).

53. We find that the FES's failure to describe the physical manifestation of these "genetic changes" in terms of the disorders and diseases which they cause is inconsistent with NEPA's mandate of full disclosure.

Non-Fatal Cancers

54. With respect to non-fatal cancers, the Staff testimony stated that according to the WASH-1400 health effects model, 10% of cancerous thyroid nodules may be fatal, and 90% non-fatal. (Hulman, et. al., ff. Tr. 11, 148, p. 7).

55. Thus the number of non-fatal thyroid nodules can be derived by sealing the consequences axes of the thyroid cancer fatality CCDF in Figure 5.4(d) by a factor of nine. (Id.).

56. However, a reader of the FES could not do this without either reading the Staff's testimony or relying upon information sources outside of the FES. While responding directly to this point, Staff witness Hulman stated that a reader could derive this estimate of non-fatal thyroid nodules by using the FES, p. 5-73, first paragraph, last sentence, (Hulman, Tr. 11,248), the witness' testimony is plainly incorrect on its face.

57. FES p. 5-73, first paragraph, last sentence, states in full:

> The health risk to an individual receiving a thyroid exposure (of 300 rems) is the potential appearance of benign or malignant thyroid nodules in about 1 out of 10 cases, and the development of a fatal cancer in about 4 out of 100 cases.

58. Yet it is plain that this sentence may provide information to the

reader of the relative health risk of a given radiation dose to the thyroid, it does not provide the reader with the 9-1 ratio of non-fatal cancerous thyroid nodules to fatal cancerous nodules. It states only that for a given exposure, one out of 10 persons receiving such an exposure will suffer either an benign or malignant thyroid nodule, and out of 1000 persons receiving such a dose 4 will receive a fatal cancer. Indeed, it is impossible to derive the ratio mathematically from the information given because the information fails to provide a crucial factor - how many malignant, or cancerous (as opposed to benign) thyroid nodules are expected in the exposed population.

59. We find that a reader's inability to determine from the information in the FES the total number of cancers without a fatal outcome is a significant defect, because (1) non-fatal cancers are serious human health effects which must be fully disclosed;[1/] and (2) expressed in terms of a per reactor year risk, the risk posed by the Limerick facility of non-fatal cancers is greater than any other health effect analyzed by the Staff in the FES. (Hulman, Tr. 11,248).

60. We conclude also that the risk of benign thyroid nodules and hypothyroidism are sufficiently serious to warrant their full disclosure. Such

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1/ We do not find that fatality is a necessary outcome of health effects to require their full disclosure in an environmental statement. Indeed, Staff itself at least partially disclosed radiation injuries and genetic effects in the FES.

cases require medical treatment in the form of hormone administration, and "for many individuals, the thyroid gland could be removed - the persons will have undergone the removal of the thyroid gland." (Acharya, Tr. 11, 262). The Staff testimony states that the risk of benign thyroid nodules would be about 15 times higher than that of thyroid cancer fatality, and that the risk of hypothyroidism would be about the same order of magnitude as the risk of thyroid nodules. (Hulman, et. al., ff. Tr. 11,148, p. 12). Expressed in terms of a per-reactor year risk basis, both these risks would be higher than the other health effects risks analyzed in the FES. (Cf. Hulman, Tr. 11,248 and Tr. 11,261-62).

61. The risk of benign thyroid nodules and hypothyroidism was nowhere disclosed in the FES. (Acharya, Hulman, Tr. 11,250).

62. While the FES assumes that with respect to radiation induced cancer in children after fetal or embryonic irradiation the risk period ends at age 10 (Acharya, Tr. 11,252), other cancer induction sources place the risk period as the entire lifetime or 30 years, depending on the cancer. (Richter, Tr. 11,250).

Spontaneous Abortions

63. While the Staff agreed that spontaneous abortions in women in the population exposed to radiation is a risk of severe accidents at Limerick, no such risk was disclosed in the FES. (Hulman, Acharya, Tr. 11,252).

64. The Staff's testimony attempts to mitigate the effect of this ommission by asserting that the societal impact is difficult to assess because the majority of such spontaneous abortions would be in the first trimester, and of those, they would "likely" occur so early as to be undetectible. (Hulman, et. al., ff. Tr. 11,148 at 9).

65. However, the Staff witness indicated that the "majority" could be anything over 50% - thus as many as 49% of such abortions may not be within the first trimester. Indeed, not all spontaneous abortions occurring within the first trimester would be undetectible ("likely to occur so early in pregnancies as to be undetectible").

66. For those pregnancies which are detected, the women either abort or carry a dead fetus. (Hulman, Tr. 11,256-7). The risk of spontaneous abortion is higher than any health effect risk the FES considered, with the sole exception of genetic effects (Acharya, Tr. 11,258). The NRC Staff has quite obviously ignored the impact of the risk of spontaneous abortion.

Sterility

67. The same analysis is also appropriate with respect to sterility. While Staff admits that sterility is a health risk of severe accidents at Limerick, the FES makes no disclosure of such an impact. According to BEIR III, depending on the dose, the sterility in males can last up to a year. (Branagan, Tr. 11,259 - 11,261).

68. While Staff's testimony deprecates the significance of this sterility by asserting that "because most individuals only conceive children intermittently . . . the vast majority of these cases would not be aware of their temporary sterility" we find such a consideration to be utterly irrelevant in terms of NEPA's requirement of full disclosure of health impacts.

69. The Staff estimated the societal risk of such sterility to be 1.6 x 10-1 per reactor year and 3 x 10-2 per reactor year for males and females, respectively (Hulman, et. al., ff. Tr. 11,148, p. 11). This societal risk, like that of non-fatal cancers, thyroid nodules, and spontaneous abortions, which were also ommitted by the Staff's FES, is larger than any health risk disclosed by the FES, except for genetic effects which we have already found to be incompletely disclosed. (Acharya, Tr. 11,248, 11,261).

70. Finally, one further health impact of radiation exposures caused by a severe accident at Limerick was impairment of development of children due to in-utero exposure of embryos and fetuses, including microcephaly, mental retardation, growth retardation, blindness, cleft palate, and spina bifida. (Tr. 11,264-5; Acharya, Tr. 11,267; Goldman, Tr. 11,317). These health impacts were not explicitly considered by the Staff or disclosed in the FES. (Acharya, Tr. 11,267-8).

71. Indeed, while Staff attempted to show that the FES' estimates of cases of early "radiation injury" provides an "envelope, the bounding type of

estimates", (Acharya, Tr. 11,267) we find the FES estimates of early radiation injury to be irrelevant to LEA's concern about developmental defects in children.

72. The WASH-1400 consequences model for estimates of early radiation injury was based upon radiation doses to three principal "organs - the whole body, the lungs, and the GI tract." The dose threshold for the whole body was 55 rems, the "injury" being abdominal vomiting. The dose threshold for occurrence of that effect in 100% of the population receiving the dose is 400 rems. (Acharya, Tr. 11,268-9).

73. The Staff testified that the FES consequence model was a modification of the WASH-1400 model and substituted a "conservative" dose whole body threshold of 200 rems to the total bone marrow, for a 100% occurrence rate in the population so exposed. (Acharya, Tr. 11,269).

74. However, Staff witness Branagan admitted that the developmental defects in children to which LEA had reference are associated with doses as low as 10 rems to the fetus and embryo. (Branagan, Tr. 11,269).

75. The Staff testified that the risk to this age group might be a "small fraction" of the risk of impairment that was reported for all age groups (Acharya, Tr. 11,271), and that the relationship between the number of infants so injured and the rest of the population would be similar to the comparison of fatalities due to embryonic in utero exposure and fatalities estimated for all persons (5-10% of the fatalities) (Acharya, Tr. 11,270).

76. The Staff witness stated he did not know, and did not calculate, the impact on the population of infants receiving radiation doses (Acharya, Tr. 11,272); it is plain, however, that if the number of infants so injured can approach 5-10% of the total number of persons injured, a large portion of the infants born after a severe accident at Limerick would be developmentally impaired.

77. We find that the modification of the consequence model in reducing the "radiation injury" dose threshold to 200 rems (whole body) simply does not encompass the child developmental defects with which LEA is concerned. This is so particularly in view of the qualitative difference between the additional cases of radiation induced "abdominal vomiting" which the modification includes,a quite temporary phenomenon, and the mental retardation, microcephaly, blindness, spina bifida which were LEA's concern.

78. The FES nowhere discloses the existence of the risk of these types of health effects in children, and we find this omission to be inconsistent with NEPA.

The Staff's Rationale for Non-Disclosure of Health Effects

79. While the FES clearly omitted any discussion of many of the health effects mentioned by LEA, the Staff attempted to justify these omissions by stating that "Staff went through all the literature and decided to

select a representative sample of the more important effects. The FES reflects that judgment. (Hulman, Tr. 11,273).

80. Mr. Hulman attempted to clarify the "representativeness" of the effects disclosed by stating that the health effects were representative of the types of health impacts and other impacts. (Hulman, Tr. 11,296), but finally admitted that the health effects disclosed by the FES are not in any way representative of the health effects not disclosed, such as sterility, spontaneous abortions, or in utero injuries. (Hulman, Tr. 11,296).

81. The Staff witnesses also testified that the Staff "considered" (in some unspecified way) the health effects mentioned by LEA in its contention, but "did not report" them, and that the Staff distinguished (in some unspecified way) between "considering" the health effects and "reporting" them. (Hulman, Tr. 11,282).

82. Thus, the Staff's fundamental rationale is that it considered itself under no obligation to disclose in the FES any health effects except those it deemed to be "a representative sample of the more important effects". (Hulman, Tr. 11,273).

83. But Staff admitted that the health effects it disclosed were not representative of the health effects it did not disclose. The lack of

"importance" of the non-disclosed health effects is utterly belied by (1) the fact that the per reactor-year risk of each of the non-disclosed health effects[1/] is higher than all the health effects 'disclosed" excepting genetic effects, and (2) the Staff's own testimony:

> It's not that we didn't think that all of the health impacts that could be associated with reactor accidents were not important. My God, they were very important. [Emphasis supplied]. (Hulman, Tr. 11,274).

84. We conclude that the Staff had no reasoned basis for excluding from the FES the health effects it disclosed in its testimony, and that NEPA requires the disclosure of all of these admittedly "very important" health impacts.

DES 4-A(2), (3), (8)

85. LEA's contentions DES 4-A(2), (3), (8) read:

> The DES Supplement fails to adequately disclose or consider:
>
> (2) the total land area in which crops will be interdicted;
>
> (3) the total land area in which milk will be interdicted;
>
> (8) the population within the land areas to be interdicted.

1/ With the possible exception of child developmental impairment, which Staff did not separately calculate.

Milk and Crop Interdiction

86. In the event of a severe accident at Limerick, there is a probability that land will be so contaminated with radioactivity that crops growing on the land and milk from dairies with pasture land in the contaminated area, will be "interdicted", i.e., either destroyed or impounded until radioactive decay reduces the contamination to "acceptable" levels. (Acharya, et.al., Tr. 11, 376-394; Hulman, et.al. ff. Tr. 11,148, pp. 12-14).

87. The FES omitted any discussion of the extent of such interdiction - it considered such interdiction solely in economic terms by including the value of contaminated and condemned crops and milk in its calculation of offsite mitigation measures "costs" of severe accidents at Limerick. (FES, pp. 5-93, Table 5.11(h) (pp. 5-99); Acharya, Tr. 11,386).

88. The FES does not disclose the land area over which either crops or milk will be interdicted (Acharya, Tr. 11,386), although the CRAC codes used by Applicant and Staff provides calculations of these areas and their associated probabilities.

89. Because the contamination threshold requiring milk interdiction is relatively low, the per reactor year risk of 1,000 square meters of land requiring interdiction of milk (7.6^{-5}) is approximately equal to the per reactor year risk of 700 million square meters (or $\frac{7,000}{2.6}$ or 2,962 square miles) requiring such interdiction. (7.74-5). (Hulman, et.al., ff. Tr. 11,148, Table 2; Acharya, Tr. 11,387).

90. Similarly, the probabilities that 1,000 square meters of 10 million square meters of land will require crop interdiction are approximately equal. (7.6-5 and 5.42-5). (Hulman, Tr. 11,387).

91. If one multiplies these per reactor year risk estimates by 30 years of plant operation, and by 2 (number of units) to arrive at a conservative estimate of the total risk of milk and crop interdiction posed by the 2 unit facility over its operating life, we reach the following conclusions:

(1) For interdiction of 700,000,000 square meters (2,692 square miles) of milk interdiction, the probability is 7.74-5 x 30 x 2, or .0000774 x 30 x 2, or .004644. This is approximately 4 chances in a thousand, or one chance in 250.

(2) Similarly, with respect to the total probability of contamination of land requiring milk and crop interdiction, the probability of 10 million square meters of land requiring such interdiction is 5.42-5 x 30 x 2, or .0000542 x 30 x 2 or .003252, or about 3 chances in 1,000 or about 1 chance in 333.

92. We find these estimates and the impact of milk and crop interdiction land areas to be sufficiently significant to warrant their disclosure as impacts. Such disclosure is not made by merely calculating the economic value of the milk and crops and "burying" these numbers in the total offsite mitigation measures cost. How much it will cost to mitigate the consequences of such contamination does not adequately express the socio-economic and environmental impact of such widespread contamination.

Population Interdicted

93. Radioactive contamination of land by a severe accident at Limerick would also require interdiction of land areas by denial of human access to those areas. (Kaiser, Tr. 11,349).

94. The CRAC code identifies two areas for the denial of such access (the area from which people would be relocated for a period of time in excess of 30 years, and an area from which people would be relocated for varying periods of time, less than 30 years) calculates the populations within each, and the respective probabilities of such relocation magnitudes. (Hulman, et.al., ff. Tr. 11,148, p. 14).

95. For causes of accidents other than severe earthquakes, at an annual probability level of 3.19^{-6}, as many as 10,000 persons would be relocated for varying periods less than 30 years. At an annual probability level of 1.83^{-3}, as many as 1,000 persons would be relocated for varying periods less than 30 years (Hulman, et.al., ff. Tr. 11,148, Table 5).

96. As Staff testified, we may obtain the risk posed by facility operation over its entire operating life, by multiplying the per reactor year risk by 30 (approximately the expected operating life of the plant) and then multiplying this figure by 2 (to account for both units).

97. As a result, the probability that 1,000 persons would be relocated for periods up to 30 years as a result of severe accidents at the Limerick facility is therefore more than one chance in 10 ($1.83^{-3} \times 30 \times 2$).

98. Neither the probability of such relocation or the population which would be affected were disclosed in the FES.

99. The same analysis is true with respect to persons to be denied access for periods in excess of 30 years. The "annual probability" of up to 7,000 persons being denied such access is 1.19^{-5} (Hulman, Acharya, ff. Tr. 11,148 at Table 5). Thus, if we perform the same exercise the total probability is 1.19^{-5} x 30 x 2 or, .0000119 x 30 x2 = .000714, or roughly 7 chances out of 1,000 or about one chance in 142.

100. The Staff ignored both these probabilities and the affected populations in the FES, which we find to be a significant defect.

DES-4(A)(6)

101. LEA contended that the FES improperly failed to "adequately disclose or consider the quantification of the cost of medical treatment of health effects" as a result of severe accidents at Limerick.

102. The only FES reference concerning such costs is found at p. 5-102, at which the Staff states that:

> The Staff has also considered the health care costs resulting from hypothetical accidents in a generic model developed by the Pacific Northwest Laboratory (Nieves,1982). Based upon this generic model, the Staff concludes that such costs may be a fraction of the offsite costs evaluated here, but that the model is not sufficiently constituted for application to a specific reactor site.

103. The Staff testimony indicated that such costs were quantifiable, that the risk of incurring such costs were ascertainable on a per reactor-year risk basis, and in its testimony the Staff in fact provided such calculations and risk estimates. It admitted that the absolute costs are large (Richter, ff. Tr. 11,148, p. 5) but attempts to mitigate the relative significance of these large absolute costs by noting the low probability of the more severe radiation releases. (Id.)

104. We readily agree that the absolute costs are large - the total health costs for the various release categories initiated by causes other than moderate to severe earthquakes analyzed by the Staff range from a low of $1,037,550 to a high of $1,356,834,304. (Id., Table 1). For release categories initiated by severe earthquakes, the costs range from $1,519,146 to $2,381,202,176. (Id., Table 2).

105. The testimony presented in Tables 1-2 of Mr. Richter's testimony demonstrates that it was possible for the Staff to present in the FES a range of values of health costs and their associated probabilities.

106. However, despite this ability, Staff did not disclose such information. The basis for this total ommission was that "the data gave us an estimate of the likely magnitude of the cost rather than precise estimates of the cost for the Limerick area. Direct and indirect cost factors are based on national data and are not specific to the area surrounding Limerick". (Richter, ff. Tr. 11,148, p. 4).

107. However, Mr. Richter testified on cross-examination that the estimates in the testimony are the best available data, that the cost estimates are based on Limerick-specific accident probabilities, and that only the "cost factors" were not Limerick-specific. He also stated that in his opinion, Limerick area specific cost factors are not likely to be signficantly different than the national data (Richter, Tr. 11,400-401).

108. We are at a loss, therefore, to understand the basis for this omission. We also note that the cost estimates which were provided in the Staff's testimony omitted calculation of the health costs genetic effects despite the Staff's use of a generic model which accommodated such calculations. (Richter, Tr. 11,408). We find this omission to be a defect, because the Staff's testimony indicates that the per reactor year risk of genetic effects is higher than any other health effect considered by the Staff in the FES. (See our Finding of Fact No. 43). The health treatment cost of this highest risk was totally omitted.

109. We cannot accord material weight to Staff's explanation for these omissions because the testimony tends to contradict the assertions that the data was not "Limerick-specific" and because any relative imprecision does not justify such a total lack of disclosure under NEPA. (See our Conclusions of Law, No. 1-3).

DES-4(B)

110. LEA's contention DES-4(B) states:

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

111. While LEA indicated it would not specifically cross-examine on DES-4(B) as a separate entity (Tr. 11,400) it has proposed findings of fact thereon, based upon the entire record of the proceeding.

112. We incorporate herein the following findings of fact relevant to this contention also: 4, 5, 43-47, 50-52, 70-78, 101-109

113. As we indicated above, the FES' discussion of risk is limited to a "per-reactor year" risk value. The "CCDF format" portrays this risk by plotting the values for the probability of a consequence and the values of the magnitude of the consequence on X-Y axes.

114. This CCDF portrayal disguises two significant matters:: (1) the per-reactor year risk is only approximately 1/60 of the total risk posed for each consequence type portrayed, and (2) the risk may be 40 times higher than that due to the uncertainty estimated by the Staff.

115. We find that the use of "average" values also disguises these significant matters as they cannot possibly cover this additional information.

116. We also find that the CCDF curve and "average value" portrayls disguise the total impact of severe accidents because their very nature is to present only the bare numbers associated with the impacts. The witnesses admitted that they did not analyze the full socio-economic impact of reactor accident risks at Limerick. (Levine, Tr. 11,397-8). These "bare numbers" do not convey the full socio-economic risk, including social upheaval, caused by a severe accident at Limerick.

117. The FES fails to comply with NEPA for these reasons as well.[1/]

Conclusions of Law

1. 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 of disclose the significant health, socio-economic and cumulative consequences of the environmental impact of a proposed action. Baltimore Gas & Electric Co. et. el. v. Natural Resources Defense Council, US , (1983) slip. op. p. 9, 19.

1/ Curiously, neither Applicant or Staff pre-filed testimony addressed this aspect of the contention, although LEA specifically pointed it out in its response to Applicant's "First Set of Interrogatories and Request for Production of Documents to Limerick Ecology Action on Severe Accident Contention", Interrogatory No. 21.

2. 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 occurrance 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. Statement of Interim Policy on Nuclear Power Plant Accident Considerations under the National Environmental Policy Act. 45 Fed. Reg. 40101 (June 13, 1980).

3. The Staff's EIS fails to comply with these mandates in:

(a) its failure to adequately disclose 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;

(b) its failure to adequately consider and disclose the total land area in which crops and milk will be interdicted and the probabilities associated with such interdiction;

(c) its failure to adequately consider and disclose the population in the areas to be interdicted, and the probabilities associated with such population interdiction due to severe accidents at Limerick;

(d) its failure to adequately consider and disclose the economic cost of medical treatment of all health effects of severe accidents at Limerick, and the probabilities associated with such costs;

(e) its use of an inappropriate assumption of population relocation beyond the plume exposure EPZ in the calculation of health effects;

(f) its use of an inappropriate evacuation delay time in the emergency response model for calculating health effects;

(g) its failure to adequately account for the probability that a portion of the population will fail to take protective action, thus understating the risk of health effects of severe accidents.

(h) its failure to disclose the total risk of a two-unit facility over 30 years of operation.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

CERTIFICATE OF SERVICE

I hereby certify that copies of "LEA'S PROPOSED FINDINGS OF FACT AND CONCLUSIONS OF LAW ON LEA CONTENTIONS DES-1,2,3, AND 4" in the above captioned proceeding have been served on the following by deposit in the United States mail, first class, or as indicated by a double asterisk by hand-delivery, this 26th day of July 1984:

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