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## UNDERSTANDING THE THREE MILE ISLAND ACCIDENT

### Barriers to be overcome:

First, scientific information and public relations material must be converted into easily understood facts. A well-known example is: "An incident in which 100% of subject biota exhibited mortality response", means: "A nuclear accident in which all the fish died" (New York Times report of a U.S. Atomic Energy Commission Report, November 1974).

Second, the reports released to the public are designed to define the limits of insurance liability, protect property values, keep the public from losing faith in the nuclear industry, and reduce if possible the cost of clean up (by reducing fear and expectations). Officials attempt to ascertain the most serious affects directly attributable to the accident, and doing this involves numerous hidden assumptions and value judgements on the part of decision makers. These judgements are primarily economic and political.

Third, the numerous government regulations, some for normal operation, some for accident situations and some for accidents when the most vulnerable persons are removed (evacuations of pregnant women and children), makes it difficult to understand statements such as: "within government regulations".

Fourth, the burden of proof is on the victim, i.e. by custom no health effect is attributed to radiation unless all other causes can be ruled out and the number of victims is clearly beyond a normal range (average plus three standard deviations; 0.2% confidence interval).

Fifth, what is not being said is often more important than what is being said. For example, "there will be very few excess cancer fatalities," leaves unanswered questions about non-fatal cancers, cancers which were accelerated by exposure (these are not "excess"), benign tumors, and many other health effects.

### Sequence of the TMI Accident:

There were three major steps in the accident. The first involved a valve which stuck open causing a: "small break loss-of-coolant accident." During replacement of the water which had been lost, an operator turned off the Emergency Core Cooling System, (ECCS) erroneously thinking the core was covered. This was a combined human and instrument error, called an "ECCS failure." After the second error was discovered and water flow was restored, there was an overflow of the primary coolant water out of the reactor vessel, onto the containment floor and into the auxiliary building. This is called officially a "breach of containment."

### Chronology:

4:00 a.m. - The accident sequence began March 28, 1979 (Wednesday)

7:00 a.m. - The ECCS failed and radiation monitors in the vent stack registered 1000 rem per hour, their highest possible reading, reported as "going off-scale". There were 3 monitors off-scale in the vent stack and 5 in the pathways leading to the stack. The operator thought the instruments were incorrect. The regional Nuclear Regulatory Commission (NRC) Office was notified about 7:15 a.m. (2).

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9:00 a.m. - James Cox, Pennsylvania State Police announced a "general emergency" at the plant. "All radiation contained within the plant," said the Metropolitan Edison (ME) spokesperson. Later he admitted a "small leak".

10:00 a.m. - "no recordings of any significant leaks" (Blaine Fabian, ME). ME had 20 TLD's (thermoluminescent dosimeters) in various places near the site. They measured ground level contamination.

"On the day of the accident, 365 millerems (0.365 rem) of beta and gamma rays per hour were measured at ground level 1000 feet from the vent stack. Directly over the vent stack a helicopter measured three times that." Albert Gibson (NRC) (2)

NOTE: Only about 1% of the beta radiation would register on the TLD. Background radiation levels are about 0.000011 rem per hour.

11:00 a.m. - "They have not detected any significant radiation off site" Karl Abraham (Regional NRC) "There was very little wind this morning so the radioactivity shouldn't have gone far" Bill Dornsife (Penna. Dept of Environmental Resources). It was discovered that the State Civil Defense Dept. had no emergency plans or evacuation procedure ready. "There is no danger of a meltdown". (ME).

NOON: - "There was a small release of radiation to the environment...No increase in normal radiation levels outside the plant".

1:00 p.m. - "The radiation leak is equivalent to one millerem per hour" Bill Dornsife (Penna. Dept. of Environmental Resources). This is about 100 times normal. (One millerem is .001 rem).

2:00 p.m. - "Some workers may have been contaminated", Jack Herbein (ME)

3:00 p.m. - "Monitoring at the edge of the 200 acre plant site shows an increase of 2 to 3 millirems per hour in radiation levels." Walter Creitz (President of ME). This is equivalent to the bone marrow dose of one chest x-ray per hour. Only 1% of the beta dose, not of course given with a chest x-ray, and none of the inhaled dose are included in the estimate.

Turbine shine, direct gamma irradiation from the reactor building was measured a mile away (NRC). The plant's walls are 4 feet thick, due to citizen pressure for extra safety since the plant is on the flight path of the Harrisburg airport. The radiation penetrated this wall(3).

5:00 p.m. - Admission of extremely high levels of radiation within the reactor building, Joe Fouchard (NRC). "Some damage to the cladding may have occurred", Leonard Matt (General Public Utilities).

7:00 p.m. - "Radiation levels inside the reactor dome are 1000 times "normal" (i.e. normal for nuclear reactors which is about 5 to 6 Roentgen per hour)", Edson Case (NRC). "Some low level release of radioactive gas beyond the site boundary...the company does not believe the level constitutes a danger to health and safety of the public." (General Public Utilities).

10:00 p.m. - George Troffer disputes NRC estimate that rates are 1000 times

plant-normal rates, and states they are only 10 times plant-normal. NRC reports radiation could be measured 16 miles from the plant, but denies damage to core. Radiation levels "are high but not yet critical" James Higgins (NRC)

7:00 a.m. - March 29, 1981 (Thursday). The plant is safely shut down and the level of radiation released "would not endanger or injure any people." Walter Creitz (President ME). It was of course, months before plant shutdown (4).

Governor Richard Thornburgh, Penna., advised pregnant women and young children in a five mile radius of the plant to stay inside on Thursday. On Friday he requested their evacuation.

An Ad Hoc Committee composed of staff from the Nuclear Regulatory Commission, the Environmental Protection Agency and the Food and Drug Administration prepared a booklet on dose to the public from the accident (5). The accident was defined as the events between March 28 to April 7, 1979 and the radiation exposure estimates were based on measurements taken during that time. There were about 30 measurements made per day on the plant site and within the three mile radius. No study was done to determine whether or not the places or timing of the measurements were appropriate. Often they were made when wind was shifting or radiation emissions were not at their peak. Based on this data the Ad Hoc group estimated that the maximum dose to the public was 100 millirem penetrating radiation. This means the dose to bone marrow was equivalent to 17 to 50 chest x-rays (6).

#### Estimated Radiation Dose to the Population:

Using the same measurements, the Ad Hoc group calculated a dose to the general public, adding up the estimated individual doses for each of the 2 million people in the 50 mile radius of the plant. This sum of doses is called the person rem dose to the population. No actual measurements were taken out to 50 miles. Rather, these doses were estimated assuming the dose dropped off exponentially with distance (7). Two sets of estimates were made:

(1) Using dosimeters within 8 miles of the plant:

1,600 person rems (ME) - 15 TLD's  
2,800 person rems (NRC) - 20 TLD's

(2) Using all dosimeters:

3,300 person rems (ME) - 20 TLD's  
5,300 person rems (NRC) - 37 TLD's

Based on these estimate of dose, officials have maintained that any increase in cancer mortality in the area would be undetectible (8).

Dr. Joseph Califano, then director of the U.S. Department of Health, Education and Welfare, said that at least one to ten excess cancers would be caused by the accident, and 10 non-fatal cancdrs (9).

#### Maximum Dose to the Individual:

Problems with the official estimate that the public received a maximum of 100 millirem radiation exposure include:

1. No estimate was made of sampling errors due to incorrect placement of monitors relative to wind directions.
2. Only the utility company's 20 TLD's were in place the first 3 days the accident. On Saturday, March 31, 37 TLD's (NRC) and rate-meters from the Nevada Test Site were added. Measurement of the first three day seriously underestimate the dose.
3. It was artificial to cut-off "accident" measurements on April 7, 1979. The people around the TMI still being exposed to radioactive gas venting and food pollution.
4. Background measurement was set too high. Doses received by the same population in March - April 1978 were subtracted. These included a Chinese weapon test, an operating nuclear reactor, and a new reactor being started up. Dose attributed to the accident was wrongly reduced by this method.
5. TLD's were evaluated by Radiation Management Inc., a company with close corporate ties with General Public Utilities and Metropolitan Edison.
6. The 100 mrem maximum dose underestimates true dose which includes beta skin and lung exposures, and all internal exposure due to ingested radionuclides.
7. TLD's have been shown to be unreliable measures of radiation exposure (10).

#### Population Dose:

Since estimation of population dose is based on the same readings used to measure individual doses, they share in all of the same basic weaknesses and biases for underestimation.

In addition to these problems, it should be pointed out that for both the ME and NRC estimates of population dose there was an increase when TLD's placed more than 8 miles from the plant were added. This means that the exponential drop off in exposure with distance did not hold true.

On June 22, 1979, Albert Gibson of the NRC testified that most of the radiation that escaped through the vent stack came through open relief valves and leaking pipes and valves. "Until, yesterday, the NRC had thought most of the escaped radiation was gas that had bubbled out of the contaminated water on the floor of the auxiliary building." He said that as much as 80% of the radiation escaped through the stack at the beginning of the accident when the monitoring devices went off-scale. (The Washington Post 6.22.79). This radioactive material would deposit at a greater distance from the plant.

Dr. Seo Takeshi, Nuclear Reactor Test Center, Kyoto University, Japan, estimated both on the basis of reported TLD's and on the basis of estimated curies of gases released that the population dose estimate should be about 16,200 Person Rems - about 4 times higher than was admitted (11).

The only other radioactive chemical emitted which the NRC measured was I 131. They admit to releasing about 14 curies. Measurement of radioactive iodine in milk, cow and goat, reached a maximum of 36 to 41 pCi (pico-curies) per liter respectively (5). In a systematic sampling of meadow voles (*Microtus pennsylvanicus*), researchers from Millersville State College and the Hershey Medical Center, found the thyroid glands of the voles caught 1.9 km downwind of the plant had significantly more radioactive iodine than those caught at other sites. The level of radioactive iodine in milk was roughly five or six times the present residual U.S. level in the fall-out path of the nuclear tests in Nevada.

Dr. Takeshi calculated that the total amount of iodine released was over 5,100 curies -- 364 times the official estimate -- but he included time periods beyond April 7, 1979.

Radioactive iodine would tend to store in the human thyroid gland. It can destroy the thyroid cells, causing a decrease in thyroid hormone production. In a fetus this causes mental and physical retardation. June 20, 1978, the State of Pennsylvania initiated a registry for infant hypothyroidism. The occurrence rate was as follows:

Hypothyroidism in Newborn's per 10,000 Births

<u>Time</u>	<u>Penna. West</u>	<u>Penna. East</u>
June 20, 1978 to March 28, 1979	1.5	1.5
March 28, 1979 to December 31, 1979	1.3	3.3
January 1, 1980 to August 31, 1980	1.4	3.6

Hypothyroidism is not considered a "health effect of concern", even though it can cause severe transmittable genetic defects. Hypothyroidism is probably a teratogenic non-transmittable effect in these children.

CANCERS CAUSED:

Since we are trying to estimate the number of cancers caused on the basis of the population dose, we have two sources of error. One source of error is dose estimate, which may be too low by a factor of four for the eleven day period. It might also be too low by a factor of 300 to 400 if the time of the accident is extended until the whole critical part of the episode was over in June. This extension does not include the clean-up exposures which will continue for at least another five years.

Cancer estimates used in official reports were based on the BEIR Committee 1972 calculations, which may be too low by a factor of 16 to 20. (12,13,14).

This means that the total error may be as much as 80 for the first nine day period, or 6,000 (18 X 350) for the entire accident.

Corrected for errors, the prediction of radiation induced fatal cancers caused by releases of radiation between March 28, 1979 and April 7, 1979 becomes 80 to 800. If the time of the accident is extended to June, 1979, the numbers become 6,000 to 60,000 cancer fatalities induced by the exposure. These do not include exposures from the clean-up.

During the accident higher radiation readings occurred in Syracuse, New York, in southern Maine and in Canada, all well beyond the 50 mile radius of the plant, hence these corrected estimates may be considered very conservative. They do not include possible cancers beyond the 50 mile radius.

#### Will the Cancers be Recognized

There will probably never be a record of the total extent of the radiation damage to human health near TMI for one or more of the following reasons:

- (1) The vast amount of damage is considered not important for liability or societal economic concern so it is not recorded. Only cancers are counted.
- (2) This accident involved skin cancers, and only non-melanoma skin cancers are now counted (15).
- (3) The State of Pennsylvania has very poor health records, so a special project lasting at least 50 years would have to be set up. It is unlikely to be set up, or to include all health effects if set up.
- (4) Most cancers are of mixed cause, including hereditary susceptibility and exposure to environmental mutagens of various kinds. Radiation promoted cancers are not counted.
- (5) The most widespread health effects to be expected is acceleration of aging. The individual cannot detect this and the government is not measuring it.
- (6) Between 100,000 and 200,000 residents in the TMI area have moved away and will not be part of the record keeping.
- (7) The victim does not know the cause of his/her cancer.

#### The Controversy over Infant Deaths:

Gordon McLeod, M.D., was appointed Commissioner of Health for Pennsylvania twelve days before the accident occurred. The State Department of Health was and is suffering from lack of money. The Department budget had gone from 2.24% of State funding in 1968, to 1.04% in 1979. After the TMI accident there was a further cut-back in health allocations to 0.84% of the State budget. State budget was itself falling behind inflation. Dr. MacLeod tried to protect the public health as well as possible during the accident.

One major dilemma was that no potassium iodide was ready for distribution at the time of the accident. On Friday, 60 hours after the TMI accident began, Joseph Califano ordered it prepared. The medicine arrived five days after the accident and was not in tablet form. The medicine was never distributed to the public apparently for public relations reasons.

Dr. MacLeod asked to testify before the Kemmeny Commission which had been appointed by President Carter to study the accident. The Commission did not have time to hear his testimony. Dr. MacLeod was fired in October 1979, and replaced with a new Health Commissioner who prepared the official report on infant deaths after the accident (16).

The first report on infant mortality changes around TMI was done by Dr. Ernest Sternglass, and was presented at the 5th World Congress of Architects, Tel-Aviv, Israel, January 25, 1980.

The new director of Health, Dr. H. Arnold Muller, in Pennsylvania rejected Sternglass's report saying numbers officially submitted by the State to the Federal Government were incorrect "due to a clerk's error." Dr. Muller drew up a new report, infant mortality in 1979, and released it to the press May 19, 1980. This report has been used extensively by the nuclear industry as public relations material (17). Muller's report does not include either the infant data on persons who moved from the Harrisburg area, or any fetal deaths prior to 17 weeks. Dr. Gordon MacLeod has said publically that the numbers in this second report have been manipulated (16). This can be ascertained even by inspection.

According to Dr. MacLeod, there are 88 births in the TMI area between July 1 and September 30, 1979 unaccounted for in the Health Department report. There are also no indications of the nature or severity of the birth defects involved. The long term genetic effects of the radiation exposure have not even been mentioned in official reports (18, 19).

#### The Accident was not "Extraordinary"

The U.S. Atomic Energy Act, 1954, defined an "extraordinary nuclear occurrence" as:

"...any event causing a discharge of source, special nuclear, or by-product material from its intended place of confinement in amounts offsite, or causing radiation levels offsite, which the Commission determines to be substantial, and which the Commission determines has resulted or will probably result in substantial damages to persons offsite or property offsite."

The Commission has determined that the TMI accident was not an "extraordinary nuclear event" (20). This will make it difficult, if not impossible, for citizens to claim compensation for damages incurred.

#### Damage to Plants and Animals

Reports of dead trees and foliage were handled unscientifically. A list of trees together with a "possible cause of death" was drawn up without overall consideration of this down-wind phenomenon coinciding with the TMI accident.

Animal illnesses were declared not attributable to the accident."

"The level of radiation exposure as calculated for the worst case (at Middletown) 100 mrem, was less than 1/1000 of that which might have caused clinically detectable effects in the

animal population that was exposed to radiation. Furthermore, there was no apparent relationships between the reported problems and the predominant wind pattern during the accident" (21).

What the researchers at TMI failed to understand is the animal susceptibility factor probably due to exposures to radiation prior to the TMI accident. TMI unit one had been operating several years, and the animals had been exposed to residue from fall-out from above ground weapon tests (18, 19).

The same animal report says of humans:

"In humans, 50 rems or less of whole body radiation generally produces no obvious signs of injury. At 100 rems a small percentage of people will show mild blood changes; at 200 rems most people will show blood changes and the most sensitive will die. At 600 rem or more almost all will die." (p. 13)

The fact that some elderly humans or very young children, might be very vulnerable to a sudden change in the radiological environment seems not to have occurred to the researchers.

Such built-in judgemental bias on the part of researchers also stems from a legalistic approach to attributing damage. The victim is in a sense blamed for being unfit to resist exposure due to poor nutrition, old age, underlying disease, etc. These latter are designated the "cause of death," not the radiation exposure which "should not have killed them."

It should be pointed out that exposures to nuclear fall-out permitted to military men (selectively chosen for good health) at the Nevada Test Site should not have caused leukemia increase. However in a recent report which studied only one test and only leukemia, rates were found to be 3.5 times normal (22). Normal was for the total male population, not a comparable group of men selected for good health, so this is an underestimation of the problem. These military men all had exposures reported to be below 3 rem.

#### The Kemeny Commission

President Carter appointed an eleven person commission in April 1979 to: "learn the causes of this accident (TMI) and make sure that the safety of our citizens is never again endangered in this way." The President said he would carry out the recommendations "if they were at all practical." He added:

"I think it would be incumbent on me as president to explain to the American people the situation that does exist with nuclear power.

There is no way that our country can close down nuclear power plants." (23)

The Commission, headed by John G Kemeny, president of Dartmouth College and former scientist on the first nuclear bomb project, obligingly made recommendations which were "practical." They stressed the need for evacuation plans and called for reorganizing the bureaucracy.

The panel members did not have the opportunity to hear testimony from persons dissenting from the basic radiation exposure report by the Ad Hoc Group. They assumed health effects were unimportant and concentrated on other aspects of the problem.

As a member of the Citizen's Advisory Committee to the Kemeny Commission, I requested information on total fission products released during the accident and on whole body counts done on members of the public in late April 1979. Senior Staff of the Commission felt that release of this information to advisors: "might interfere with the objectivity of the panel."

The advisors were expected to give advice on who should pay for the accident, and how the nuclear industry could best restore public faith in nuclear power plants.

Dr. Kemeny then "dissolved" the Citizen Advisory Committee, and later even denied having formed it.

The Kemeny report is in my opinion a total cover-up with respect to health effects.

Further Information:

For technical information on the TMI accident see: Spectrum, November 1979. This issue of the Journal of the Institute of Electrical and Electronics Engineers, deals exclusively with the engineering problems related to the episode.

For ongoing information on the clean-up operations contact:

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Environmental Coalition on Nuclear Power  
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State College, Pa. 16801. U.S.A.

There is also an excellent film on TMI called "We Are the Guinea Pigs", available on 16 mm or video tape, from:

The Other Cinema  
79 Wardour Street  
London, England W1V 3TH  
Phone: 01-734-8508

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2. Washington Post, June 22, 1979, gives details of the morning of the accident.
3. Eventually the measurement of radiation inside the containment was determined to be 30,000 R on the average. Measurement near the containment wall, on the outside, were 30R. Attenuation was about 1000-fold.
4. Names and quotations are from Associated Press reports during the accident.
5. Population Dose and Health Impact of the Accident at Three Mile Island Nuclear Station. May 10, 1979. U.S. Government Printing Office document number 017-001-00408-1.
6. Bertell, R. Measurable Health Effects of Diagnostic X-ray Exposure. Testimony before Subcommittee on Health and the Environment, Committee on Interstate and Foreign Commerce, U.S. House of Representatives. U.S. Government Printing Office, document number 95-180.
7. The most distant monitoring stations for Metropolitan Edison's measurements were 15 miles S.E., and 15 miles N.W. Eleven of their 20 stations were less than one mile from the nuclear station.
8. "Even the highest figure, 5300 person-rem, represents an insignificant addition of radiation over what the population in this area would normally receive." Press release, U.S. Department of Health, Education and Welfare, May 12, 1979. Contact person, Wayne Pines.
9. New York Times. May 4, 1979, "Califano now says a Cancer Death from Nuclear Accident is Possible."
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13. Morgan, K.Z., "Cancer from Low Level Ionizing Radiation." The Bulletin of the Atomic Scientists. September, 1978.
14. Bertell, R. The Nuclear Worker and Ionizing Radiation. American Industrial Hygiene Association Journal. May 1979.
15. See Cancer Facts of 1979. American Cancer Society publication.
16. Dr. MacLeod related this at a public meeting of the New York Chapter of Physicians for Social Responsibility, November 22, 1980. Columbia University International Affairs Auditorium.
17. A copy is enclosed as an appendix to this paper.
18. Muller, H. Radiation and Heredity. American Journal of Public Health. January 1964.

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19. Bertell, R. Radiation Exposure and Human Species Survival. Committee on Federal Research into the Biological Effects of Ionizing Radiation, Working Papers, March 10-11, 1980. Request copy from NIH Bldg., 1, Room 103, Bethesda, Md. 20205.
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