

EXPERT WITNESS REPORT
THREE MILE ISLAND LITIGATION
FOR HEPFORD, SWARTZ, AND MORGAN
— REPRESENTING PLAINTIFFS

Table of Contents

FINDING 1	— Minimizing Exposure to the Public.....	1
FINDING 2	— Providing Information to the State of Pennsylvania.....	1
FINDING 3	— Accident Damage Indications.....	1
FINDING 4	— Radiation Releases.....	2
FINDING 5	— Severity of Accident.....	3
FINDING 6	— Misleading Information.....	4
FINDING 7	— Materially False Information.....	4..
FINDING 8	— Dose Calculations.....	6
FINDING 9	— Undue Emphasis on Field Data.....	8
FINDING 10	— Hydrogen Detonation.....	9.
FINDING 11	— Core Temperature.....	9
FINDING 12	— Reporting to State and Federal Authorities.....	1 0
FINDING 13	— Evacuation.....	1 1
FINDING 14	— Failure to Evaluate Releases.....	1 2
ENDNOTES	1 3

Arnold Gundersen

Free Lance, P.O. Box 2474, New Preston, CT 06777
telephone (203) 868-9310 - fax 868-0424

FINDING 1 — Minimizing Exposure to the Public

Prior to the accident at Three Mile Island (TMI) Nuclear Power Station, the Defendant clearly understood its legal responsibility for operating a safe nuclear power plant and for protecting the health and safety of the general public, in the event of a nuclear accident.

- The Defendant specifically said, "A high degree of protection against the occurrence of postulated accidents... is provided through correct... operation..."¹
- Additionally, the Defendant acknowledges its responsibility for "Protection of the health and safety of the Public" and to make "... every reasonable effort to minimize exposure... even in emergencies."²

FINDING 2 — Providing Information to the State of Pennsylvania

Prior to the accident, the Defendant understood its legal responsibility for prompt and accurate information and notification to limit exposure to the general public. Specifically,

- The Defendant acknowledged it was "... responsible for prompt notification of appropriate Pennsylvania State Authorities if an accident is causing or is threatening to cause significant off-site exposure."³
- The Defendant also acknowledged that "... early information [is] needed to decide what action must be taken to limit radiation exposure to the general public in the event of a site or general emergency."⁴

FINDING 3 — Accident Damage Indications

During the first several hours (i.e. by no later than 10 a.m.) following the accident, the Defendant had accurate information from multiple, independent sources which indicated severe core damage, release of lethal concentrations of radioactive material into the containment, and hydrogen generation from a zircromium-water reaction. Specifically:

- Thermocouples within the core accurately indicated core temperatures in excess of 2100°F.⁵ This indicated the core was uncovered; a meltdown was in process, and hydrogen generation was occurring.
- Hot leg thermocouples accurately indicated superheated steam at temperatures in excess of 700°F.⁶
- Reactor coolant pump amperage accurately indicated that there was no water for the pump to pump, but rather only steam.⁷
- Neutron detectors outside the vessel accurately indicated increased neutron levels, which could only have been caused by an uncovered core.⁸
- Reactor building dome radiation monitors accurately showed that the concentration of radioactive material inside containment was lethal,⁹ indicating extensive fuel failure.
- Reactor coolant samples showed exposures in excess of 200 R/hr. This indicated extensive fuel failure.¹⁰

FINDING 4 — Radiation Releases

During the first several hours (i.e. no later than 10 a.m.) after the accident, the Defendant had accurate information from multiple, independent sources which indicated large quantities of radioactive material had escaped from the containment and had entered other plant areas as well as the environment outside the plant. Specifically:

- Health Physics technicians informed TMI Staff to evacuate an auxiliary building after taking readings as high as 10R/hr.¹¹
- Numerous plant radiation monitors, including those monitors measuring releases to the environment, alarmed with readings off the scale.¹²
- An engineer, with two years of training in the calculation of accident dose rates, and his supervisor, calculated the exposure, to residents in the town of Goldsboro, from the plume at 10R/hr. The engineers used the procedures approved for the site's emergency plan.¹³

- A radiation protection foreman working outside on a roof became personally contaminated to a level of 20mr/hr. He concluded he was contaminated by airborne radiation because he received a uniform radiation dose of 20mr/hr over his entire body.¹⁴

FINDING 5 — Severity of Accident

The Defendant recognized the severity of the accident from the accurate in-plant instrument readings and from knowledge of releases to the environment. Specifically:

- Miller said he was scared about the temperature within the core, "...the bottom line here is that the [the incores] are hot, they were hot enough that they scared you..."¹⁵
- Kunder said he was scared. "The thing that was scaring me was the thought that we were putting water in the core and... concentrating boric acid."¹⁶
- Miller said that after he could not start the pumps, "We were not in our minds convinced the core was totally covered."¹⁷
- Kunder recognized the seriousness of the problem. "... it was pretty clear based on hot leg temperatures that ... we were into a very serious problem."¹⁸
- Under pressure from GPU Corporate officers to reduce the emergency condition from "General" to "Site", Miller acknowledged, "The reason we have not... is because... We don't know where the hell the plant (sic) was going."¹⁹
- Miller acknowledged, "... pretty early... we were scared that wasn't happening. Radiation was all over the place. Everything was off scale."²⁰
- When asked if he felt the incore instruments were accurately reading temperatures in excess of 2,000°, Ivan Porter said, "I guess I was afraid it was real."²¹
- Miller notes that the accident could not have been any worse. "A LOCA wasn't something that would have made a difference in this crisis because we were already in as severe a crisis as we ever could get into."²²

EXPERT WITNESS REPORT by Arnold Gundersen
THREE MILE ISLAND LITIGATION
FOR HEPFORD, SWARTZ AND MORGAN -- REPRESENTING PLAINTIFFS

Page 4 of 14

FINDING 6 — Misleading Information

Early in the accident, the Defendant had accurate information delineating the severity of the accident. Despite its commitment to provide prompt and accurate information to the State of Pennsylvania the Defendant consistently misled state officials on the severity of the accident by failing to provide complete, timely, and accurate information on the conditions within the Defendant's plant and on the Defendant's radioactive releases to the environment.

- In a 7:30 a.m. telephone call to Gerusky, the Defendant acknowledged it had calculated exposures to the community of Goldsboro of 10R/hr, adding that the calculations seemed to be too conservative. The Defendant did not inform the state of the highly degraded condition of the plant, nor did it acknowledge that its own employees, working outside, had received significant radiation exposure. In addition, the Defendant did not acknowledge that almost all of its in plant radiation monitors had off scale readings due to the high level of radiation at the site.^{2,3}

1

FINDING 7 — Materially False Information

Early in the accident, the Defendant had accurate information delineating the severity of the accident. Despite its commitment to provide prompt and accurate information to the State of Pennsylvania the Defendant consistently misled state officials on the severity of the accident by providing state officials with false and erroneous information about radiation surveys in the surrounding communities.

- * Thomas Gerusky, Director of the Pennsylvania Bureau of Radiation Protection, said, "In the meantime, I requested them to try to get their teams somehow to Goldsboro, and they said that the State Police helicopter was there and that they would get one of their teams up in the air and over Goldsboro. We stayed on the phone with them. They found no radiation levels on-site or in Goldsboro that would indicate any kind of a leak. So therefore, we then notified the Civil Defense to hold tight. That was all before 8:00 [a.m.]²⁵
- Miller said, "At approximately 7:30 [a.m.] or a little before,... I dispatched a State Police Helicopter with an off-site team along... to the West Shore (Goldsboro)"²⁶
- From Miller "8 a.m. Off-site team in Helicopter at West Shore (Goldsboro): Zero Reading, we actually were ahead of the plume."²⁷
- Miller said, "As I remember, the readings were back before Dubiel had thought the plume had gotten there. In other words, we had gotten there faster than the radiation would have at the wind speed, which was very slow."²⁸
- Dubiel said that a helicopter was on its way to Goldsboro at 7:40 a.m. and arrived about five minutes later.²⁹
- However, the helicopter never even arrived on site to pick up TMI personnel to go to Goldsboro until 8:35 a.m. The reports of zero radiation readings in Goldsboro at 7:30 a.m. are material false statements as there was no helicopter available until more than an hour later.³⁰

The Defendant fabricated information which it provided to The Bureau of Radiation Protection. The critical information the Bureau of Radiation Protection required to ascertain the severity of the accident and the need for evacuation was denied to the Bureau by the Defendant.

Furthermore, if the helicopter survey had actually been taken in Goldsboro at 8 a.m., the Defendant acknowledged that the plume would not yet have reached Goldsboro. Zero radiation, a null (0) answer, would have been expected, and would not have indicated that the calculation of 10R/hr was incorrect, but rather the radioactive plume had not yet reached the community of Goldsboro. Instead of the truth, the Defendant said that a null (0) answer, zero radiation, proved that there was no risk to the public.

At 9:30 a.m., Iodine in Goldsboro was measured at least 100 times higher than MPC, indicating a major release had reached Goldsboro by then. This would have substantiated the dose calculations done at 7 a.m. The State was never contacted about this measurement, which confirmed the severity of the accident and the toll on the general public's health and safety.

FINDING 8 — Dose Calculations

Dubiel said he believed the calculated dose assessment indicating 10R/hr was too conservative, specifically because the containment pressure appeared to be low.³¹ Dubiel had never criticized the methodology although the procedure used to calculate the radiation release had been in use during two years of emergency drills³² and had been approved by two plant superintendents and two Plant Operating Review Committees (PORC).³³ Yet, in the middle of a severe "crisis"³⁴, [a real accident], Dubiel, a supervisor acting under pressure, chose to ignore the readings by labeling them as too conservative. Given the determination of my Finding #1 and Finding #2, and the overall condition of the plant (Finding #3), Dubiel's actions are unconscionable.

Furthermore, the calculation in Procedure 1670.4 showed no pressure dependency. Indeed, paragraph (¶) 4.91 and 4.9.2 clearly state, "The containment initially leaks at its maximum design leak rate"³⁵ for both a major LOCA or a small line break. In NUREG 0600, P II-2-6, the NRC said, "... it would appear that the initial projected exposure rate should not have been discounted so readily." Dubiel assumed that because the containment pressure appeared to be low that it therefore wasn't leaking fast, however, this technical procedure has no such pressure dependent correlation.

During the late 1970s it was brought to the attention of the nuclear power industry as a whole that X/Q (dispersion coefficient) calculations for low wind speeds underestimated dose calculations by a factor of 10. This revision was due to the improvement of stall speeds of weather instruments on plants like TMI. The superior instrumentation created new X/Q calculations which produced higher dose rates than the old methodology and instrumentation. This is especially true of plants in river valleys.

It is contradictory and incongruous that the Defendant placed undue emphasis on the belief that the containment pressure appeared low and yet doubted the accuracy of all other plant instrumentation which indicated high radiation readings and a severe accident in progress. It is implausible that the Defendant never doubted the accuracy of the containment pressure instrumentation on the morning of March 28, yet on the afternoon of March 28, the Defendant noted that it doubted its containment pressure readings that indicated a hydrogen explosion had taken place.³⁶

The circular logic used by the Defendant clearly shows that readings manipulated to show a "zero release" thesis were promoted, while readings from the same instrument that clearly indicated a crisis were rejected.

FINDING 9 — Undue Emphasis on Field Data

The Defendant placed undue emphasis on the accuracy of its field survey data being representative of actual maximum exposure to the general public. Specifically:

- John Collins, of the NRC, said, "My problem... the concern I have about aerial monitoring was that for the first three days we were pretty much into a very static air condition. There was very little... dispersion. When you were flying your helicopter and taking your aerial measurements, you were actually reading erroneous readings... I really doubt some of the measurements that were made."³⁷
- Collins also said, "Going out in an automobile and chasing a plume with a meter is a very difficult job. You never know the width of the plume, you never know whether you are in the center or on the edge of it. At best, it gives you a rough idea. At best."³⁸
- Collins also said, "... not only should we have good monitors but also people who understand how to use them. That was a problem here since day one. They get data and nobody sits down and evaluates the data to try to understand what it means."³⁹
- At 7:30 a.m. on the morning of the accident, "...The wind was westward and very light, with minute to minute variation of about 10 to 30 degrees."⁴⁰
- A review of the Defendant's meteorological data⁴¹ and Dr. I Vergeiner's affidavits,⁴² as well as the fact that I did my Masters Thesis on plume behavior during different atmospheric conditions, reveals that if an observer is less than 6° off the center line of a radioactive plume the measured value of radioactivity can be more than 10,000 times lower (i.e. 1 million percent lower) than the center line value.

In layman's terms, this means that in Goldsboro, about 1.2 miles from the plant, if the survey team missed the center line of the plume by no more than 600 feet, they would have indicated exposures 10,000 times smaller than at the center. Accurate field measurements were further limited because the plume was meandering with minute to minute variations of 10 to 30 degrees. In concurrence with Collins and disagreement with the Defendant, in my professional opinion it was almost impossible for the survey teams to accurately detect the plume. The low readings obtained by the survey teams do not indicate general conditions at the center of the plume. Given the directional variability of the plume and the fact that the plume was an elevated release which may or may not have touched down in Goldsboro, it is more likely that field survey crews would have detected nothing even though the release was substantial.

The Defendant ignored its most accurate plant data and chose to rely on the least accurate method of monitoring the effects of the accident. The Defendant denied the State its most accurate data,⁴³ which clearly showed the severity of the accident, and instead, provided its least accurate data as a basis to preclude the possibility of an embarrassing evacuation.

FINDING 10 — Hydrogen Detonation

Although the Defendant was aware of the hydrogen detonation within the containment, it chose not to inform either the State or the NRC until two days after the accident occurred.⁴⁴

FINDING 11 — Core Temperature

The Defendant deliberately and knowingly misled the NRC about the temperature within the core. The NRC had requested the thermocouple data from within the core shortly after noon (12:20 p.m.).

- "At approximately 4:10 p.m., Met Ed supervisor reported to Region I (in response to NRC's request for incore thermocouple data which was initially asked for at about 12:20 p.m.) that the incore data was not available because the computer was printing question marks."⁴⁵

- In response to the NRC's question about why there were question marks instead of data, the Defendant said, "That means that either the computer point is messed up... or that the line... is broken."⁴⁶ When, in fact, the Defendant knew that question marks indicate the measurements were off scale and exceeded 700°. The Defendant sent an instrument crew to directly measure this data as early as 9 a.m. The instrument crews determined at that time that temperatures exceeded 2100°. Ivan Porter was informed and Miller also knew of these temperature readings. However, the NRC was totally unaware of these incore temperature readings until several days after the accident, due to the Defendant's material false statements.⁴⁷

- "Yet practically coincident with the conversation in which the NRC was told the computer was printing question marks, the computer was... displaying two on scale readings... 596.9°... and 562.1°. Both temperatures were indicative of super heated conditions in the core..."⁴⁸ Once again, the Defendant chose not to inform the NRC of these readings.

FINDING 12 — Reporting to State and Federal Authorities

I endorse Myers' conclusion in its entirety. I hereby incorporate Pages 103-120 in their entirety. My conclusion is the same as Myers.

"VI. Conclusion"

"The record indicates that in reporting to State and Federal officials on March 28, 1979, TMI managers did not communicate information in their possession that they understood to be related to the severity of the situation. The lack of such information prevented State and Federal officials from accurately assessing the condition of the plant. In addition, the record indicates that TMI managers presented State and Federal officials misleading statements (i.e. statements that were inaccurate and incomplete) that conveyed the impression the accident was substantially less severe and the situation more under control than what the managers themselves believed and what was in fact the case."⁴⁹

FINDING 13 — Evacuation

Had the State been informed of the seriousness of the situation, the deteriorated condition of the core, and the high dose readings from the environment outside the plant, it would have evacuated the Low Population Zone (LPZ).

- General Emergency Procedure 1670.3 stated that if predicted exposures exceed 5 Rem whole body or 30 Rem thyroid, then an evacuation of the LPZ shall be initiated.⁵⁰

The Defendant's own procedures indicate that an evaluation of the LPZ should have been called between 7 and 8 a.m. based on reactor building radiation readings and meteorological data at the time. Other degraded in plant parameters confirm this was the correct decision to make at 7 a.m.

By 10 a.m. the accuracy of the thermocouples within the core was confirmed and it was known that a meltdown was underway. Knowing this it was unconscionable that an evacuation was not called for by 10 a.m.

A hydrogen detonation at 2 p.m. indicated that an ongoing zircromium-water reaction and core melt down was in progress. Knowing this, it was unconscionable that an evacuation was not called for at 2 p.m.

Throughout the day of the accident the Defendant jeopardized public health and safety by knowingly relying on off-site surveys, which could not have accurately reflected the severity of the accident.

Conditions clearly warranted an evacuation under the ascribed emergency procedures. Had the State received accurate, complete, and timely information, it would have implemented its planned emergency evacuation. However, the fact that the Defendant provided misleading and false data prevented an evacuation from occurring.

FINDING 14 — Failure to Evaluate Releases

I have reviewed instrumentation data, dose measurements, the testimony at the In Limine hearing of Paul Blanch, Douglas Akers, and John Daniel (as well as the reports of these individuals), Dr. Richard Webb's deposition testimony and his June, 1993 treatise, and I conclude that the releases of radioactive isotopes were greater than as represented by defendants and their experts, and that one of several driving forces for the releases was a blowout, as well as through other pathways. The fact that the defendants failed to evaluate for the plausibility of a blowout and other pathways for releases was a departure from sound engineering principles. The failure of defendants to make the evaluations was consistent with their state of mind to minimize the severity of the accident. Yet defendants could not make a sound judgment of the accident severity without engaging in a full and detailed analysis of the releases and an evaluation of all release pathways. In fact, Defendants expert Daniel so testified at the In Limine hearing.

The Defendants' apparent blind reliance upon data from instruments that were tasked beyond their performance specifications and capabilities and on incomplete and inaccurate survey data was a departure from good science and contributed to their misinforming the public and the authorities regarding the severity of the accident.

An analysis of releases and alternative release pathways was warranted, but the defendants failed to make such an analysis in accordance with methodologies that were available to them and dictated by the circumstances.

To my knowledge, the defendants have never attempted to analyze whether a blowout occurred based upon principles of physics but have instead relied upon fallible data.

— End —

ENDNOTES

- ¹Amendment 65, Docket # 50-320, P 13A-5
- ²Ibid. ¶ 7.1
- ³Ibid. P 13A-5
- ⁴Radiation Emergency Procedure 1670.4 ¶1.0
- ⁵Deposition of Thomas Wright, July 7, 1979 (i.e. TMI Investigation Interviews) and Dr. Henry Myers, "A Report Prepared by the Majority Staff of the Committee on Interior and Insular Affairs", "Reporting of Information Concerning the Accident at Three Mile Island", March 1981.
- ⁶ Ibid.
- ⁷ Ibid.
- ⁸Dr. Henry Myers, "A Report Prepared by the Majority Staff of the Committee on Interior and Insular Affairs", "Reporting of Information Concerning the Accident at Three Mile Island", March 1981.
- ⁹Ibid.
- ¹⁰NUREG 0600
- ¹¹Ibid.
- ¹²Dr. Henry Myers, "A Report Prepared by the Majority Staff of the Committee on Interior and Insular Affairs", "Reporting of Information Concerning the Accident at Three Mile Island", March 1981. P 30.
- ¹³Ibid. P 39
- ¹⁴Ibid. P 45
- ¹⁵Ibid. P 51
- ¹⁶Ibid. P 53
- ¹⁷Dr. Henry Myers, "A Report Prepared by the Majority Staff of the Committee on Interior and Insular Affairs", "Reporting of Information Concerning the Accident at Three Mile Island", March 1981, P 44.
- ¹⁸Ibid. P 28
- ¹⁹Ibid. P 53
- ²⁰NUREG 0600
- ²¹Draft Report, William Fisher, NRC Investigator, 1981
- ²²NUREG 0760 / NUREG 0600
- ²³Deposition of Thomas Gerusky
- ²⁴Draft Report, William Fisher, NRC Investigator, 1981
- ²⁵Ibid.
- ²⁶Ibid.
- ²⁷Ibid.
- ²⁸TMI Station Procedure 1670.4
- ²⁹Dr. Henry Myers, "A Report Prepared by the Majority Staff of the Committee on Interior and Insular Affairs", "Reporting of Information Concerning the Accident at Three Mile Island", March 1981. P 53.
- ³⁰TMI Station procedures 1670.4
- ³¹Dr. Henry Myers, "A Report Prepared by the Majority Staff of the Committee on Interior and Insular Affairs", "Reporting of Information Concerning the Accident at Three Mile Island", March 1981.
- ³²Deposition John Collins, P 114

33 Ibid.

34 Ibid.

35 Draft Report, William Fisher, NRC Investigator, 1981

36 Ibid.

37 NUREG 0600 / NUREG 0760

38 Expert Witness Testimony, I. Vergeiner

39 Dr. Henry Myers, "A Report Prepared by the Majority Staff of the Committee on Interior and Insular Affairs", "Reporting of Information Concerning the Accident at Three Mile Island", March 1981.

40 Ibid. P 71

41 Ibid. P 117

42 Ibid. P 32

43 Dr. Henry Myers, "A Report Prepared by the Majority Staff of the Committee on Interior and Insular Affairs", "Reporting of Information Concerning the Accident at Three Mile Island", March 1981.

44 Dr. Henry Myers, "A Report Prepared by the Majority Staff of the Committee on Interior and Insular Affairs", "Reporting of Information Concerning the Accident at Three Mile Island", March 1981, P 54.

45 Ibid. P 32

46 Ibid. P 32

47 Ibid. P 121

48 Ibid. P 32

49 Ibid. P 121

50 General Emergency Procedure 1670.3