

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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ATOMIC SAFETY AND LICENSING APPEAL BOARD

OFFICE OF SECRETARY
DOCKETING & SERVICE
BRANCH

Administrative Judges:

Gary J. Edles, Chairman
Dr. John H. Buck
Dr. Lawrence R. Quarles

SERVED OCT 25 1982

In the Matter of)	
)	
METROPOLITAN EDISON COMPANY,)	Docket No. 50-289 - SP
<u>ET AL.</u>)	
)	
(Three Mile Island Nuclear)	(Emergency Planning)
Station, Unit No. 1))	
)	

Mr. Robert E. Zahler, Washington, D.C. (with whom Messrs. George F. Trowbridge and Thomas A. Baxter, and Ms. Delissa A. Ridgway were on the brief), for Metropolitan Edison Co., et al., licensees.

Mr. Norman O. Aamodt, Coatsville, Pennsylvania (with whom Ms. Marjorie M. Aamodt was on the brief), and Dr. Bruce Molholt, Philadelphia, Pennsylvania, as representative of Mr. Norman O. Aamodt and Ms. Marjorie M. Aamodt, intervenor pro se.

Mr. Joseph R. Gray (with whom Messrs. James M. Cutchin, IV, and Jack R. Goldberg and Ms. Mary E. Wagner were on the brief) for the Nuclear Regulatory Commission staff.

DECISION

October 22, 1982

(ALAB-697)

This is the first of several decisions arising out of our appellate review in the Three Mile Island restart proceeding. A detailed procedural history of this case is set forth in the Licensing Board's first partial initial

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decision, and we need not repeat it here. ^{1/} In essence, after the accident that occurred at Unit 2 of the Three Mile Island nuclear facility on March 28, 1979, the Commission ordered Unit 1 of that facility to remain in a cold shutdown condition. (Unit 1 was, by coincidence, coming up to full power after a refueling outage and was immediately shut down by the licensee following the TMI-2 accident.) The Commission at that time indicated that, based on its preliminary review of the Unit 2 accident chronology, it lacked the necessary reasonable assurance that the Unit 1 facility could be operated without endangering the health and safety of the public. Thereafter, the Commission ordered that a hearing be held to determine whether Unit 1 should be permitted to resume operation and, if so, under what conditions. ^{2/} At issue are the licensee's management capability and technical resources, the adequacy of Unit 1 design and procedures, separation of Units 1 and 2, and

^{1/} See Metropolitan Edison Co. (Three Mile Island Nuclear Station, Unit 1), LBP-81-32, 14 NRC 381, 386-99 (1981) (procedural background and management issues, §§ 1-588, at §§ 1-36).

^{2/} See CLI-79-8, 10 NRC 141 (1979).

emergency preparedness. ^{3/} Hearings on these matters lasted nearly two years and produced a transcript of over 27,000 pages, as well as hundreds of exhibits. The Licensing Board has issued three separate partial initial decisions, plus companion orders dealing with environmental concerns and the monitoring of improvements found to be required; together, they comprise over 1,300 typewritten pages. Now before several Appeal Boards are various appeals from those decisions.

The Licensing Board issued its decision in parts to allow the maximum time for Commission review. ^{4/} On August 27, 1981, the Board issued its first partial initial decision on licensee's management competence but retained

^{3/} The operating license for Unit 1 (now suspended) lists GPU Nuclear Corporation, Metropolitan Edison Company, Jersey Central Power and Light Company, and Pennsylvania Electric Company as licensees. For convenience, we refer to them collectively as "the licensee" throughout this decision.

^{4/} See LBP-81-32, note 1, supra, 14 NRC at 399 (PID ¶36). The Commission originally intended to review the Licensing Board's decision itself but later directed that an Appeal Board be designated to hear initial appeals. See CLI-81-19, 14 NRC 304 (1981). Whether, or when, TMI-1 is permitted to restart, however, is before the Commission as part of its immediate effectiveness review. CLI-81-34, 14 NRC 1097 (1981). In an order served on October 6, 1982, the Commission announced its intent to rule by December 10 on whether to lift the immediate effectiveness of its order that TMI-1 remain in cold shutdown.

jurisdiction over management issues to inquire into allegations of cheating on examinations given to licensee's reactor operators. ^{5/} Then, on December 14, 1981, the Board issued its second partial initial decision concerning plant design and procedures, separation of units, and emergency planning. ^{6/} A separate decision dealing with environmental matters was issued a day later. ^{7/} The final partial initial decision on management capability, addressing the cheating inquiry, was issued on July 27, 1982. ^{8/}

Exceptions have been filed to each partial initial decision. Our review is divided among different Appeal Boards and has been segmented to correspond to the three major categories of issues in the proceeding: (1) management capability; (2) plant design, procedures, environment, and

^{5/} LBP-81-32, note 1, supra, 14 NRC at 420-403 (PID ¶¶ 44-45).

^{6/} LBP-81-59, 14 NRC 1211 (plant design, procedures, and separation, PID ¶¶ 589-1329; emergency planning, PID ¶¶ 1330-2028).

^{7/} LBP-81-60, 14 NRC 1724 (1981).

^{8/} LPB-82-56, 16 NRC ___ (PID ¶¶ 2029-2425).

separation; and (3) emergency planning. 9/ This decision concerns only those emergency planning issues raised on appeal by intervenors pro se, Norman and Marjorie Aamodt. The remaining emergency planning issues are addressed in a companion decision which is also being issued today. 10/ Matters of management competence (including the reopened proceeding on cheating), as well as plant design, procedures, environment, and separation, will be considered in subsequent decisions.

Emergency preparedness received considerable attention at the restart hearing. As described in the Licensing Board's decision, the record on emergency planning "consists of approximately seven thousand transcript pages, over a thousand pages of written direct testimony, and many

9/ Mr. Edles and Dr. Buck are assigned to review all three phases of the TMI restart proceeding. Participating with them are Ms. Kohl for the management phase, Dr. Gotchy for the technical issues and certain emergency planning and environmental matters, and Dr. Quarles for the Aamodts' emergency planning appeal.

10/ ALAB-698, 16 NRC ___ (1982). This division of emergency planning issues was a result of Dr. Gotchy's recusal from the Aamodt appeal. See our order of June 8, 1982 (unpublished) and Dr. Gotchy's June 8, 1982 memorandum to the parties.

thousands of pages of exhibits." ^{11/} The parties litigated over one hundred contentions encompassing many detailed aspects of emergency planning. During the course of the proceedings, the Commonwealth and the licensee continued to revise and improve their emergency plans, with the result that some contested matters were rendered moot by subsequent developments. Only a handful of issues remain for disposition on appeal, suggesting that, in most respects, the parties are essentially satisfied with the Licensing Board's decision.

Licensee and the Commonwealth of Pennsylvania each urge reversal of only one aspect of the Licensing Board's decision. Their appeals are considered in ALAB-698, note 10, supra. The Aamodts challenge the adequacy of the Board's decision in only four subject areas: information transmittal, public education, emergency plans for farmers, and the ingestion exposure pathway. For reasons explained below, we affirm the Licensing Board's disposition of those emergency planning issues raised by the Aamodts.

I. INFORMATION TRANSMITTAL

Commission regulations provide that licensees must establish procedures for notification of state and local

^{11/} LBP-81-59, note 6, supra, 14 NRC at 1455 (PID ¶1330).

emergency response organizations. 10 CFR 50.47(b)(5). They require that licensees have the capability to notify responsible state and local governmental agencies within fifteen minutes of declaration of an emergency. 10 CFR Part 50, Appendix E, Sec. IV.D.3. Provision must also be made for prompt communications among principal response organizations to emergency personnel. 10 CFR 50.47(b)(6).

According to the licensee's and the Commonwealth's emergency plans, when the licensee determines that an emergency of some kind exists at TMI-1, it immediately notifies the Nuclear Regulatory Commission, the Pennsylvania Emergency Management Agency (PEMA), and Dauphin County. PEMA, in turn, is responsible for notifying the Commonwealth's Bureau of Radiation Protection (BRP) as well as local jurisdictions other than Dauphin County. Rogan, et al., fol. Tr. 13,756, at 86-87; Chesnut, fol. Tr. 15,007, at 38; Licensee Ex. 30, §4.6.1, at 6-1. In the event of a "general emergency," which is the most serious of the four categories of emergency used by licensee and the Commonwealth, ^{12/} the licensee must immediately and directly

^{12/} The Commission's emergency planning regulations require the use of a "standard emergency classification and action level scheme" that includes the following emergency classes: (1) unusual event; (2) alert, (3) site area emergency, and (4) general emergency. 10 CFR 50.47(b)(4); 10 CFR Part 50, Appendix E, Section IV.C. (As Appendix E indicates, further guidance on the use of these classes is provided in NUREG-0654, FEMA-Rep-1, Rev. 1, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants" (November 1980).)

notify the NRC, PEMA, and all five local "risk counties."^{13/} Licensee's emergency plan calls for initial notification by telephone. Rogan, et al., fol. Tr. 13,756, at 62. In every case, the counties are apprised of the emergency class, the populace and geographical areas potentially affected, the type and magnitude of potential or actual radiological releases, and any protective action recommendations. Chesnut, fol. Tr. 15,007, at 31-32; Licensee Ex. 30 at 6-3. As the Licensing Board explained, the assignment of responsibility to PEMA to notify the BRP and most local authorities is normal operating procedure during non-nuclear

^{13/} Commission regulations designate two regions to be used for emergency planning purposes. One is the "plume exposure pathway emergency planning zone," or plume EPZ, which consists of an area with a radius of approximately 10 miles surrounding a nuclear power facility. The other is the "ingestion exposure pathway emergency planning zone," or ingestion EPZ, which is an area with a radius of approximately 50 miles surrounding the facility. 10 CFR 50.47(c)(2). As defined in the Commonwealth's emergency plan, "risk counties" are those that are located either partially or completely within the plume EPZ of a nuclear power facility. Commonwealth Ex. 2a, Annex E, Part III (Definitions), at 4 and Attachment 1 to Appendix 1, at p. 1-3. For the Three Mile Island reactors, those counties are Dauphin, York, Lancaster, Lebanon, and Cumberland.

as well as nuclear emergencies, has been successfully used on numerous occasions, and provides for a consistent chain of command. 14/

On appeal, the Aamodts argue that initial notification by telephone is inadequate and that available backup systems have not been proven reliable. 15/ They maintain that ordinary telephone circuits can be expected to be busy in the event of an accident. For this reason, they contend that dedicated lines should be required for notification of all five risk counties in the event of a general emergency. Aamodt Brief (March 9, 1982) at 1-2. Licensee and the NRC staff respond that dedicated lines are not necessary. They also argue that the Aamodts' assertions are based on a mischaracterization of the record. 16/

14/ 14 NRC at 1519.

15/ At the hearing, the Aamodts sought to establish that all risk counties should be notified of any radioactive releases and that dedicated telephone lines should be provided for that purpose. App. Tr. 6-12. The Aamodts' appeal concerns only the means of initial notification, not the content or recipients of the notification.

16/ Staff Brief (May 20, 1982) at 46-47; Licensee Reply Brief (May 10, 1982) at 134-35.

Contrary to the Aamodts' assertion, the record does not suggest that busy telephone lines will interfere with initial notification. ^{17/} More importantly, various backup communication systems are available and reliable. One alternate communication link in the event of telephone system failure is the National Warning System ("NAWAS"). NAWAS is a dedicated radio-telephone system designed to provide an immediate means of emergency information flow to PEMA. That system is tested daily. Another backup line is the Dauphin County cross-monitoring radio system, which is tested on a weekly basis. Rogan, et al., fol. Tr. 13,756, at 62; Tr. 14,060-61 (Giangi).

There is no evidence demonstrating that radio communication links are likely to be overloaded. Indeed, NAWAS is a dedicated system, making it available solely for its intended use. The Aamodts argue, however, that licensee "failed to demonstrate conclusively that radio channels

^{17/} The Aamodts rely on the testimony of licensee's witness Giangi to support their claim. In fact, Mr. Giangi neither acknowledged nor disputed Mr. Aamodt's assertion that the Dauphin County telephone lines would be "subject to busy signals which might occur if someone suspected beforehand that there was an accident going on." Tr. 14,123. Other testimony, however, was to the effect that in the early stages of an emergency, before notification of the public, use of commercial telephones should be adequate. Adler and Bath, fol. Tr. 18,975, at 6 (Testimony of Feb. 23, 1981); Curry, fol. Tr. 20,787, at 3.

could not be overloaded." Aamodt Brief at 1. Of course, licensee generally bears the ultimate burden of proof. See 10 CFR 2.732. But intervenors must give some basis for further inquiry. Cf. Pennsylvania Power and Light Co. (Susquehanna Steam Electric Station, Units 1 & 2), ALAB-613, 12 NRC 317, 340 (1980). In this case, the Aamodts presented no evidence that even suggests that the radio channels linking TMI to Dauphin County or Dauphin to the other counties could become jammed or that amateur radio operators would refuse to clear radio frequencies for emergency use. Accordingly, we have been given no reason to doubt the reliability of available backup systems. ^{18/}

Dedicated telephone lines would undoubtedly provide additional redundancy in communications capability. The initial notification of state and local officials, however, was apparently not a problem during the TMI-2 accident,

^{18/} The Aamodts also argue that rapid escalation of emergency action levels is possible and that licensee's "step-by-step approach at notification could result in failure to notify counties in the event of rapid escalation of action levels," citing the testimony of licensee's witness Tsaggaris. Aamodt Brief at 1. Although Mr. Tsaggaris acknowledged it was "conceivable" that a failure to notify the risk counties could occur should the declaration of a general emergency immediately follow initial notification of a site emergency, he nevertheless considered it "highly unlikely." Tr. 14,114-16. Moreover, this possibility would exist regardless of the presence of the dedicated telephone lines the Aamodts urge as a solution.

whatever other communications problems may have occurred.^{19/} Moreover, the record here indicates that it is not likely to be a problem should an accident occur at TMI-1 in the future. The Licensing Board concluded that licensee's provisions for initial notification and information transmittal are adequate, and we see no reason to disturb that determination.

II. PUBLIC EDUCATION

An important aspect of the Commission's emergency planning regulations is public education. Pursuant to 10 CFR 50.47(b)(7), licensees must periodically make information available to members of the public concerning how they will be notified and what their initial actions should be in an emergency. Provisions must be made for yearly dissemination of "basic emergency planning information, such as the methods and times required for public notification and the protective actions planned if an accident occurs, general information as to the nature and

^{19/} See Report of the President's Commission on the Accident at Three Mile Island (October 1979) at 120-122 (hereinafter referred to as the Kemeny Commission Report).

effects of radiation, and a listing of local broadcast stations that will be used for dissemination of information during an emergency." 10 CFR Part 50, Appendix E, Section IV.D.2.

At the hearing below, the Aamodts challenged the adequacy of the public education program and materials for informing TMI area residents about protective measures for nuclear power plant emergencies. The Licensing Board reviewed licensee's and the Commonwealth's provisions for informing the public and found "reasonable assurance that the proper information is currently supplied or should soon be provided to the general resident population in the vicinity of TMI-1." LBP-81-59, supra, 14 NRC at 1525 (PID §1537).

On appeal, the Aamodts dispute this finding, pressing essentially the same arguments that they advanced below. Their main concern is that the public education materials introduced into the record provide inadequate or misleading information about the hazards of radiation. Aamodt Brief at 3-4. They also claim that the assignment of responsibility for public education to several public agencies and the licensee is insufficient and that there are no guidelines or criteria for evaluating public education programs. Id. at 4, 5. Both licensee and the staff reject the Aamodts' arguments as lacking evidentiary support.

At oral argument, the licensee's counsel informed us that the Commonwealth's public information pamphlet, entitled "What You Should Know About Nuclear Radiation Incidents," ^{20/} had been revised and that he would provide us and the parties with copies. App. Tr. 83 (Zahler). As a result of the revision, the issue of the acceptability of the original pamphlet has been rendered moot.

At our invitation, the Aamodts reviewed the revised pamphlet and pronounced it a "positive response to many of [their] concerns with the earlier version." ^{21/} Indeed, they found the new brochure "essentially acceptable." Among other things, the analogy between radiation and sunlight contained in the original pamphlet that was the subject of so much argument below and in the briefs on appeal ^{22/} has been deleted. It would appear, therefore, that as a direct result of the Aamodts' efforts a substantially improved product has been produced..

^{20/} Commonwealth Ex. 3.

^{21/} Aamodt Comments Concerning New Information Provided by the Licensee and Staff in Response to the Appeal Board's Order, June 29, 1982 (August 6, 1982) at 1.

^{22/} Aamodt Brief at 2, 3, 4-5; Licensee Reply Brief at 137-38; Staff Reply Brief at 51-53.

This improvement in the pamphlet implicitly renders moot other criticisms which, although not directed specifically to the content of the pamphlet, nevertheless had, as their ultimate objective, the rejection of the old pamphlet and the preparation of a better one before restart. Certain of the Aamodts' concerns, however, continue to warrant some additional comment on our part. We address them briefly.

To begin with, the Aamodts assert that there are no criteria or guidelines for judging the adequacy of public information programs. We disagree. The Commission's emergency planning regulations contain general standards governing the types of emergency preparedness information to be distributed to the public. See 10 CFR 50.47(b)(7) and 10 CFR Part 50, Appendix E, Section IV.D.2. In addition, NUREG-0654 (note 12, supra) provides guidelines in the form of evaluation criteria for licensee, state, and local public education programs. See NUREG-0654 at 49-51. While we fully recognize that these guidelines require particularization in light of local conditions and circumstances, they provide, in our judgment, a reasonable framework for evaluating the sufficiency of educational material. ^{23/}

^{23/} The Aamodts rely on the testimony of licensee's witness Rogan in support of their argument that no criteria are available. Aamodt Brief at 4. But that witness did not testify that no criteria are available. Rather, Mr. Rogan stated that the NRC has established minimum guidelines and that he was unaware of any criteria for judging excellence in public education programs. Tr. 14,134-35 (Rogan).

Second, the Aamodts claim that the assignment of responsibility for public education is inadequate. Because responsibility is shared among licensee, the Commonwealth and the five risk counties, the Aamodts assert that "accountability rests nowhere." Aamodt Brief at 4. In their view, the failure to designate one entity in charge of the program constitutes inappropriate management. App. Tr. 17-18; Aamodt Brief at 4.

We disagree. The testimony of Mr. Rogan, on which the Aamodts rely, does acknowledge that responsibility for the public education program is shared rather than assigned to a single corporate or governmental entity. Tr. 14,131-32. The witness does not suggest, however, that no one is accountable for the overall program. To the contrary, responsibility for developing, implementing and maintaining discrete aspects of the public education program is assigned to designated personnel in the emergency plans of the licensee (Licensee Ex. 30, Appendix B), the Commonwealth (Commonwealth Ex. 2a, Appendix 15), and the risk counties (see generally PID ¶1546-1557 and Board Exs. 5-9). All plans have been reviewed and approved by the Licensing Board to ensure coordination. Importantly, the record does not suggest that shared responsibility is inherently defective or results in a lack of coordination. Rather, the recent revision and distribution of public information materials suggests that shared responsibility is, indeed, workable.

See p. 14, supra. As a consequence, we see no basis for upsetting the Licensing Board's determinations.

The Aamodts also argue that several specific instances of lack of candor remain in the new pamphlet to render it inadequate. Again, we must disagree. We doubt that unanimous agreement on every sentence of every brochure could ever be obtained. Such agreement is not required. 24/ Educational material must be judged in its entirety. We have examined the revised brochure and, in our view, it is fully adequate. 25/

24/ One item is illustrative in this regard. One sentence of the brochure reads: "Radiation doses of about 350,000 millirems in a short period can cause illness or even death if no medical care is received." The Aamodts argue that illness or death may occur whether or not medical care is received and urge excision of the phrase "if no medical care is received." In our view, readers will not be misled into believing that medical treatment will, in all circumstances, be successful; such a guarantee cannot be offered in any medical emergency. Retention of the phrase, however, explicitly highlights the need for medical attention and will, in our judgment, encourage individuals to seek such attention promptly.

25/ In addition, the Aamodts urge that the Licensing Board erred in denying the Commonwealth's request that distribution of public information brochures be withheld until all revisions desired by the Commonwealth are made. Aamodt Brief at 5. To the extent that the Aamodts would have us withhold distribution of public information materials so that even further changes can be included, we have determined that no further revision is required.

Finally, we share the Aamodts' sense of frustration that while the licensee, the Commonwealth, and the staff were vigorously defending the earlier version of the PEMA pamphlet in this proceeding, the Commonwealth was at work incorporating the Aamodts' suggestions into a revised brochure. It seems obvious that the Aamodts' criticisms have contributed significantly to a better public information pamphlet. Indeed, it appears that an opportunity for comment from the general public or efforts toward compromise might have eliminated the need to litigate this issue. We do not suggest that responsibility for the preparation of educational documents should be transferred or that members of the public should be given a veto right over particular documents. We nonetheless urge the licensee and the government agencies involved to develop ways of improving the revision process to include public comments and suggestions as additional changes are considered.

III. EMERGENCY PLANS FOR FARMERS

The Aamodts participated in the litigation of a number of contentions regarding the adequacy of the Commonwealth's emergency plan for farmers. The Licensing Board reviewed the Commonwealth's plan in detail and found it adequate to protect the public health and safety. LBP-81-59, supra, 14 NRC at 1671-80 (PID §§1919-1940). The Board noted, however, that better agricultural response plans should be devised. Id. at 1680 (PID §1940).

On appeal, the Aamodts argue that the Licensing Board erred in its findings, failing to appreciate the "central issue: the farmers' personal health and safety." Aamodt Brief at 1a. They maintain that the Board ignored evidence that the relationship between farmers and their livestock is so binding that farmers would remain with their animals during a general evacuation. They also claim that the Commonwealth's plan for the protection of livestock is unworkable and provides inadequate protection for farmers. Specifically, the Aamodts criticize the plan's recommendations concerning sheltering, limited care of livestock, and evacuation. In essence, they urge that, unless a better plan is devised for the protection and care of livestock, the health and safety of the farm population cannot be assured. Licensee and the staff reject that position. Although we agree with both the Licensing Board and the Aamodts that provisions for the care of livestock could be improved, we are fully convinced of the correctness of the Board's overall conclusion that the plan is adequate to protect the farmers. Accordingly, we affirm the Board's decision but make specific recommendations for improvement.

The Commission's emergency planning regulations are directed to the protection of the public health and safety. They require that a range of protective actions be developed for emergency workers and the public within the plume EPZ, and that protective actions appropriate to the locale be

developed for the ingestion EPZ. 10 CFR 50.47(b)(10). See note 13, supra. Protective actions in agricultural areas necessarily will involve some consideration of farm animals and crops in order to provide adequate protection for the food ingestion pathway, as required by 10 CFR 50.47(c)(2). Nevertheless, the basic regulatory approach is directed to protecting the health and safety of the public in general. There are no provisions specifically addressing any special needs of farmers that may arise because of their concern for their livestock. In short, the regulations do not require any protective measures for livestock unless they are necessary to protect the farmers.

In contrast, the Commonwealth's plan goes beyond the regulatory requirements and devotes considerable attention to the special needs of farmers. In addition to the 38-page Department of Agriculture Plan for Nuclear Power Generating Station Incidents, there is also a 22-page Annex to that Plan. See Commonwealth Ex. 2a, Appendix 7 and Annex B. The Plan provides general information on protective actions for farmers and contains detailed recommendations for food protection and the care of livestock.

In common with the general public, farmers are advised to remain indoors or evacuate the area, depending on the circumstances. They can also rely on dosimetry to monitor radiation dosage and can protect themselves to some extent through the use of potassium iodide. Commonwealth Ex. 2a,

Appendix 7, at 15-17; see also p. 26, infra. Concerning food protection, the plan indicates that, in some instances, dairy cattle can be sheltered and given stored feed. Surface contamination of fruits and vegetables can be removed by washing and peeling. There are also specific instructions with regard to the use of various kinds of packaged and/or stored foods. Contaminated milk and foodstuffs will be confiscated, if necessary. Commonwealth Ex. 2a, Appendix 7, at 20-30.

With respect to the sheltering of livestock, the Commonwealth plan advises farmers on the relative effectiveness of various types of commonly available shelters for livestock. Information is provided on means of augmenting those shelters, priorities for sheltering livestock, space and ventilation requirements, and means of providing protected feed and water. Specific instructions are given for various kinds of livestock. Commonwealth Ex. 2a, Appendix 7, Annex B.

In the event of a general emergency, farmers would have to choose one of three options depending on the circumstances: (1) evacuate the area and abandon their animals; (2) evacuate the area but return periodically to provide limited care for their animals; or (3) remain on the farm to care for their animals. The Aamodts criticize each of these options as unworkable.

Concerning the option of evacuation, the Aamodts argue that farmers would refuse to leave their animals. Their assertion overstates the record. The testimony of farmers, veterinarians, and a county agricultural agent suggests that, although farmers would plainly be reluctant to abandon their animals, they would not generally refuse to evacuate if circumstances were to make such action necessary. ^{26/} At oral argument, Mr. Aamodt candidly acknowledged that, in the event of a very serious emergency, farmers would have to abandon their animals. He also conceded that absolute protection of livestock need not be guaranteed as a condition of restart. See App. Tr. 28-31. Rather, the Aamodts' position, as we understand it, is that emergency plans must reflect reasonable efforts to ensure protection for livestock and those farmers who choose to remain with them during less serious radiological emergencies.

^{26/} The Aamodts rely on the opinions of two veterinarians and a county agricultural agent who testified that, in most instances, farmers would remain with their animals. Smith, fol. Tr. 21,243, at 3; Tr. 18,769, 18,775-76 (Samples); Tr. 18,787 (Weber). They also cite the testimony of two farmers. One stated that he did not evacuate during the TMI-2 accident. V. Fisher, fol. Tr. 18,749. Another testified generally that he would not abandon his cows. Lytle, fol. Tr. 18,749. But none of the farmers who testified indicated that he would not evacuate in the event of a genuine need to do so. Two testified that they would decide what to do based on the situation at hand and the availability of means to care for their livestock. Tr. 18,728 (Lytle); Tr. 18,730 (V. Fisher). A third indicated that he would definitely evacuate in the event of an accident. Tr. 18,702-706 (J. Fisher).

The Aamodts argue that the plan's provisions for sheltering of livestock are inadequate. Aamodt Brief at 5-6. They cite one farmer's testimony that it would be impractical to shelter and provide water for his entire herd of cattle in accordance with the Commonwealth's suggestions. Tr. 18,695, 18,738-39 (Lytle). They also rely on the testimony of one of the Commonwealth's agricultural agents, who stated that not all farms in the TMI area have sufficiently modern facilities to allow farmers to leave their herds unattended for a few days. Tr. 18,326-29 (Van Buskirk).

The Licensing Board recognized, as do we, that some of the Commonwealth's recommendations may not be practical for all farms in the TMI area. ^{27/} Indeed, we acknowledge that the Commonwealth's plan does not guarantee absolute protection for livestock in all circumstances. Nor is it required to do so. See p. 20, supra. The Licensing Board nonetheless concluded that the plan's guidance should enable farmers to provide some form of sheltering protection for at least a portion of their livestock in a radiological

^{27/} Specifically, the Board cited the testimony of Mr. Lytle (Tr. 18,738), mentioned above, and Dr. Samples, who expressed concern that the plan's recommendation to reduce ventilation to a minimum could, if followed, cause cattle to develop respiratory problems and decrease their milk production. Tr. 18,766-67 (Samples).

emergency. LBP-81-59, supra, 14 NRC at 1675-76 (PID ¶1927). In this regard, the testimony of Commonwealth witness Van Buskirk (an agricultural agent) and Aamodt witness Fisher (a farmer) indicates that some sheltering is possible for many animals in the EPZ. Tr. 18,328-30 (Van Buskirk); 18,713, 18,716 (J. Fisher). Most barns have water piped in from a protected source, as long as electric power is available. Tr. 18,809 (Samples); 18,327-28 (Van Buskirk). Several witnesses stated that cattle would survive for at least three days without water and two weeks without food. Tr. 18,719 (Lytle); 18,720 (V. Fisher); 18,720-21 (J. Fisher); 18,307 (Cable). Thus, the sheltering option does provide a measure of protection for at least some of the livestock in the TMI area.

The Licensing Board also found that farmers could evacuate the area and then contact their county agricultural agent for assistance in caring for their animals during the period of general evacuation. See LBP-81-59, supra, 14 NRC at 1676-77 (PID ¶¶1928-29). The Aamodts criticize the Licensing Board's reliance on the testimony of witness Furrer of the Pennsylvania Department of Agriculture, who indicated that the Department can supply 57 officers, most of whom are farmers, to provide assistance in an emergency. Tr. 18,850-51, 18,853. We agree that the availability of sufficient agricultural personnel to care for livestock in a radiological emergency is, at best, questionable. There has

been no advance planning to arrange for the care of abandoned livestock. Assistance will be provided based on the particular circumstances of the emergency and may involve the county agricultural emergency boards and the U.S. Department of Agriculture as well as the Pennsylvania Department of Agriculture. Tr. 18,302-304 (Cable). The extent of assistance that can or will be provided is uncertain, making this aspect of the proposal unreliable.^{28/}

^{28/} The Licensing Board also found that farmers could accomplish a limited evacuation of livestock. See LBP-81-59, supra, 14 NRC at 1676 n.217. The Aamodts assert that the unplanned evacuation of cattle would be impossible to accomplish. Aamodt Brief at 9-11. We agree. There is no dispute that a general evacuation of livestock would not be feasible. LBP-81-59, supra, 14 NRC at 1676 n.217; see Tr. 18,822-23 (Weber); Tr. 18,805-06 (Samples); Adler and Bath, fol. Tr. 18,975, at 50 (Testimony of March 16, 1981). The Commonwealth plan characterizes it as not only disruptive of human evacuation but dangerous to the animals' health as well. Commonwealth Ex. 2a, Appendix 7, at 17.

Concerning a more limited evacuation of livestock, there is some record support for the Board's conclusion. Individual farmers may move all or some of their animals without prior permission from the state unless their herds have been quarantined. Tr. 18,314 (Van Buskirk). Commercial livestock haulers are available in the area, and many farmers have small trucks that can be used to move a small number of their most valuable animals. Tr. 20,234 (Steward); Tr. 18,737 (Lytle). The Aamodts do not dispute the facts; rather, they urge that a limited evacuation of livestock would be insufficient and that the Board erred in viewing it as a genuine option. We concur in that assessment. There has been no advance planning for the movement of livestock, nor has there been any assessment of how many animals could be moved safely.

The second option is that of limited care, which permits farmers to return periodically to provide care for their livestock during a general evacuation. This is closely related to the third option, that of remaining on the farm. The Aamodts argue that, in either case, farmers will clearly be placed at risk unless they are supplied with protective measures such as potassium iodide, dosimetry, and protective clothing. Aamodt Brief at 9. As the Licensing Board pointed out, the Commonwealth now intends to treat farmers with livestock as "emergency workers" requiring dosimetry and potassium iodide. ^{29/} The Commonwealth and county emergency plans will be modified prior to restart in order to provide for distribution of dosimeters and potassium iodide. LBP-81-59, supra, 14 NRC at 1675 n.214. This greatly improves the safety and feasibility of allowing farmers to remain with or return to their livestock in the event of a general evacuation..

^{29/} The Aamodts allege that these measures are insufficient because supplies fall far short of those needed. Aamodt Brief at 7. The record is silent on this point. The Commonwealth's plan is to predistribute to the county level supplies adequate to equip one emergency worker per farm. See LBP-81-59, supra, 14 NRC at 1675, n.214.

So far as we can determine, the Aamodts raised the issue of protective clothing for the first time on appeal. It is not clear what sort of clothing they are referring to. Ordinary coveralls are generally available and would provide a measure of protection; accordingly, we have suggested that farmers be so advised in the Commonwealth's instructional materials. See note 31, infra.

The Aamodts' final criticism concerns public information for farmers. They argue that public information pamphlets intended for the general public are not suitable for farmers and their families because they contain no information explicitly directed to the needs of farmers and their families. Aamodt Brief at 11-12. The Licensing Board examined the PEMA pamphlet and county brochures and concluded that they were appropriate for farmers. The Board also approved the Commonwealth's other means of conveying emergency information to farmers, as explained below. See LEP-81-59, supra, 14 NRC at 1677 (PID ¶1932).

The PEMA pamphlet contains general information that would be of assistance to farmers. Like other local residents, farmers can protect themselves by remaining indoors during times of greatest risk in an emergency. State milk sanitarians will contact dairy farmers about the possible contamination of milk. See pp. 33-34, infra. Emergency broadcast system messages will also be employed. Adler and Bath, fol. Tr. 18,975, at 50 (Testimony of March 16, 1981). In addition, the Commonwealth has committed to prepare and distribute an agricultural information brochure to farmers with livestock in the 10-mile plume EPZ. A final version of the brochure is anticipated to be available by

the end of this month. ^{30/} We fully expect that the Commonwealth will accomplish the prompt distribution of these materials.

We are concerned, however, that neither the PEMA pamphlet nor the Commonwealth's Department of Agriculture plan contains specific instructions on self-protection for those farmers who remain on the farm or return to care for their livestock. ^{31/} The Commonwealth's plan to provide

^{30/} The Commonwealth originally committed to distribute pages from the Agricultural Extension Service Disaster Handbook to farmers with livestock in the 10-mile plume EP2 in the form of "fact sheets," which set forth guidance for the protection of livestock and food-stuffs grown on the farm. Tr. 20,421-22 (Furrer). The Commonwealth reiterated this commitment in its July 13, 1982 reply to our order of June 29, 1982. Then, on September 22, 1982, the Commonwealth informed us that substantial revisions in the text and format of the Handbook made it no longer suitable for most farmers, necessitating the preparation of an agricultural information brochure. Copies will be distributed to us and the parties as soon as they are available. See letter of September 22, 1982 from Robert W. Adler, Assistant Counsel for the Commonwealth, to members of the TMI-1 Appeal Boards for emergency planning issues.

^{31/} The Commonwealth's Department of Agriculture Plan contains a brief section on protective measures for farmers. Commonwealth Ex. 2a, Appendix 7, Section V, at 15-17. It describes the available options (evacuation, sheltering, and thyroid prophylaxis) and instructs farmers to contact their county agent for advice and assistance. Farmers could be reminded of the obvious use of a weather vane to determine the best time to tend to their livestock (*i.e.*, when the wind is blowing radioactive fallout away from the farm). They could also be told to wear protective clothing and use wet cloths as a means of respiratory protection.

farmers with dosimetry and potassium iodide is a definite improvement in this area. ^{32/} We strongly recommend that protective information specific to farmers be developed and distributed. We also urge that the agricultural brochures be distributed to all farmers throughout the 50-mile ingestion EPZ. See pp. 34-35, infra.

It is clear that, as the Aamodts contend, the options available to farmers offer only a partial solution for the protection and care of livestock. The degree of protection available will depend on the circumstances and severity of the emergency. Despite a number of deficiencies in its plan, however, the Commonwealth has made a reasonable effort to insure protection for farmers that is consistent with the requirements of the Commission's emergency planning regulations. There is reasonable assurance of adequate protective measures for the health and safety of farmers. Guidance and options offering some protection of livestock are also available. Thus, we agree with the Licensing Board's conclusion that, although the safety of livestock cannot be guaranteed, the Commonwealth's emergency plan for farmers is adequate.

^{32/} For a discussion of the role of dosimetry in protecting all emergency workers, including farmers, see our companion opinion, ALAB-698, 16 NRC at ____ (slip opinion at 8-19).

As the foregoing discussion makes clear, we do not think it necessary to impose our suggestions as a condition for restart. We nevertheless hope that the Commonwealth will adopt our recommendations in its continuing efforts to improve its emergency plan for farmers and livestock. As in the case of educational materials, we believe that the solicitation of comments and suggestions from affected members of the public, i.e., farmers, is likely to result in a substantially improved product.

IV. INGESTION EXPOSURE PATHWAY

The ingestion EPZ is an area of about 50 miles in radius surrounding a nuclear plant. See note 13, supra. Its exact size and configuration are determined "in relation to local emergency response needs and capabilities as they are affected by such conditions as demography, topography, land characteristics, access routes, and jurisdictional boundaries." 10 CFR 50.47(c)(2). Protective actions that are appropriate to the locale must be developed for the ingestion exposure pathway EPZ. 10 CFR 50.47(b)(10).

In Contention EP-11, the Environmental Coalition on Nuclear Power (ECNP), an intervenor below, challenged the Commonwealth's protective action guide for ingestion (based on a projected dose to an infant from milk) as providing inadequate protection to the fetus. ECNP presented the testimony of Dr. Bruce Molholt, a microbiologist, in support

of this contention. Fol. Tr. 19,690. Because ECNP filed no proposed findings and was therefore in default on this issue, ^{33/} the Licensing Board discussed the contention "only briefly in order to clarify its thrust . . . and to give the bases for its rejection." LBP-81-59, supra, 14 NRC at 1591 (PID ¶1713).

As part of their appeal of the Licensing Board's decision on emergency plans for farmers, the Aamodts rely on Dr. Molholt's testimony to raise several issues regarding the adequacy of protective measures for the ingestion exposure pathway. Only one of these issues relates particularly to farmers; the others are of more general concern. Briefly, the Aamodts argue that the Board erred in (1) failing to determine the ingestion exposure pathway EP2; (2) finding that farmers who consume milk from their own cows will be adequately protected; (3) rejecting the proposal that the thyroids of small field rodents be used to measure radioactive iodine in the environment; and (4) finding that increased rates of neonatal hypothyroidism and infant mortality were not indicative of the Commonwealth's failure to detect radioactive iodine following the TMI-2 accident. Aamodt Brief at 13-18. The staff and licensee

^{33/} See 10 CFR 2.754 and the Licensing Board's Order of May 22, 1980 at 12.

maintain that the Licensing Board's decision on these matters is correct and that the Aamodt's allegations are not supported by the record.

The Aamodts' appeal raises some potentially serious questions that are undoubtedly matters of concern to TMI area residents. For this reason, we have reviewed the record with particular care in reaching our conclusion that the Licensing Board correctly decided these issues in connection with its disposition of Contention EP-11.

A. Determination of the Ingestion EPZ

The Aamodts argue that the Licensing Board failed to determine the ingestion exposure pathway EPZ, as required by Commission regulations. But the Board found that an ingestion exposure pathway EPZ of about 50 miles in radius had been developed and defined for TMI, as set forth in the Commonwealth's emergency plan. LBP-81-59, supra, 14 NRC at 1555 (PID §1610). No party contested the adequacy of the TMI-1 ingestion exposure pathway EPZ. Accordingly, the Licensing Board was not required to make more specific findings concerning its exact size and configuration.

B. Protection of Farmers from Contaminated Milk

The Aamodts assert that the Licensing Board erred in finding the Commonwealth's procedures for detecting contaminated milk adequate to protect farmers who consume

milk from their own cows. They rely on the testimony of Commonwealth witness Reilly that the extent of contamination in milk at individual farms can vary considerably and that the Commonwealth makes its recommendations regarding milk consumption based on the amount of contamination found at the dairy processor. The time required to transport milk to the dairy would allow some radioactive iodine to decay, and the fact that milk is commingled for processing would result in the dilution of some contaminated sources. Thus, milk at the dairy would be less contaminated than that found at some farms. Tr. 18,220, 18,225 (Reilly). See also Tr. 20,546-47 (Peterson). For this reason, the Lamodts believe that a farm family whose sole source of milk is its own herd may face an unacceptable health risk.

Milk sampling is performed by regional milk sanitarians under the direction of the Commonwealth's Department of Agriculture. Initial sampling for contaminated milk takes place at individual farms. Samples are analyzed by the Commonwealth's Department of Environmental Resources laboratory or a laboratory chosen by that Department. Commonwealth Ex. 2a, Appendix 7, at 36-37. Regional milk sanitarians will contact dairy farmers directly to provide information on the possible contamination of milk. Tr. 20,407, 20,417-18 (Fouse). If dangerous levels of radioactivity were found, farmers in the neighboring area

would also be so informed. Tr. 18,226 (Reilly). ^{34/} These provisions make it likely that, if dangerous levels of contamination are detected at individual farms, farmers will be so advised.

It is reasonable to expect that farmers will be aware of the need for caution with regard to potentially contaminated livestock and produce. The Commonwealth's public information pamphlet recommends certain precautions for the use of food and beverages that should alert farmers to the possibility of radiological contamination. In addition, the Commonwealth has committed to distribute its agricultural brochures concerning protective actions for livestock and food to farmers with livestock herds in the 10-mile plume exposure EPZ. See pp. 27-28, supra. In view of the importance of these brochures, we shall require their distribution to all farmers in the 10-mile EPZ.

We conclude that the Commonwealth's planning is adequate to protect farmers who consume milk from their own cows. To provide further assurance that farmers are fully aware of the steps they should take to protect themselves, their families, and the public from ingestion of contaminated milk

^{34/} Although the Aamodts claim this means of notification is inadequate to reach the many farms in the 50-mile ingestion EPZ, they cite no evidence in support of that assertion. Our review of the record reveals nothing to suggest that such is the case.

and foodstuffs, we strongly recommend that the agricultural brochures be distributed to all farmers throughout the remainder of the 50-mile ingestion EPZ as well.

C. Use of Vole Thyroids for Environmental Monitoring

As part of his testimony on behalf of intervenor ECNP, Dr. Molholt asserted that the thyroid glands of voles (which are small field rodents) provide a more sensitive means of detecting radiiodine in the environment than does milk sampling, and that the Commonwealth should therefore be required to use them for that purpose. Molholt, fol. Tr. 19,690, at 14; Tr. 20,033 (Molholt). The Licensing Board considered this assertion and rejected it because there is currently no means of projecting human doses from a measured amount of vole thyroid contamination. 35/

The Aamodts maintain that the Licensing Board erred in its finding. They argue that vole thyroids provide a more sensitive and reliable measure than milk sampling, and offer the advantage of an integrated monitor for both ingestion and inhalation exposures. Aamodt Brief at 15-16. We agree with the Licensing Board's decision, as explained below.

In considering the Aamodts' arguments, it is important to appreciate the difference between detecting the presence

35/ See LBP-81-59, supra, 14 NRC at 1593 (PID ¶1717).

of radioiodine in the environment, on the one hand, and determining actual or projected doses to humans, on the other. Commonwealth witness Reilly acknowledged that, although vole thyroids are a good indicator of the environmental presence of radioactive iodine, they are less reliable than milk samples for evaluating radiation doses to humans. Tr. 18,191-93 (Reilly). Moreover, the transfer factors from air and food to the vole thyroid are unknown. Tr. 19,947-48 (Molholt). Thus, it is currently impossible to convert a measured vole thyroid dose to an estimated dose for humans. In contrast to voles, milk is part of the ingestion pathway to humans. Tr. 19,946, 19,841 (Molholt); Tr. 18,241-42 (Reilly). Assuming that vole thyroids provide a better means of detecting the presence of radioiodine, milk sampling is clearly superior for determining the existence of a human health hazard. Thus, the Licensing Board's refusal to require the use of vole thyroids as an environmental monitor for radioiodine was entirely correct.

D. Infant Mortality and Neonatal Hypothyroidism After the TMI-2 Accident

Finally, the Aamodts argue that the Board erred in failing to consider evidence of increased rates of neonatal

hypothyroidism ^{36/} and infant mortality ^{37/} as proof of the Commonwealth's inadequate monitoring of radioiodine following the TMI-2 accident. They rely on Dr. Molholt's testimony that the incidence of such cases increased significantly after the TMI-2 accident. Molholt, fol. Tr. 19,690, at 13. The Licensing Board found Dr. Molholt's analysis unconvincing because (1) the spatial distribution of cases of neonatal hypothyroidism was inconsistent with radioiodine releases from TMI-2, (2) only low levels of radioiodine were found in the environment following the accident, and (3) the Commonwealth's direct evidence demonstrated that the majority of cases of infant mortality and neonatal hypothyroidism are attributable to causes unrelated to the accident. LBP-81-59, supra, 14 NPC at 1593-95 (PID ¶¶1719-21).

We agree with the Licensing Board's assessment. To facilitate our discussion, we have reproduced Dr. Molholt's

^{36/} Neonatal hypothyroidism is a deficiency of thyroid gland activity in newborns that results in a lowered metabolic rate. It can impair skeletal development and result in mental retardation and eventual death, if not treated. See Molholt, fol. Tr. 19,690, at 12.

^{37/} Infant mortality is generally defined as death of an infant within the first year after birth. See Tr. 19,892 (Molholt).

Table I below. ^{38/} Dr. Molholt claimed that there was a statistically significant increase in neonatal hypothyroidism in an area he termed "downwind" of TMI-2 in the nine months after the accident, as compared to the nine months before. Molholt, fol. Tr. 19,690, at 13. He grouped the data in six categories, some of which overlap. For (1) the entire Commonwealth of Pennsylvania, (2) the area of Pennsylvania west of Harrisburg, (3) the five county area near Philadelphia and (4) the downstream area (Lancaster

^{38/} Molholt, fol. Tr. 19,690, at 23.

Table 1

NEONATAL HYPOTHYROIDISM

During the nine months before and after the accident

<u>Geographic Area</u>	<u>[Number of Cases]</u>	
	<u>Before</u>	<u>After</u>
Pennsylvania west of Harrisburg	7	7
Five county area of Philadelphia	6	6
Rest of Pennsylvania	4	14*
Total	17	27
Downwind TMI (Dauphin, Lebanon, Berks, Schuylkill, Lehigh, Carbon)	2	8*
Downstream TMI (Lancaster County)	2	6

* Difference significant at $p < 0.05$.

County), there was either no increase or an increase that is not statistically significant. For the area Dr. Molholt designates (5) "downwind of TMI," and (6) the "rest of Pennsylvania" (after separating out the areas west of Harrisburg and near Philadelphia), there was a statistically significant increase. See note 38, supra.

At the outset, it should be recognized that there is considerable uncertainty concerning Dr. Molholt's definition of "downwind." For the first 48 hours after the accident, when the largest radioactive releases most likely occurred, the wind prevailed in a sector between north and northwest; i.e., to the north-northwest. Tokuhata, fol. Tr. 20,097, at 3-4. 39/ It continued to prevail in that direction for about the first week after the accident, from March 28, 1979 to April 3, 1979. Tr. 19,929-30 (Molholt). There were no cases of neonatal hypothyroidism to the north-northwest after the accident. Tokuhata, fol. Tr. 20,097, at 3-4. See Molholt, fol. Tr. 19,690, at 22, Figure 4. Then, from April 3 to April 14, 1979, the wind prevailed to the northeast. Tr. 19,929-30 (Molholt). Dr. Molholt combined the two time periods from March 28 to April 3 and from April 3 to April 14 in order to obtain his northeasterly definition of

39/ See also the Kemeny Commission Report, note 19, supra, at 110-157 (radiation detected in offsite areas to the west and northwest during the first two days of the accident).

downwind. Id. ^{40/} Dauphin is the county closest to TMI-2 in either the northwesterly or the northeasterly direction. There were no cases of neonatal hypothyroidism in Dauphin County in the nine months after the accident. Molholt, fol. Tr. 19,690, at 22 (Figure 4). Dr. Molholt's statistically significant cases of neonatal hypothyroidism occurred, for the most part, in the more distant counties to the northeast. ^{41/}

^{40/} Other data indicate that, during the first month after the accident the wind was, in fact, multidirectional and prevailed to the southeast over one-third of the time. Tr. 19,990-91 (Molholt).

^{41/} As mentioned previously (p. 39, supra), Dr. Molholt identified two categories of statistically significant increases in neonatal hypothyroidism: (1) downwind of TMI, and (2) the "rest of Pennsylvania." It should be noted, however, that the "rest of Pennsylvania" category is nothing more than the sum of those cases contained in the "downwind" and "downstream" categories. That is, it includes the downstream Lancaster County cases as part of a statistically significant group. Taken alone, the Lancaster County cases are not statistically significant. Thus, there is in reality only one statistically significant category, that "downwind of TMI." Obviously, the grouping of these cases has a great deal of influence on the significance of the data. See Molholt, fol. Tr. 19,690, at 22, Figure 4.

With regard to the geographical distribution of cases, we note that three of the eight cases counted in the "downwind of TMI" category after the TMI-2 accident occurred in Lehigh County, which is entirely beyond the 50-mile radius of the reactor. A fourth case that occurred in Berks County also appears to be outside the 50-mile radius. Id.

Dr. Molholt hypothesized that this could have resulted from the radioactive plume skipping nearby areas and touching down farther away from the reactor. Tr. 19,877-78. Although "skipping" or "looping" of a plume from high stacks has been noted under certain unstable weather conditions (usually occurring between noon and 2 p.m. under clear skies) no such skipping occurs for low release plumes such as those from reactor buildings or filters. ^{42/} Therefore, we cannot accept that explanation in this case. Furthermore, Dr. Molholt knew of no plume touchdown or radioiodine measurements to support his hypothesis. Id. In addition, it is inconsistent with the environmental sampling data on which Dr. Molholt relied in reaching his conclusions about the use of vole thyroids as an environmental monitor for radioiodine. That is, the concentration of radioiodine found in vole thyroids decreased as a function of distance

^{42/} A full discussion of plume "looping" can be found in the U.S. Atomic Energy Commission publication "Meteorology and Atomic Energy," TID-24190, Section 2-7.2, pp. 56-61 (1968). A discussion of plumes from rounded buildings such as reactor structures may be found in Sections 5-5.2.2.3 through 5-5.2.2.5, pp. 227-232.

from the TMI-2 reactor. Tr. 20,037-38 (Molholt). ^{43/}
Finally, it is inconsistent with the amount of iodine estimated to have been released and the levels of radioiodine actually found in the environment after the TMI-2 accident. See p. 43, infra.

Dr. Molholt also testified that, in the nine months following the TMI-2 accident, there were ten times the number of cases of neonatal hypothyroidism in Lancaster County than would be expected based on the nationwide incidence of such cases. Molholt, fol. Tr. 19,690. But the increased incidence of such cases was not statistically significant in comparison with those that occurred in the nine months before the accident. See note 38, supra. More importantly, Dr. Molholt knew of no evidence to support his hypothesis that these Lancaster County cases downstream from TMI-2 were caused by radioiodine released directly into the Susquehanna River. Tr. 19,880, 19,883. He also did not possess important information about the mothers of the hypothyroid infants born in Lancaster County hospitals -- for example, whether the mothers actually lived in the county, drank water from the Susquehanna River, and remained

^{43/} Dr. Molholt did caution that the number of locations from which vole thyroids were obtained was too small to draw accurate conclusions about radioiodine dispersal. He acknowledged, however, that the vole thyroid data were inconsistent with the locations of increased incidence of neonatal hypothyroidism. Tr. 20,037-38 (Molholt).

in the county during or after the TMI-2 accident. Tr. 19,992-93. Dr. Molholt acknowledged that the limitations of the data are severe and that he was only able to suggest "a potential, a plausible causal linkage" between the TMI-2 accident and the subsequent increase in health effects. Tr. 20,053. At one point, he stated his "honest suspicion" that the increased rates of neonatal hypothyroidism in Lancaster County in 1979 and in 1980 were not attributable to the TMI-2 accident but were caused by "another source of iodine-131 insult." Tr. 20,019.

In addition to these problems with Dr. Molholt's analysis, we note the Licensing Board's finding that the increases in neonatal hypothyroidism and infant mortality were inconsistent with the amount of iodine estimated to have been released and "the levels of radioiodine found in the environment after the accident." LBP-81-59, supra, 14 NRC at 1594 (PID ¶1720). Extensive monitoring of air, milk, and water following the TMI-2 accident was conducted by Pennsylvania's Bureau of Radiation Protection, the NRC, the Department of Energy, and the Environmental Protection Agency. These monitoring efforts revealed only low levels of radioiodine. Id.; Tr. 18,154, 18,189-90, 18,194-95 (Reilly). The Licensing Board further found that there had been no evidence presented to cast doubt on either the estimated releases or the monitoring results. 14 NRC at

1594 (PID ¶1720). Significantly, the Aamodts filed no exceptions to the Board's findings. Nor do they challenge the evidence upon which the Board relied, except insofar as they argue that Dr. Molholt's infant and animal data are "highly suggestive" of the Commonwealth's failure to detect radioiodine following the TMI-2 accident. Aamodt Brief at 18.

Dr. George Tokuhata, a member of the Hypothyroidism Epidemiological Investigating Committee formed by the Pennsylvania Department of Health, testified for the Commonwealth. He endorsed the Committee's conclusion that, based on "metabolic screening and diagnostic data compiled by the Pennsylvania Department of Health, there is no evidence to indicate that the incidence of neonatal hypothyroidism has been affected by the TMI nuclear accident." Tokuhata, fol. Tr. 20,097, at 1. He explained that the Commonwealth began its screening program for various types of neonatal hypothyroidism in July 1978 and, initially, screening procedures and standards were not fully established. Thus, the data for 1978 were limited and incomplete and should not be used as a basis for comparison. Id. at 2. Moreover, the overall rate of neonatal hypothyroidism for 1978, which Dr. Molholt used to evaluate the increase for 1979, was lower than normal. Id.; Tr. 20,015-17 (Molholt). The statewide incidence of neonatal

hypothyroidism was within normal range for both 1979 and 1980. Id.

Using the Commonwealth's more complete data, the Committee analyzed in detail the seven neonatal hypothyroidism cases that occurred in Lancaster County in 1979. One occurred two months before the accident. One was born only three months after the accident with severe central nervous system abnormalities, most of which probably developed before the accident. Two were cases of displaced thyroid glands (one of which occurred in a pair of twins born to an Amish family), suggesting developmental anomalies not likely to be related to radiation exposure. Another was an Amish infant unable to synthesize thyroxine, a condition that is usually inherited. The final two did not receive thyroid scans, making their diagnostic status unknown. Based on these findings, the Committee concluded that "the apparent concentration of neonatal hypothyroidism in this particular location is not related to the TMI nuclear accident." Tokuhata, fol. Tr. 20,097, at 2-3; see also Tr. 20,118-19 (Tokuhata).

Dr. Tokuhata explained that Lancaster County is atypical because of its considerable Amish population, in which consanguinity is not uncommon and the incidence of genetic disorders is relatively high. Tokuhata, fol. Tr. 20,097, at 3. This is further supported by the fact that the rate of neonatal hypothyroidism in Lancaster County

remained high during the first nine months of 1980. Tr. 20,018-19 (Molholt). Thus, we agree with the Licensing Board's finding that there is no basis in the record to conclude that any increased incidence of neonatal hypothyroidism during the last nine months of 1979 was caused by the TMI accident.

Dr. Molholt also identified a statistically significant increase in infant mortality within a ten-mile radius of TMI-2 following the accident. Molholt, fol. Tr. 19,690, at 13, 24 (Table 2). There was no statistically significant increase within a five-mile radius of the reactor. Id. at 24. Dr. Molholt derived his results from data for equivalent six-month periods (April through September) in 1977, 1978, and 1979. He took an average of the 1977 and 1978 data as the basis for comparison with the 1979 data. Id.; Tr. 20,023-24 (Molholt). He did not examine the individual cases to determine their cause, nor was he able to obtain other relevant information, such as whether the mothers evacuated during the TMI accident. Tr. 19,895, 20,021 (Molholt). Accordingly, he recognized that the statistics were not conclusive but rather, a point for "further investigation." Tr. 20,021 (Molholt).

As noted above, the Licensing Board found that the increased incidence of both neonatal hypothyroidism and infant mortality were not consistent with the low levels of radioiodine found in the environment after the accident, and

the Aamodts have not appealed that finding. See p. 37, supra. The Board also relied on Dr. Tokuhata's testimony that "a Pennsylvania Department of Health study of infant mortality concluded that there was no relationship between the TMI-2 accident and changes in infant mortality in the TMI area." LBP-81-59, supra, 14 NRC at 1595 (PID ¶1721), citing Tokuhata, fol. Tr. 20,097, at 6-7.

Dr. Tokuhata testified that the infant mortality rate within a 10-mile radius of TMI (either including or excluding Harrisburg) was not significantly different from that in the rest of Pennsylvania for 1977, 1978 and 1979. Infant mortality within the 10-mile radius including Harrisburg was abnormally high during the first quarter of 1979 (i.e., before the accident), and continued at that level during the second quarter. It declined substantially during the third and fourth quarters, which is inconsistent with the hypothesis that the TMI accident had a significant influence. In addition, the rate for 1978 was unusually low compared with both 1977 and 1979. Tokuhata, fol. Tr. 20,097, at 6-7. This testimony fully supports the Licensing Board's conclusion that any changes in infant mortality in 1979 were not attributable to the TMI-2 accident.

The Aamodts argue that the Licensing Board's reliance on Dr. Tokuhata's testimony was "gross error." Aamodt Brief at 18. They rely on the Board's reservations concerning Dr. Tokuhata's radiobiological expertise. See LBP-81-59, supra,

14 NRC at 1595 (PID ¶1722). Specifically, the Board found that "Dr. Tokuhata was unclear about how the fetal thyroid could be irradiated (Tr. 20,108), how radiation from I-131 might lead to dishormonogenesis ^{44/} (Tr. 20,114-17), and the conditions by which radiation might be implicated in fetal mortality incidence in the Harrisburg black population. Tr. 20,131-32." Id.

We believe that the Licensing Board's criticism of Dr. Tokuhata's radiobiological expertise and understanding of genetics was unwarranted. Dr. Tokuhata's apparent difficulty in answering the above questions seems to have resulted from a misunderstanding of the intent of the questions rather than a lack of knowledge of the answers. Furthermore, Dr. Tokuhata is a recognized authority in epidemiology, a field that necessarily requires an understanding of the role of genetic and environmental factors in the incidence, distribution, and control of

^{44/} Dishormonogenesis is the lack of a necessary enzyme resulting in an inability to synthesize thyroxine and/or difficulty in releasing thyroxine. It is usually inherited. Tokuhata, fol. Tr. 20,097, at 1.

disease. ^{45/} Thus, it was incongruous for the Licensing Board to regard Dr. Tokuhata as a fully qualified epidemiologist and to rely on his expert testimony while doubting his understanding of important aspects of his specialty. Although we reject the Licensing Board's analysis, we do not consider the three examples cited above sufficiently serious to support a finding that Dr. Tokuhata's expert testimony was unreliable. Accordingly, the Licensing Board did not err in relying on it.

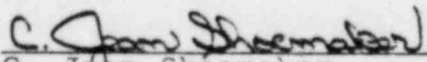
For all the foregoing reasons, the Licensing Board's decision is affirmed subject to the following condition:

Prior to restart, the Commonwealth's agricultural information brochure shall be distributed to all farmers in the 10-mile plume exposure EPZ.

^{45/} Dr. Tokuhata received the Doctor of Public Health degree in epidemiology and public health from Johns Hopkins University. He has served as Director of the Bureau of Health Research for the Pennsylvania Department of Health since 1975. He is also an adjunct professor of epidemiology and biostatistics at the Graduate School of Public Health, University of Pittsburgh, and Associate Professor of Community Medicine, Temple University College of Medicine. He has served on numerous public health committees and task forces and has authored over sixty published articles and reports concerning epidemiology and public health concerns. Tokuhata, fol. Tr. 20,097 (Curriculum Vitae); See also LEP-81-59, supra, 14 NRC at 1595 (PID 21722).

It is so ORDERED.

FOR THE APPEAL BOARD


C. Jean Shoemaker
Secretary to the
Appeal Board