763

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

September 7, 1984

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

Glenn O. Bright
Dr. James H. Carpenter
James L. Kelley, Chairman

In the Matter of CAROLINA POWER AND LIGHT CO. et al. (Shearon Harris Nuclear Power Plant, Unit 1)	Docket 50-400 OL ASLBP No. 82-468-01 OL

Wells Eddleman's Response to Applicants'
8-09-84 Emergency Planning Interrogatories

RESPONSES TO GENERAL INTERROGATORIES

G-1(a) Paul Holmbeck, 1300 Green St., Durham NC 27705 provided analysis of the Harris offsite ERP on which contentions 215 and 224 are based. I do not specifically recall whether Holmbeck contributed any analysis to other contentions filed in 1984 which I composed. (b) see the contentions. (c) As stated in the contentions.

2(a) and (b) OBJECTION incorporating past objections to this interrogatory, 3-21-83 and following.

3(a) None identified so far. (b)(c) see (a).

4(a) NUREG-0654; Harris offsite emergency response plan; other documents cited in contentions; no other documents identified, though there may have been some. 10 CFR 50.47 and appendix E thereto.

5(a)(b) See specific responses.

6. See objection to 2 above. See specific responses

7(a)(b) None identified yet.

RESPONSES TO SPECIFIC INTERROGATORIES

#30-1(a) Not possible to give a fully complete list -- evaluation is continuing; however: Emergency response personnel, immobilized persons, the handicapped, the hospitalized, persons under the influence of drugs (including alcohol) which preclude their being able to drive, or preclude rational thinking, or keep them asleep

(b) numbers not yet determined; some groups, like those under the influence of drugs with effects mentioned in answer to (a) above may vary in numbers substantially with time.

(c) see (b)

(d) the number would have to be (with allowance for shelf life, damage (e.g. in an earthquake which could cause an accident at the Harris nuclear plant) and losses , sufficient to provide KI at levels adequate to block absorption of radioiodines during the longest possible Harris release (which would probably be above 10 hours (I'm enclosing a copy of the document on release times since its source is not identified) for all persons for whom evacuation may be infeasible or very difficult with an allowance for margin (reserves of KI doses).

addition to (a): persons trapped in wreckage (e.g. of houses or buildings after a tornado which could cause a nuclear accident (LOOP etc) at the Harris nuclear plant; Schoolchildren who could not be evacuated.

(e) the number of doses must obviously be enough to give everybody for whom " evacuation may be infeasible or very difficult". KI. A reserve margin is just common-sense prudence. Allowance for shelf life is necessary so that enough effective doses will be available. Allowance for damage is necessary to assure enough doses are usable. Allowance for losses is necessary to assure enough doses are delivered and administered. Analysis of the amount of each such allowance and margin is currently not complete.

30-2. You have asked what is necessary "to meet your concern". This would mean (1) providing sufficient KI doses as described in response to 30-1 above with adequate allowances and margins; (2) assuring enough personnel to deliver it (3) obtaining prior informed consent for the administration of KI from every identifiable person who may need it, especially the handicapped, immobilized persons, emergency response personnel, and any others whose evacuation may be infeasible or very difficult,that can be identified in advance, since KI has side effects and risks itself; (4) assuring the means of delivering the KI to each such person whose evacuation may be infeasible or very difficult, in a timely manner (i.e. before radio-iodines fromthe Harris plant can be getting to such persons); (5) storage of KI at places from which its prompt (i.e. "timely" as described in (4) above) delivery is assured. The basis for such changes is simply that without planning to take care of all these things, effective and timely administration of KI to those who cannot be evacuated, or for whom evacuation is very difficult, is not assured. Further info gathering will continue re this.

30-3. Cancellation or not operating the Harris plant would take care of the problem. Whether the changes listed in response to 30-2 above are made in the plank or not, they need to be made if the Harris nuclear plant is going to operate, to ensure that KI will be available when needed to those who will need it. Further info gathering re this will continue.

57-C-3-1(a) 1o CFR 50.47(a)(1),(b) (see fn 1, NUREG-0654),(b)(5), (b)(6), FEMA 43; there are certainly other "publications" which apply, but I can't get a complete list yet. GAO RCED 84-43 of 8/1/84, I believe applies.

(b) I don't have all the applicable documents, but as far as I now know, none makes explicit reference to time of day or year. Since accidents can happen any time, I infer that the requirement to assure that adequate protective measures will be taken applies as much at night as in the daytime, and (since your question misstates the contention, or appears to) as much when people are sleeping as when they are all awake.

(c) see (b) above.

57-C-3-2(a) Probably it would fail. You can't tell for sure without testing it. I know of no accounting for time for people to awaken, and no tests of the ability of the system to awaken sleeping people. You do not specify in your question what the "Alert and Notification System ~~xxxxxxxx~~ described in the offsite emergency planks" is. I presume you refer to (a) pp 34-36 of Part 1 of the plan (per the index) and/or the NUREG-0654 criterion E.6 on page H-2 of annex H thereto, or Annex C.

57-C-3-x2(b). The plan never really says anything about the capabilities of the system other than some bald assertions about the sirexns providing notification within 15 minutes (pt. 1 p.81; Annex c). No information about the ability of the sirens to wake people up is even referenced, though part 1 p.81 does mention that special information on how the public will be alerted between 12 midnight and 6 am should be made available(when the emergency starts at other hours, obviously) once emergency conditions exist. No description of such alerting is in the plan as far as I can see so far. The other primary notification is EBS radio and TV, but people who are asleep are not generally watching radio or TV ; police car notification, aircraft, etc. do not have their capabilities to awaken sleeping people addressed, nor are they able to mobilize within 15 minutes according to anything in the plan I've located so far. The amount of roads to be covered by xixexx vehicles is not addressed directly, but the plans allow speeds to be estimated, e.g. average of 30 mph for Wake county (pt. 5 pp 22-25) 37 mph average for Chatham County (hgigh variability in speeds required to complete routes in times assumed, 15 minutes, etc); average 42 miles per hourr in Harnett county, and 24 miles per hour in Lee county, vs. 15 mph for vehicles stopping every 1/4 mile to make announcements. (This assumption is at Pt. 2 p.2, pt. 3 p.20, pt. 4 p.19, pt. 5 p.20). 15 mph seems reasonable for an average speed for such work, due to the curving roads in the EPZ, need to accelerate and decelerate between stops, and need to make an announcement every 1/4 mile. Ability of bullhorns to wake people up is apparently not addressed in the plan -- there's no data, no reference, not even, so far as I have found, any bald statement that the bullhorns will be able to awaken sleeping people or how long it will take to get them awake. No information on the effectiveness(in waking people up), or delay time to get airborne for aircraft notification is in the plan so far as I can tell thus far. (ref. G. Kats, A Critique of the proposed emergency preparedness plan for the Shearon Harris Nuclear Power plant p.21 for vehicle speeds and assumptions). There doesn't seem to be anything in Section IV.D of Part 1 of the plan about how it would notify people who are sleeping.

Obviously, if the plan doesn't assure alerting within the times specified, for people who are asleep, then it will not work when they are asleep. This is not assurance that effective protective actions "can and will be taken" 50.47(a)(1), that notification provides "provisions ... for prompt communication ... to the public" because you can't communicate with a person who is asleep; no means are provided in the brochure about how sleeping people will be notified (50.47(b)(7), cf. Plan part 1 p.81; analysis continues as to other noncompliances. The basic one is that people sleeping have to be awakened before communication is possible, and without communication the plan cannot be activated in a timely manner as required by the applicable rules and regulations, in such a way that effective protective action can and will be taken.

(c) See (b) above; analysis continues.

(d) see (a)(b) and (c) above. "probably" is close enough to affirmative that I've just answered as if the answer were affirmative.

57-C-3-3. See 57-C-3-2(b) above.

57-C-3-4. Although less action is required when awakening persons and telling them to take shelter, there is still the delay of awakening, getting emergency information, and taking shelter. Sleepy people don't generally react as fast, may be confused or drowsy, and thus will be slower to act. Effective sheltering requires the building to beclosed tightly (even sealed, if possible) before the

radioactive plume gets there. Warning times for many serious accidents are estimated at 1.0 hours for PWRs (see reference enclosed for 30-1(d)) and there is no analysis in the plan that I have found, of how long it will take from warning, at a time when many emergency response personnel are also asleep (the "graveyard shift" will be awake only) to (1) get the notification system activated, and (2) wake people up and tell them to take shelter, and (3) assure they actually do this, and don't evacuate in a panic, as being awakened with news of a nuclear accident may reasonably produce some panicky reactions. Without some assurance that this can and will be done on a timely basis (and that means are available to prevent the plume from equalizing radiation levels inside and outside typical structures within 2 or 3 hours by ordinary air exchange with the outside, even with windows closed and heating/ventilating/air conditioning systems off (effective sheltering means some protection from radiation, compared to the protection afforded by evacuation), the plan is clearly inadequate. See also 57-C-3-2(b) above.

57-C-5(a) Possibly, for sirens, depending on the direction of the siren, which window(s) are open, and the location of the sleeping person(s). Sleeping next to an open window is fairly common among folks without air conditioning around here, in my experience, and some who are trying to reduce high electric bills bill turn air conditioners off and open windows on many summer nights, again from my experience as an energy consultant. However, this doesn't apply at all on winter nights, when most people will keep their windows closed.

(b) see (a)

57-C-3-6(a) Yes. (b) see 57-C-5-(a) above. Since it is usually hotter during the day, more people without air conditioning will keep their windows closed then; those with air conditioning will very likely keep their windows closed in the daytime, to keep the cooling inside and avoid even more outrageous electric bills.

57-C-3-8(a) For those who are asleep, yes. For others, possibly. It depends on the means used, and how close the people are to the nuclear plant.

(b) The means have to be sufficient to wake people up if they are asleep. They have to be awakened in time to take effective protective action or get help in taking it. (50.47 (a)(1) and (b), NUREG-0654 II.F. 3,4,5,6; 50.47(b)(5) The messages have to get to the public, and sleepers don't get the message. The actions have to be effective and in time. This can be elaborated a good bit, and analysis along those lines is continuing). For those not asleep, the ability to receive the messages and get EBS advice is necessary. Folks up fishing in the early morning, e.g. at 4 a.m., may very well not have radios. Therefore the aircraft or boat notification needs to provide the same messages to them that the EBS provides to those with radios or TVs.

57-C-3-9(a) There are several varieties of automatic phone-dialing equipment. Information is available from both manufacturers and suppliers of such equipment. I am checking my files for information concerning same. None has been located in writing so far. However, the two basic types I understand are available are sequential dialer types which simply dial every possible number in an exchange (e.g. 362-0000 thru 362-9999) in sequence, and multiple-dialers which can call a large number of numbers simultaneously and store (by computer memory) the busy numbers to be dialed again in the next cycle.

(b) Jesse Riley informed me that these are available from Southern Bell; since the breakup of AT&T, I don't know exactly who is marketing this equipment. More inquiry along these lines is needed & will happen when I have more time.
(c) I don't know. Further inquiry will occur when I have time. Right now I'm busy with the start of school and getting ready for the mismanagement and safety hearings.

57-C-3-10. A complete list of all changes required isn't available yet; however, see responses to 57-C-2,3, and 4 above. The plan needs to provide specific, provably effective means (e.g. tone warning radios, automatic phone dialing) for persons (including transients) within the EPZ to make sure they can be awakened in time to take effective protective action in the event of a nuclear accident at the Harris plant, including very rapidly developing accidents. At present, the plan does not appear to effectively address the problem of awakening people when an emergency begins during normal sleeping hours; it evidently only makes a passing reference to the need to inform the public of measures to alert them between midnight and 6am (the information and means do not appear to be specified) when an accident begins in non-sleeping hours (pt. 1 p.81). The plan needs to address awakening persons without telephones, especially in light of rapidly rising telephone rates which may reduce the number of persons who have telephones in their homes. Tone alert radios are one means to do that. As usual, the reason for the need is to be sure people are awake to receive information from EBS and/or take needed protective actions promptly (within NUREG-0654 guidelines) in the event of a nuclear accident, including rapidly developing accidents, at Harris. Further analysis re these matters will continue when I have more time.

57-C-3-11. Besides having the right stuff in the plan (see responses to 57-C-3-10 and referenced responses in it, above), it has to actually be done, be tested (somewhere, not necessarily here) and proved to work effectively within the times needed to alert people in the event of a nuclear accident within normal sleeping hours. What that means is that telephone notification (automatic), tone alert radios, and/or other effective means must be found, bought, installed, and properly tested, maintained and checked, and all this must be in place prior to the Harris nuclear plant's getting a full power license. Alternatively, scrapping the plant would take care of the problem, since if the plant doesn't operate, evacuation planning won't be needed from nuclear power accidents at the plant. Additional analysis on this question may be done when I get more time.

57-C-10-1(a) List incomplete now. NUREG-0654 (I presume you mean NRC and FEMA publications) is one.10 CFR 50.47(a)(1) requires adequate protective measures "can and will be taken in the event of a radiological emergency"; 10 CFR 50.47(b)(9) requires adequate methods, systems and equipment "for assessing and monitoring actual or potential offsite consequences of a radiological emergency condition" to be in use.

(b) Since the dose to people in shelter is one of the actual or potential consequences of a radiological emergency condition, without some evaluation of the protective value of sheltering for exposure to airborne radionuclides (through inhalation or "shine" or both) must be in place (in use, in the words of 10 CFR 50.47(b)(9)) lack of evaluation of PFs is inconsistent with this requirement. 10 CFR 50.47(a)(1) requires that adequate protective measures "can and will be taken"-- sheltering effectiveness (protection factor) has to be reasonably known before the adequacy of the protective action (sheltering) can be known. 50.47(b)(10) seems ambiguous about whether the protective

action guidelines have to be based on valid information, but dose assessment cannot properly be done without knowing the effect on dose that will result from sheltering (or evacuating) and comparing the two for the population of the EPZ or subzones therein to determine the effective protective action 50.47(a)(1) requires can and will be taken. NUREG-0654 ~~xxfxxxxxx~~(II.J.10.m,p.64) requires inclusion in the plan of "bases for the choice of recommended protective actions from the plume exposure pathway during emergency conditions. This shall include expected local protection afforded (fn 2 cites documents which "may be considered in determining protection afforded) in residential units or other shelter for direct and inhalation exposure..." That's about as clear a requirement as I can imagine, and the determination of "protection" in residential units or other shelter for direct and inhalation exposure isn't done, and obviously needs to be done to allow informed choice of protective actions. If sheltering effectiveness is overestimated, or underestimated, it may lead to the wrong actions being chosen for recommendation by the emergency ~~x~~ response authorities.

(c) see (b) above. I am reluctant to think that the emergency planners can't read or understand NUREG-0654 II.J.10.m even if they might interpret the other cited authorities differently. NUREG-0654 criteria are required to be met by 10 CFR 50.47(b) (see footnote to (b) before section (b)(1)). In an accident it will be too late to determine from scratch the expected protection afforded by all shelters, residential and other. Any sensible planner would have done the determination in advance, updating it as necessary when new information that would change the determination of ~~xhx~~ sheltering effectiveness comes along.

(d) N/A

57-C-10-2(a). An exhaustive list has not been compiled yet. However, the bases in the plan have to state the sheltering effectiveness which is to be used in choosing recommended protective actions. This has to include sheltering effectiveness for direct and inhalation exposure. Since people can't stop breathing during nuclear accidents (or if they did it wouldn't be effective protective action after a short time), the inhalation exposure must be determined over time, so that if exposure continues while people are sheltered, emergency response personnel can estimate when evacuation would result in less total dose than continued exposure in shelter. Since typical structures exchange air several times an hour (and air changes per hour are influenced by wind speed)with outside air, this needs to be considered in detail in determining sheltering effectiveness. Radiation exposure from nuclides outside a shelter continues as long as the nuclides are there and people are in it, so that dose needs to be considered over time. That is, sheltering effectiveness changes with time, as radionuclides infiltrate the shelter with air exchanged with the outside under the influence of wind, leaktightness of shelter, air handling equipment (e.g. can outside intake vents be closed? automatically? manually? how tightly? how fast?) etc. The sheltering effectiveness needs to be reasonably well known as it will develop over time, and that needs to be included in the bases for choice of protective actions. Otherwise, the choice will be based on inaccurate information, in violation of 10 CFR 50.47(a)(1) (effective protective action must be assured; "can and will be taken"). The plan itself need not contain all this analysis; just its results in useful, understandable form, provided the analysis is accurate and consistent.

(b) see (a). Basis is NUREG-0654 II.J.10.m, 50.47(a)(1), and the common sense requirement that the basis of choice of protective action should be accurate.

This
57-C-10-3(a) ~~&~~ lack of information indicates that the authors of the plan don't understand the requirements of NUREG-0654 II.J.10.m. According to interrogatory responses received to date, the emergency planners have some information on direct exposure sheltering effectiveness available in their files; little if any useful or accurate information on inhalation exposure sheltering effectiveness; and this information relates solely to buildings evaluated for use as fallout shelters in a nuclear war. It does not relate to homes or other typical structures, and I don't see any ~~&~~ schools in the material provided, though there may be some. The information on sheltering effectiveness of typical structures for direct radiation exposure is available in very crude form, i.e. just for brick and wood houses, no evaluation of house geometry, high-protection areas, or air infiltration appears to be in it. Whether this lack of information proves a lack of knowledge by the planners, I'm not certain; I have asked them to tell me what they know in interrogatories to them. The information provided is surely not sufficient to meet the requirements of II.J. 10.m, and would not be of much use in protective action decisionmaking unless the planners also know how many people will be in each shelter and its sheltering effectiveness and capacity (typical, for homes) and how the sheltering effectiveness varies with time.
(b) see (a) (c) see (a), N/a

57-C-10-4(a). The bases must be stated, not described, in the plan. A description is not adequate. Whether this requirement does require the state planners to document "the entirety of their knowledge of 'sheltering effectiveness' " in the plans would depend on how much they know. If they know more than what is required, they need only document what is required. If they know less than what is required, putting that in the plan will not meet the requirement. If they know exactly what is required, then putting in all they know will meet the requirement. See also end of response to 2(a) above. &(c) below

(b) I think this is a silly question, but see answer to (a) above.

(c) The contention is that the plan provides no useful information or analysis of sheltering effectiveness, has inadequate discussion of protective actions, fails to comply with NUREG-0654 II.J.10.m. Having the stuff in reference books to look up after an accident has started is silly, since that takes time and the reference books can (and ~~&~~ should) be consulted at leisure before the accident happens. The information for the Harris EPZ on sheltering effectiveness is the basis required by NUREG-0654 II.J.10.m. I know of no reference books containing information on direct and inhalation exposure sheltering effectiveness in the Harris EPZ, and none have been identified upon discovery yet. The basis information needs to be worked out in advance for the Harris EPZ and put into the plan. I don't think I have to tell you how to use the information, but since you asked, even though you should know, the objective is to minimize dose received by persons in the EPZ. If sheltering followed by withdrawal after a cloud of radioactive material has passed will result in less dose than evacuation or other action, sheltering would be a preferred action unless and until continuing sheltering seems likely to result in higher total dose. You can't make these sorts of determinations, or any decision on sheltering versus evacuation, without knowing the sheltering effectiveness. That's what the "lack of knowledge" part is about. Since the NUREG-0654 standard requires the bases to be in the plan, if they're not in there it's either lack of knowledge or dereliction of duty. The licensing board in this case rejected contentions that the planners were not adequately trained, so it would seem lack of knowledge is it.

57-C-10-5. If they have knowledge, they haven't put it in the plan where the rules say they have to put it. I infer they lack knowledge. See 4(c) above. They have also responded to interrogatories, and produced documents, which show that sheltering effectiveness information isn't there for inhalation exposure, highest protectio n factor areas haven't been identified, typical structures of homes in the Harris EPZ aren't identified, and so on. This is certainly a lack of knowledge of sheltering effectiveness; for the homes they haven't even begun what's needed (e.g. sampling structure types, locating the high PF areas, calculating PFs, measuring infiltration of air in typical structures at varying wind speeds, measuring infiltration of particulates in typical structures at varying wind speeds, etc) to determine sheltering effectiveness for typical homes, and for other structures in the Harris EPZ. See 57-C-2 responses above, 57-C-3 response above, 4(a) response above also.

57-C-10-6. The plan needs to discuss protective actions and their effectiveness in enough detail (and providing enough quantitative information, as well as qualitative information where quantitative information cannot be obtained) to provide useful guidance to emergency response personnel. A prime example is protection for inhalation. See e.g. contentions 227A and B and supporting documents filed 10 August 1984 in this proceeding. Accurate knowledge of the effectiveness of protective actions is required in order to assure that effective protective actions can and will be taken (10 CFR 50.47(a)(1). The plan needs to (1) document at least the major effective protective actions known to the emergency planners and quantitatively (if at all possible) detail the effectiveness of such actions specifically for the Harris EPZ, and (2) be accurate in that documentation; (3) other protective actions considered should be listed in the plan if possible, and they should be documented as to quantitative effectiveness. As used here, quantitative measures of effectiveness would refer to determinations of protection afforded for direct and for inhalation exposure. Another example would be taping up cracks around windows and doors, which would have to include some analysis of how long it takes to do it, and the radiation exposure incurred in doing it (if not finished by the time the plume of radioactivity arrives) versus the saving in exposure by doing it, especially if those who are saved from exposure are more radiosensitive (e.g. young children, pregnant women, the elderly, etc). All these things need to be figured out in advance, and updated as appropriate, so you don't have to figure them out during an accident. That's the basic purpose of planning anyway, and for nuclear accidents the planning should (and is required to) concentrate on reducing public exposure to radiation.

57-C-7. The information compiled for the plan must be accurate; the determinations of quantitative effectiveness must be made accurate; in order to be effective, the public has to be informed of some of these protective actions (e.g. which types of breathing protection and which methods of attachment of such protection are most effective; being advised to keep masking tape or duct tape to tape up houses --or car vents and doors and windows' edges during an evacuation, if needed) The public needs to be encouraged to take such measures, especially those which are cheap and easy to do.

57-C-13-1. The plan says people should go to the area of highest PF. The average person has no concept of where that is. While general guides for finding higher PFs could be given during an accident, it's clearly more effective to determine them before

the accident, when well-trained personnel can do the job and take their time doing it, as opposed to letting untrained people do it (with perhaps some expert advice) under time and stress pressure during an accident. By analogy, would it make sense to locate fire lanes during a major fire, or to have done it earlier? Would it make sense to lay out evacuation routes before evacuation is required, or have planners find them the day of the evacuation during an accident? It's not effective to wait til the last minute and let untrained people do it.

57-C-13-2(a). The basic criteria, effectiveness of protection for both direct and inhalation exposure, are those of NUREG-0654 II.J.10.m. Another obvious criterion is the capacity of the area. For ill, injured, or any other persons (e.g. nursing home residents) who require care, space to allow for the care and materials or devices needed to provide it, must be available. Determination of inhalation protection should include air infiltration patterns and rates, particularly at bed height for bedridden persons, or at floor level where people may be required to lie on the floor or sit on the floor. The shielding from direct exposure in high-PF areas has to be evaluated from all outside surfaces of the shelter building. The infiltration of particulates of sizes typical of radioactive releases needs to be determined; the effect of wind speed on infiltration of radioactive gases and particulates needs to be determined; the time after which interior air would be producing roughly the same exposure as outside air needs to be determined in advance for each high-PF area. All methodology for making these determinations needs to be as quantitative and accurate as it practically can. Equipment for measuring air infiltration rates is commercially available. Access to the high-PF are (ability to get people in and out of it in time to be of use) is also important as a criterion. Protection isn't any good unless people are in the protection. Since hospital and nursing home patients will take longer to move than many people will (e.g. thos. who have their own transport and are in vigorous good health), protection factor assessment is more important in case these people prove infeasible or very difficult to evacuate from the hospital(s) and/or nursing homes.
(b) see (a); further info will be put together when I have more time.

57-C-13-3(a) I don't know. The State doesn't seem to know either, nor do other emergency planners, according to discovery received so far.
(b) see (a).

57-C-13-4(a). Since knowledge of this PF is part of the determination of sheltering effectiveness for those hospitals and nursing homes, yes. NUREG-0654 II.j. 10.m. PFs for other areas of the hospitals and nursing homes should be generally known to guide emergency planners if and when patients can't be moved into the highest PF areas, or all of them can't be moved in (or won't fit). This is also basis for decisions on protective actions, and should be in the plan.
(b) see (a); (c) N/A

57-C-13-5 ~~I~~ See above responses, e.g. 4(a),2(a),1. There may be other changes required if it is not feasible to determine the highest PF areas or to move people into them.

57-C-13-6. Hospital and nursing home personnel should be made familiar with the highest PF areas, alternative high PF areas, and each hospital or nursing home should have its own plan or procedure for sheltering patients in high PF areas and providing for their needs there in the event of a nuclear accident at Harris. The determination of PFs needs to be made accurately, updated as necessary.

144 responses based on CP&L SHNPP Emergency Plan, Rev. 2 dated February 1984 and received by me March 10, 1984

144-1 The Harris plant, Table 7.2-1 of the above-cited report, uses columns headed "30-45 min" and "60-75 min" for the columns required in NUREG-0737 Supplment 1 Table 2 to be "30 min" and # "60 min" respectively. NUREG-0737 requires 3 additions in T&C .. in the 30 minute column aand CP&L only provides 2 (Repair and corrective actions). NUREG-0737 requires a radwaste operator in 60 minutes (same task area) but CP&L doesn't identify one at any time. The fire brigade and security are unspecified and if I omit them it's not saying they are correct. CP&L hasn't organized its table exactly as NUREG-0737 supplement 1 organizes Table 2, so there may be more deficiencies I haven't caught.
(b) Basis is direct comparison of Tables specified.
144-2 see 1(
144-3 see 1
144-4 Provide the required personnel in the required times. If you can't do it, the onsite plan should not be approved.
144-5. Provide adequate capability among the personnel at all times. The plan won't work if the personnel aren't capable of carrying it out, and this does not seem to be assessed. Seee.g. sections 5.2.1 and 5.2.2 of onsite plan,

154-1(a) It certainly describes a procedure, but as best I can tell, the plan does not include the procedures referenced in Annex E although Annex E of the onsite plan shows all those procedures as "implemented plan section 4.4.3". Section 4.4.3 of the plan, in turn, refers to Table 4.5.1 (once) and Annex B (twice) and gives no detailed procedures. Table 4.5.1 is the protective action guidelines (per dose, and it says it's from the (offsite) ERP, Figure 10). Annex B is all that's left. Section 4.4.3 refers to ERFIS computerized dose projections, but it also specifies that if radiation data is offscale, it's suspect or bad and assessment will have to wait for measurements. That's a prejudgment that would be disastrous if the readings really were offscale because of high radiation release. Moreover it appears to contradict Annex B which says that if release values are offscale certain assumptions will be used in the absence of data.
(b) see (a) the question is confusingly stated; answer not affirmative
(c) The procedures the operators will carry out, insofar as they are described in the plan, refer to Annex B, which has the sophisticated requirements for judgment as referred to in Contention 154.

154-2(a) Your interpretation (this question is not really a question; it's more of a request for admission) appears to be consistent with the plan provided you define procedure narrowly. However, it is clear from contention 154 that the "procedures" it refers to are those "given in Annex B" of the onsite plan. Annex B says, in its first line "When an emergency situation exists at a nuclear plant ..." and continues" the methods and equations used to estimate dose projections are based on the documents in the reference section." and describes how the estimates are made, referring to the references. I think Annex B does indeed describe procedures for making dose assessments; it does say health physics, not operators, should do it. It does not say that the operators would make estimates in any other way. The only other thing the plan refers to re this as far as I can see, is operators using the computer. Still, judgments would have to be made per Annex B, and the computer might not be working. (b) See 1541(a) & abov

154-3. Annex E does list such procedures. It doesn't tell anything about them but their titles and a reference to section 4.4.3 of the plan --- see 154-1(a) response above.

154-4. This contention isn't about "steps" as distinct from "judgments". If you look at Annex B, there are some difficult judgments to make, including the composition of the source term (by radionuclides), estimating the source term, what to do when the indicators are offscale (the 4.4.3 determination that offscale data is "bad" etc can be dangerous, see 154-1(a) response above), and do on. The list is basically in Annex B.

(b) Probably not. There is no indication the operators can measure the variables required, and no indication they are trained well enough to do the estimating that Annex B says health physics should do.

(c) See (b). You can't do it reliably without knowledge plus experience, and unless the operator involved is also a health physicist trained to deal with reactor releases and dose estimation therefrom, they can't be counted on to have that knowledge and experience. (Indeed, even if they do have all those qualifications, there's no guarantee they'll do it right; however, the plan itself only goes so far as referring to health physicists being needed to make the assessments -- Annex B) I have no information indicating CP&L has any operators who are health physicists with such training, or that they intend to get any.

154-5(a) As I understand it, one can become a nuclear plant operator if one has formal education to the extent of graduating from high school with a "C" average in math. I am not aware of information being made available as to the level of formal education Harris plant operators have. However, see (b) and (c) in response to 154-4 above. (b) see (a) Lack of formal education is not the statement of the contention, which says "unqualified".

154-6(a) Yes (b) see 154-4(b) and (c) responses and Annex B of the onsite plan, which is the basis for contention 154. See also the statement of basis for contention 154 itself.

(c) See 154-4(b) and (c) and basis for contention 154 as filed. I'm not sure why you keep putting "plant operators" in quotes, but it means the same thing as plant operators to me in context of this contention. I believe if such training was made available to operators (as 154-4(b) and (c) responses say they should have) CP&L would have said so in its training references, but section 5.2.2.3 of the onsite plan says only that Senior Control Operators and Shift Technical Advisors receive training "in the following areas" including "Dose projection procedures and protective action recommendations" i.e. not health physics. Assuming Applicants define "procedure" here as narrowly as their earlier questions indicate, then the procedures are simply cookbooks, not training in judgment, much less the health physics knowledge and experience I believe is required (and Annex B certainly indicates is required) for accurate or reasonable dose assessments and judgments in accident conditions.

154-7(a) comprehensive list would require more knowledge about the operators; see 154-6(a) answer above, 154-4(b) and (c) answer above, 154-1 and -2 responses also. (b) see referenced responses.

154-8. Either have a senior (experienced) health physicist trained in dose assessment on shift at all times, or do as 154-4(b)(c) suggest. See above for bases. 154-9. Upgrade operator TRAINING. See ANNEX B

154-9 continued
see 154-4(c) response.
and more reliable
213-1(a) Quicker, notification (has to be 15 minutes since the lake is closer to the plant (within 5 miles of it). NUREG-0654 Appendix 3 B.2.b requires "The initial notification system will assure direct coverage of essentially 100% of the population within 5 miles of the site." It further states (p.3-3, ibid.) The basis for any special requirements exceptions (e.g. for extended water areas with transient boats ...) must be documented." The offsite EPP does not appear to document any such exception for the Harris lake.

Prompt notification, NUREG-0654 says (App.3 B.1)"the system shall provide an alerting signal and notification by commercial broadcast (e.g. EBS) plus special systems ..." This means a message has to get to the people in boats on the Harris lake, including those without radios (either regular radios or NOAA weather-band radios). The only way to do this is with powerful loudspeakers, e.g. on aircraft (NUREG-0654 App. 3 C.4.d), and it is not evident from the plans that such aircraft could be mobilized in time to deliver the warnings to the Harris lake within 15 minutes. Alternatively, powerful loudspeakers covering the lake (and able to be heard in adverse weather, e.g. thru a thunderstorm) could automatically transmit the message, under direct control from the Harris plant or some other rapid means of activation, and repeat the message notification continuously to tell boaters and swimmers on the lake what to do. Or boat-mounted loudspeakers could be used, provided the boats can cover the lake thoroughly in 15 minutes. It would certainly be helpful if prepared leaflets describing the warning systems and appropriate actions were distributed at boat access to the Harris lake. I believe this would be required for transients from outside the EPZ who would not have a brochure or other written information regarding nuclear accident emergency procedures. (NUREG-0654 II.G.1 and 2 require information be made available to transients through means not limited to the brochure)

(b) See (a) above.

213-2(a). Enough boats to, under adverse weather and noise conditions, e.g. a sudden thunderstorm or rain beginning at or soon after the time notification is required, transmit an audible and understandable notification message (per NUREG-0654 App.3 B) to all points on the Harris lake. I have not calculated how many this is yet.

(b) See (a) above and 1-a above that.

213-3(a) Sufficient to assure that (allowing for people not showing up, by providing sufficient backup personnel and backups to the backups in case they don't show up) the types of notification required by NUREG-0654 and discussed in responses 1-a and 2-a above can be performed at any time of the day or year, within 15 minutes of activation of the alert and notification system.

I have not calculated this number of personnel. It depends, of course, on the system chosen. If none of these systems is used, it would appear a much larger number of persons would be required, to individually notify persons on the Harris lake by direct contact (the equivalent of the "knocking on doors" alternative for notification of persons on land).

(b) NUREG-0654 Appendix 3, pp 3-1 and 3-2, include requirements that the "plan shall include" The specific organizations or individuals, by title, who shall be responsible for notifying ... the affected population and the specific decision chains for rapid implementation of alert and notification systems" and

213-3(b) continued

"A capability for 24-hour per day alerting and notification". These capabilities cannot exist without having the required personnel, and won't work without them. If they won't work, they violated 10 CFR 50.47(a)(1) which requires assurance that appropriate protective actions can and will be taken.

213-4(a) Provisions for boat accidents on water should include the ability to assist victims of boating accidents and remove them from the lake (e.g. by boat or helicopter) whenever evacuation is required. The number of such boats or helicopters required depends on (1) the time in which helicopters with rescue personnel can reach the Harris lake after being alerted that they are needed there, including time to get rescue personnel to the helicopters, get pilots, be sure the helicopters are fueled, etc.; plus the time required for the boating accident(s) to be noticed and helicopters called for. (3) it also depends on the number of accidents, which would tend to depend on the number of boats allowed on the lake (see below). If boats are used for rescue, the boats with appropriate supplies would have to be maintained at the Harris lake (probably by CP&L), and rescue personnel appropriately trained would have to be available to go out in these boats in the event of boat accidents on the Harris lake during an emergency caused by a nuclear accident at the Harris nuclear plant. It would be desirable for the rescue boats to go with notification/alert boats so that accidents could be found and attended to more rapidly (the alert boat shouldn't be the rescue boat because if it does come on a boating accident and stops to conduct resuce operations, that interferes with alert/notification to other parts of the lake). Again the capability of such rescue boats and crews should be to assist the maximum number of boat accidents on the lake, and get the people involved in those accidents out within required evacuation times (or get them into shelter with appropriate medical care if sheltering is ordered instead).

For traffic accidents, e.g. in moving boats or evacuating in vehicles from the Harris lake, sufficient wreckers should be available to ensure that prompt evacuation is not impeded by such accidents either near the lake access, or on the evacuation route out of the EPZ. Special coverage should apply to the nearest State highway or road not controlled by CP&L, and should be available on a 24-hour basis with the ability to respond promptly to any such traffic accidents. Transport and/or shelter as appropriate, and medical care, for victims of such traffic accidents, should also be available in CP&L-controlled areas an off state or county roads.

The limitations of numbers of boats or boaters on the lake when the Harris reactor is critical or fuel handling is taking place, should be based on (1) the ability of all such boats to return their occupants to land for sheltering or evacuation promptly in the event of a nuclear accident at Harris, with due allowances for boats running out of fuel, having engine malfunctions, having accidents, propellers tangled in weeds or plants, fishing line, etc, and provision to get boaters with such problems off the lake -- i.e. the more rescue and assistance provisions there are, the more boats could be allowed on the lake; (2) the number of boat accidents possible as the number of boats on the lake increases; (3) the ability of all such boats to reach appropriate landing sites near the access area so that their occupants can reach vehicles for evacuation-- if there are two many boats, they will overcrowd this area and impeded evacuation.

213-4(a) continued

I have not calculated these limitations. They would also depend on the type of boats. Rowboats or canoes should not be permitted on the lake unless pickup for their occupants is provided on a dedicated basis (boat available at the lake at all times with sufficient capacity and speed to reach and remove all such occupants), since the occupants of these unpowered boats could not return to landing areas rapidly enough in the event of an accident.

I have not calculated the numbers yet -- these are the principles.

(b) 10 CFR 50.47(a)(1) requires assurance that appropriate protective actions can and will be taken. There is no protection from radioactive material out on the lake; even enclosed boats would provide little if any protection from airborne radioactivity. There is no shelter on the lake. Therefore, to take appropriate protective action effectively, the people have to be able to get off the lake promptly when alert/notification is declared. This has to be doable in worst-case conditions, and where it can't be done (e.g. rowing or canoeing too far from landing areas to return on human power in time) that sort of use of the lake has to be forbidden; where limits are required to assure that people can get off the lake in time, those limits should be imposed.

213-5(a) I don't know. (b) N/A

213-6(a) Persons who have boated to an area far from access and are swimming would have to return to their boats and then return to the access; water-skiers cannot come through heavy boat traffic safely and would have to return to boats or swim to reach the shore at access points; any swimmers move slower than most boats and would take longer to get outof the lake than a boat at the same distance from shore. (b) see (a)

213-7. Swimming should be forbidden except in designated areas close to access and behicle parking, so that all swimmers can get out of the lake promptly in an alert situation, and so that all swimmers can be alerted and notified promptly (the alerters will know where they are and/or automatic systems can be aimed at the swimming areas, e.g. loudspeakers); All of the requirements discussed in 213-4(a), 213-1(a), 213-2(a) and 213-3(a) and 6(a) above should be thoroughly covered. The changes must be made to assure that effective protective action can and will be taken by persons on or in the Harris Lake (10 CFR 50.47 (a)(1)).

213-8. The physical facilities (e.g. dedicated rescue boats, wreckers, available helicopters),rescue and alert personnel, pilots, wrecker operators and others must be available with sufficient backups to be sure that all required personnel are available during an actual nuclear accident at Harris to carry out the tasks covered in the above responses in a timely and effective manner. If the plan isn't backed up by people and equipment to carry it out, who are available when needed to carry it out, the plan is no good. 10 CFR 50.47(a)(1) requires that effective protective actions can and will be taken. This includes also providing shelter to persons on the lake, when sheltering is the indicated action. The shelter needs to be big enough to held all such persons, and provide useful protection from radiation. (same authority, 50.47(a)(1). There may be other specific authorities that supplement this basic requirement that effective actions for protection can and will be taken.

215-1 Paul Holmbeck's address is 1300 Green St. Durham NC 27705. His present occupation is

(b) See pp. 1-3 of Holmbeck's testimony in Byron; his preparation of that testimony; extensive familiarity with the requirements of NUREG-0654;and experience in analyszing emergency plans including those for the Byron and Harris plants. I don't know what other qualifications he has. I believe a person is an "expert" in law when she or he has greater knowledge of the subject than the average person (e.g. a juror) or the other fact-finder in the case, by reason of education, training or experience or a combination of these.

215-2. Do you mean Eddleman 215 as admitted or as revised? Applicants have moved th have the entire contention 215 thrown out. In general, any conservatism is not realistic (if it were realistic it wouldn't be a conservatism to use it) and varies from actual conditions likely to obtain in an evacuation. Thus any conservatism introduces error into the evacuation time estimates. As to the specific effects of conservatisms, see the contention as admitted and as revised.

215-3. Persons who are away from home (e.g. at work, shopping, on errands) and the time of the order to evacuate (or instructions to evacuate), especially those with their children or families with them who might have to go back into the EPZ to reach home; persons who are at work and leave from there to go home and then evacuate; persons without transportation; persons already outside the EPZ at the time of an evacuation, e.g. at school or work or shopping or on errands or at the doctor's or dentists or on recreation. Because there are many reasons why people may be away from home, the listing of reasons for being away from home above should not be viewed as exhaustive. People who for whatever reason aren't home, people who for whatever reason are outside the EPZ, etc are the operative groups in this answer.

215-4. I don't know what people will do in an accident exactly. I don't think anyone does know for sure. However, it would be reasonable for persons or families outside the EPZ to stay outside it if evacuation were ordered, unless they thought they had to go back inside it to see to families, relatives, friends, coworkers etc. In part, how many people would stay outside the EPZ would probably depend on the availability of telephone communications whereby they could contact family, relations, coworkers, friends etc inside the EPZ to assure themselves these folks were OK and could get out OK.

As for persons in the EPZ, the assumption that people without transportation evacuate from home and occupy an extra vehicle is not realistic for those who could fit into another evacuating vehicle and got a ride out that way.

As for persons away from home in the EPZ, subjective factors and the availability of communications would influence whether they went home or evacuated directly. One subjective factor is how seriously they take the instruction to evacuate; another is how seriously they take the danger of the accident; another is the location of the plume; another is whether the plume is already escaping or not; another is whether the location of the plume is known. Communication to relatives at home or at work (to arrange evacuation, or just let them know "We're leaving from where we are and will meet you ...(place)"), if effective, could lead to fewer people going home. Unavailability of such communications (e.g. telephones, or the phone system overloading) could lead to relatively more folks going home, but still probably not 100% since for some no one would be home to get.

(b) see (a). Further basis info research will go on later.

215-5. One obvious such situation is when one vehicle is outside the EPZ; another is large families; another is people with one car at home and one at work (or who have a vehicle available at home, e.g. a pickup or other truck, etc, which can be used for evacuation); another and very obvious one is people who have 2 vehicles and 2 drivers but don't want their vehicles contaminated by being left in the EPZ and would therefore take both vehicles out. See responses to 215-2,3, and 4(a) above. People do things based on their own judgment.

215-6. I don't know. Analysis would have to have the names or addresses of all the drivers to get a reasonably meaningful answer, and since not all people in the same household necessarily use the same surname, addresses would have to be checked too.

215-7. I don't know. It depends on their membership in groups identified above. The only reliable way I know to get an answer would be to survey them and ask them about various situations such as discussed in response to 215-2,3,4(a) above.
(or ETEs)

215-8. There is nothing in the plan indicating that the persons in households without vehicles have been surveyed (as I recall) nor that their neighbors have, nor that the locations of their nearest neighbors have been determined, nor that the capacities of those neighbors' cars or other vehicles have been determinated to be sufficient to carry the neighbors plus those from households without vehicles, nor that the neighbors will give them rides out (nor that the neighbors will be there to give them rides out), and not anything I remember about the number of drivers and extra vehicles being available or assured from those neighbors to make one extra vehicle per household without transportation.
The assumption appears to be exactly that, an assumption, and its basis is not clear. Its basis, if any, should be documented and shown to be either accurate, or inaccurate (revising the ETEs to correct inaccura

215-9. I don't know. Worse, I think you don't know either. This would have to be determined through a survey of those households and their neighbors. You allege there are only a few hundred of them (based on vehicle registration and/or census) so a survey is feasible.

215-10. The ETEs need to be computed in an accurate manner without using the conservatism, in each case. Accurate or realistic information rather than the conservatisms should be used in each case.

224-1. NUREG-0654 Appendix 4 requires (I.B) that all assumptions used in the (ETE) analysis shall be provided. IV.A. of the same appendix says "Adverse conditions would depend on the characteristics of a specific site and could include flooding, snow, ice, fog or rain. The adverse weather frequency used in this analysis shall be identified and shall be severe enough to define the sensitivity of the analysis to the selected events. These conditions will affect both travel times and capacity. More than one adverse condition may need to be considered." it goes on to say that a "northern" site with a high tourist population in summer would have to consider rain, flooding or fog as the (summer) adverse condition along with snow with winter population estimates. Nothing in NUREG-0654 excludes southern sites with reacreational populations in the summer and snow or ice in the winter from this requirement. NUREG-0654 continues "The text accompanying the table shall indicate the critical assumptions which underlie the time estimates ... The relative significance of alternative assumptions shall be addressed, especially with regard to time dependent traffic loading of the segments of the evacuation roadway network."

224-1 continued

I understand this to mean that not just the weather frequency itself, but the types of adverse weather (and all their frequencies) that can be adverse conditions for evacuating the Harris EPZ need to be identified and established to be "severe enough to define the sensitivity of the analysis to the selected (adverse) events". The text is required to explain the relative significance of alternative assumptions .... especially with regard to time dependent traffic loading of the segments of the evacuation roadway network." This clearly includes the relative significance of adverse weather conditions (not only those used, but alternative assumptions) since they "will affect both travel times and capacity", which of course affect the loadings and timing of traffic loadings on the segments of the evacuation network.

224-2. You could read it. Or you could read answer 224-1 above. See also p.4-10 of 0654 Appendix 4 (for facilties) weather must be considered

224-3(a) Because if the adverse weather isn't the real adverse weather encountered at the time of the evacuation, the time estimates aren't of any use. Also, NUREG-0654 requires the adverse weather frequencies and the effects of alternative assumptions (including weather) to be included in the ETES. I presume this is so these effects will be known to the planners. Also, of course, weather with low frequencies (e.g. tornados, hurricanes, extreme icing, rapid rains, floods, snow, ice, etc) would have to be considered among the alternative assumptions for a site like the Harris EPZ where all such things can occur (see 0654 App 4 IV A "Adverse conditions would depend on the characteristics of a specific site"). I understand that this information is in there so that in the event of an emergency under adverse weather conditions, the effect of those weather conditions is known to the emergency response personnel so they can use the information to decide what protective action(s) may be appropriate. Obviously, actions based on inaccurate information re adverse weather would not be accurately determined to be the best actions. The actions without such information are based on unreliable information because the adverse weather frequencies aren't used (both directly and as alternative assumptions) as NUREG-0654 requires.

(b) See cites in (a) andin 224-1 response(s) above.

224-4. The plan's ETE study must be brought into full compliance with both the letter and the intent (as described in answers 224-1,224-3(a) above, and otherwise) of NUREG-0654 as regards the use of adverse weather frequencies identified in the plan, and putting those frequencies (both as adverse weather conditions and as alternative assumptions) into the plan. All of the adverse weather possibilities for the Harris site (as shown in answers above or in the ER or FSAR re meteorology) should be considered as alternative assumptions in the ETEs.

PRODUCTION OF DOCUMENTS

Within 30 days of these responses, above-referenced documents (except NRC documents, per agreement) will be made available for inspection and copying at a mutually agreeable time and place by contact with Wells Eddleman.

I affirm the above answers are true to the best of my present knowledge and belief. Wells Eddleman

Wells Eddleman 3 September 1984

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the matter of CAROLINA POWER & LIGHT CO. Et al.) Docket 50-400
Shearon Harris Nuclear Power Plant, Unit 1) O.L.

CERTIFICATEOF SERVICE

I hereby certify that copies of WE Responses to Applicants' August 9, 1984 Interrogatories on Emergency PIanning

HAVE been served this 7 day of September 1984, by deposit in the US Mail, first-class postage prepaid, upon all parties whose names are listed below, except those whose names are marked with an asterisk, for whom service was accomplished by hand

* Judges James Kelley, Glenn Bright and James Carpenter (1 copy each)
Atomic Safety and Licensing Board
US Nuclear Regulatory Commission
Washington DC 20555

*George F. Trowbridge (attorney for Applicants)
Shaw, Pittman, Potts & Trowbridge
1800 M St. NW
Washington, DC 20036

Ruthanne G. Miller
ASLB Panel
USNRC Washington DC 2055 5

*Office of the Executive Legal Director
Attn Dockets 50-400/401 O.L.
USNRC
Washington DC 20555

Spence W. Perry
FEMA Room 840
500 C St. SW
Washington DC 20740

*Dan Read
CHANGE/ELP
5707 Waycross
Raleigh, NC 27606

Docketing and Service Section (3x)
Attn Dockets 50-400/401 O.L.
Office of the Secretary
USNRC
Washington DC 20555

Dr. Linda W. Little
Governor's Waste Mgt. Bd.
513 Albemarle Bldg.
325 N. Salisbury St.
Raleigh, NC 27611

* John Runkle
CCNC
307 Granville Rd
Chapel Hill Nc 27514

Bradley W. Jones
USNRC Region II
101 Marietta St.
Atlanta GA 30303

* Travis Payne
Edelstein & Payne
Box 12607
Raleigh NC 27605

Robert Gruber
Exec. Director
Public Staff
Box 991
Raleigh NC 27602

Richard Wilson, M.D.
729 Hunter St.
Apex NC 27502

Certified by W. Wells Eddleman

TABLE VI 2-1 SUMMARY OF ACCIDENTS INVOLVING CORE

Release Category	Probability (reactor-yr^{-1})	Time of Release (hr)	Duration of Release (hr)	Warning Time for Evacuation (hr)	Elevation of Release (meters)	Energy Release (10^6 Btu/hr)	Fraction of Core Inventory Released[a]							
							Xe-Kr	Organic I[b]	I[b]	Cs-Rb	Te-Sb	Ba-Sr	Ru[c]	La[d]
PWR 1	9×10^{-7}[e]	2.5	0.5	1.0	25	20 and 520[e]	0.9	6×10^{-3}	0.7	0.4	0.4	0.05	0.0	3×10^{-3}
PWR 2	6×10^{-6}	2.5	0.5	1.0	0	170	0.9	7×10^{-3}	0.7	0.5	0.3	0.06	0.02	4×10^{-3}
PWR 3	4×10^{-6}	5.0	1.5	2.0	0	6	0.8	6×10^{-3}	0.2	0.2	0.3	0.02	0.03	3×10^{-3}
PWR 4	5×10^{-7}	2.0	3.0	2.0	0	1	0.6	3×10^{-3}	0.04	0.04	0.03	5×10^{-3}	3×10^{-3}	4×10^{-4}
PWR 5	7×10^{-7}	2.0	4.0	1.0	0	0.3	0.3	2×10^{-3}	0.03	9×10^{-3}	5×10^{-3}	1×10^{-3}	6×10^{-4}	7×10^{-5}
PWR 6	6×10^{-6}	12.0	10.0	1.0	0	N/A	0.3	3×10^{-3}	8×10^{-4}	8×10^{-4}	1×10^{-3}	9×10^{-5}	7×10^{-5}	1×10^{-5}
PWR 7	4×10^{-5}	10.0	10.0	1.0	0	N/A	6×10^{-3}	2×10^{-5}	2×10^{-5}	1×10^{-5}	2×10^{-5}	1×10^{-6}	1×10^{-6}	2×10^{-7}
PWR 8	4×10^{-5}	0.5	0.5	N/A[f]	0	N/A	2×10^{-3}	5×10^{-6}	1×10^{-6}	5×10^{-6}	1×10^{-6}	1×10^{-8}	0	0
PWR 9	4×10^{-4}	0.5	0.5	N/A	0	N/A	3×10^{-6}	7×10^{-9}	1×10^{-7}	6×10^{-7}	1×10^{-9}	1×10^{-11}	0	0
BWR 1	1×10^{-6}	2.0	0.5	1.5	25	130	1.0	7×10^{-3}	0.60	0.60	0.70	0.05	0.5	5×10^{-3}
BWR 2	6×10^{-6}	30.0	3.0	2.0	0	30	1.0	7×10^{-3}	0.90	0.50	0.30	0.10	0.03	4×10^{-3}
BWR 3	3×10^{-6}	30.0	3.0	2.0	25	20	1.0	7×10^{-3}	0.10	0.10	0.30	0.01	0.03	4×10^{-3}
BWR 4	2×10^{-6}	5.0	3.0	2.0	25	N/A	0.8	7×10^{-6}	8×10^{-6}	5×10^{-3}	4×10^{-3}	6×10^{-6}	6×10^{-6}	1×10^{-6}
BWR 5	1×10^{-4}	3.0	5.0	N/A	130	N/A	5×10^{-6}	2×10^{-9}	6×10^{-11}	4×10^{-9}	8×10^{-12}	8×10^{-10}	0	0

(a) Background on the isotope groups and release mechanisms is presented in Appendix VII.
(b) Organic iodine is included with other iodines since it is a negligible contribution to consequences since release fraction is relatively small for all large release categories.
(c) Includes Ba, Sr, Co, Mo, Tc.
(d) Includes Y, La, Sr, Nb, Ce, Pr, Nd, Np, Pu, Am, Cm.
(e) Accident sequences within PWR 1 category have two distinct energy releases that affect consequences. PWR 1 category is subdivided into PWR 1A with a probability of 4×10^{-7} per reactor-year and 20×10^6 Btu/hr and PWR 1B with a probability of 5×10^{-7} per reactor-year and 520×10^6 Btu/hr.
(f) Not applicable.